International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0197
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1308 - 1313

Knowledge, Perception, and Barriers to-wards Low-Flow Anaesthesia and Modern Anaesthesia Workstations among Anaesthesia Technologists: A Survey Study

Vinod AM[1], Sandhya S[2], Sheba Cherian[3], Ameya Raj KP[4], Chethan CR[5], Jovita[6]

[1,2,3]Assistant Professor – Anaesthesia and Operation Theatre Technology, Yenepoya School of Allied and Health Care Professions, Yenepoya (Deemed to be university), Bangalore, Karnataka.

[4,5,6]Post Graduate – Anaesthesia and Operation Theatre Technology, Yenepoya School of Allied and Healthcare Professions, Yenepoya (Deemed to be University), Bangalore, Karnataka.

EmailID: *vinodam.blr@yenepoya.edu.in[1], sandhyas.blr@yenepoya.edu.in[2], shebacherian.blr@yenepoya.edu.in[3], 33161@yenepoya.edu.in[4],39128@yenepoya.edu.in[5], 46727@yenepoya.edu.in[6]*

Abstract

Low-flow anaesthesia (LFA) has become increasingly feasible with the advancement of modern anaesthesia workstations and provides significant economic, environmental, and clinical benefits. Despite these advantages, the adoption of low-flow anaesthesia in routine clinical practice remains inconsistent. This inconsistency may be attributed to gaps in knowledge and perception among anaesthesia providers, along with institutional, technical, and safety-related barriers. This study aims to assess the knowledge, perceptions and barriers regarding low-flow anaesthesia and the utilization of modern anaesthesia workstations among anaesthesia technologists. The study aims to identify knowledge and perception gaps regarding low-flow anaesthesia and to highlight institutional, technical, and safety-related barriers that affect its routine practice. Anaesthesia technologists are anticipated to demonstrate modern knowledge of low-flow anaesthesia with variable practice patterns influenced by factors such as inadequate training, monitoring concerns, and institutional constraints.

Keywords: *Anaesthesia Technologists; Barriers; Knowledge; Low-Flow Anaesthesia; Modern Anaesthesia Workstations; Perception.*

1. Introduction

Use of volatile anaesthetics during general anaesthesia was formally introduced after the discovery of nitrous oxide as an inhalational anaesthetic by WTG Morton. The low-flow anaesthesia technique was widely used because of its simplicity, but in the early times, it lacked adequate monitoring, which led to complications and death. It also posed a major challenge because anaesthetic concentrations could not be measured, and the depth of anaesthesia could not be accurately assessed. Improved monitoring led to the development of low-flow anaesthesia, where reduced fresh gas flows provide adequate anaesthetic delivery while minimising wastage and offer economic savings upto 80%, which even reduces environmental pollution [1].Low-flow anaesthesia is commonly defined as FGF less than 1L per min, and minimal flow anaesthesia as Fresh Gas Flow less than 0.5L per min [2].Otherwise, FGF less than alveolar ventilation can be considered as LFA. Modern anaesthesia workstations with integrated gas analysers and monitoring tools have simplified the application of low-flow anaesthesia by enabling real-time assessment of anaesthetic concentration and MAC. These advancements help individualise anaesthesia delivery while improving efficiency and safety. Although LFA is experiencing renewed interest, its global implementation remains limited in resource-restricted settings due to financial and infrastructural constraints [3].Unnecessarily high fresh gas flow rates and the avoidance of N_2O can reduce the environmental impact of inhaled anaesthetics [4].

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0197
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1308 - 1313

Understanding the current practice patterns will help identify gaps in infrastructure, monitoring, and knowledge, thereby guiding improvements in anaesthesia practice and environmental safety. Therefore, our study aims to assess the awareness, practice patterns, and monitoring methods related to low-flow anaesthesia and the use of modern anaesthesia workstations among anaesthesia providers to identify areas that require improvement.

2. Method

This study was designed as a questionnaire-based survey among anaesthesia technologists regarding their knowledge, perceptions, clinical practices, and barriers related to low-flow anaesthesia and the use of modern anaesthesia workstations. This study was carried out by circulating online forms to anaesthesia technologists working in various hospitals. A validated questionnaire was taken, which contains 16 questions related to demographic details, use of workstations, practice of low flow anaesthesia, etc. [3] the participation was voluntary, and the identity of the participants was kept confidential. The full version of the questionnaire was checked for relevance, comprehensiveness, and content validity before the beginning of data collection. Participants who expressed interest in the study were enrolled, and those with missing information were excluded. Statistical analysis of the survey responses was done using JAMOVI 2.7.24.Shows Table 1 Demograph Table 2 Demographics Distribution of responses to knowledge-based questions Shown as FIGURE 1 Graphical Representation of Participants' Perception Regarding Low-Flow Anaesthesia Figure 2 Graphical Representation of Utilisation of Anaesthesia Equipment

Table 1 Demograph

Demographics	n	n%
Experience (in years)		
0-5	128	65.3
5-10	51	26
10-15	16	8.2
15-20	1	0.5
State/Region of practice		
Andhra Pradesh	1	0.50
Tamil Nadu	18	9.3
Delhi	1	0.50
Karnataka	141	71.90
Kerala	26	13.20
Pondicherry	1	0.50
Telangana	8	4.10
Gender		
Female	85	43.4
Male	111	56.6
Subspecialty		
Cardiac and Vascular	51	26
Critical care	29	14.8
General	103	52.6
Neuro	1	0.5
Oncology	1	0.5
Paediatric Anaesthesia	11	5.6
Practice setting [Government institution]		
Non-teaching	9	25.7
Teaching	26	74.3
Practice setting [Private institution]		
Non-teaching	109	67.7
Teaching	52	32.3

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0197
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1308 - 1313

Table 2 Demographics Distribution of responses to knowledge-based questions

Knowledge section	n	n%
What is the fresh gas flow rate you use?		
0.5-1L	70	35.70
0.5L	25	12.80
1-1.5L	35	17.90
1.5-2L	10	5.10
<0.5L	56	28.60
How long after induction do you decrease the flow to low flow?		
10 m	47	24.00
15 m	133	67.90
20 m	16	8.20
What concentration of oxygen do you use when practising low-flow anaesthesia?		
30-40%	91	46.40
41-50%	102	52.00
51-60%	3	1.50
Please specify the agent of your choice while practising low-flow anaesthesia		
Isoflurane	5	2.60
Sevoflurane	191	97.40

FIGURE 1 **Graphical Representation of Participants' Perception Regarding Low-Flow Anaesthesia**

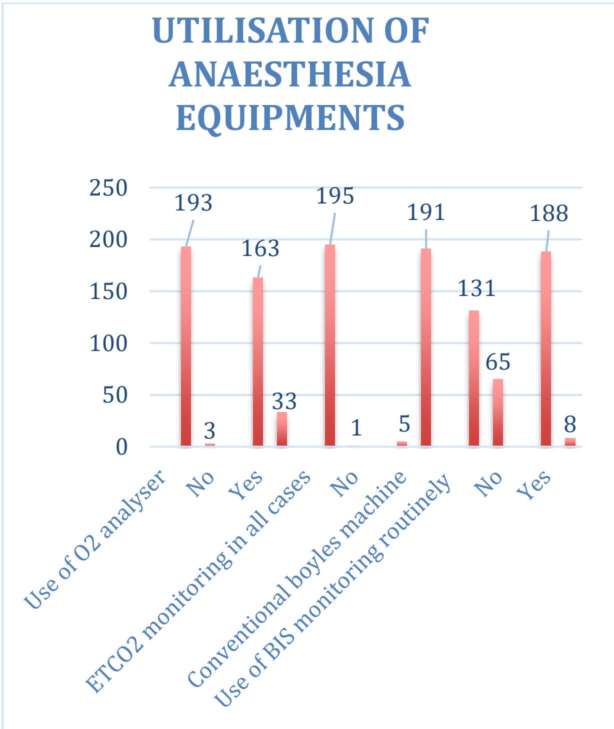

Figure 2 **Graphical Representation of Utilisation of Anaesthesia Equipment**

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0197
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1308 - 1313

3. Results

The research involved 196 anaesthesia technologists who took part in the research study. The average experience of participants in anaesthesia reached 5.13 years with a standard deviation of 3.41 years, while most participants (65.3%) had between 0-5 years of experience, which included 56.6% male and 43.4% female participants. The majority of respondents practised in private institutions, which included non-teaching hospitals as their primary work sites. The government hospital practitioners made up a smaller fraction of the total workforce. The study found that 85.2% of technologists applied low-flow anaesthesia practices as their standard procedure, while 14.8% of them rejected this practice. The study found that 35.7% of participants used fresh gas flow rates between 0.5 and 1L/min, while 28.6% used <0.5L/min and 17.9% used 1-1.5L/min, and 12.8% used 0.5L/min, and 5.1% used 1.5-2L/min. Technologists used 67.9% of the time to reduce flow after 15 minutes of induction, while 24.0% of technologists reduced flow after 10 minutes, and 8.2% reduced flow after 20 minutes. Participants demonstrated good practice adherence through stepwise flow reduction, which 99.5% of them reported as their practice method.The study found that monitoring practices achieved exceptional performance because oxygen analysers reached 98.5% usage, agent analysers achieved 83.2% usage, and ETCO2 monitoring reached 99.5% usage. Air served as the main carrier gas for 90.3% of users, while only 9.7% of users chose nitrous oxide. The study found that 97.4% of participants operated contemporary anaesthesia workstations, while only 2.6% used standard Boyle's machines. Advanced monitoring systems included a MAC display (87.8%), Scavenging systems (95.9%), and BIS monitoring (33.2%). The most common practice among technologists involved 52.0% usage of 41 to 50% oxygen, whereas 46.4% chose 30 to 40% oxygen, and only 1.5% used oxygen concentrations between 51% and 60%. The results indicate that patients generally prefer to use moderate oxygen levels during their low-flow anaesthesia treatment.

Sevoflurane (59.2%) and isoflurane (40.8%) represented the most common volatile agents, yet when asked about specific usage patterns.

4. Discussion

The study explored the comprehension and views, as well as challenges encountered by anaesthesia technologists when utilising LFA and modern anaesthesia workstations. It was found that 85.2% of respondents showed their acceptance of low-flow anaesthesia since they used it in their daily tasks. The growing awareness of LFA's cost-effective and environmental benefits indicates that people understand how LFA decreases anaesthetic agent use and operating room environmental damage [5,6].

Most participants reduced their fresh gas flow approximately 10 to 15 minutes after anaesthesia induction because this timing aligns with established guidelines that suggest this step following denitrogenating and once anaesthesia depth stabilises. The gradual reduction method, which 99.5% of practitioners use, demonstrates that most doctors adopt safe transition techniques to prevent hazards such as hypoxia or insufficient anaesthesia [7]. Real-time notification effectively lowers inhalational agent use by reducing unnecessary FGF's [8].The adoption of LFA demonstrated widespread use among healthcare professionals, and observed flow rates fluctuated throughout the practice. Most healthcare professionals used flow rates between 0.5 and 1L/min, while a smaller subset opted for ultra-low flows below 0.5L/min, and some practitioners maintained higher flow rates. The application of LFA reflects high knowledge levels among people who understand the concept, yet the actual use of LFA shows gaps between different users. The research indicates that individuals display varied preferences influenced by their educational background, personal comfort, organisational protocols, and safety risk evaluation. The research shows that the participants followed essential monitoring requirements through their implementation of oxygen analysers, capnography and agent monitoring systems. Maintaining continuous monitoring is crucial in LFA, as it ensures patient safety by detecting hypoxia and insufficient anaesthetic agent delivery. Modern anaesthesia workstations enable safe LFA operations through their designs, which include an accurate flow control system [9]. Anaesthesia providers' knowledge and motivation to practice sustainable methods are increased through training. This leads to increased awareness and practice of low-flow anaesthetic agents and low environmental impact agents, which reduce environmental harm. Sustaining eco-friendly anaesthesia and reducing emissions related to healthcare services requires training and support [10].

Conclusion

The study reveals that LFA is a common practice, reflecting a high degree of awareness and a positive perception of the clinical and environmental benefits of low flow anaesthesia. A high percentage of respondents used modern workstations, but variations in FGF and inadequate use of advanced monitors reflect that optimum utilisation of the technology is still not achieved.Though the transition to LFA is well established, it is important to bridge the gap between knowledge and clinical practice to achieve the clinical, economic, and environmental benefits of low flow anaesthesia.

Acknowledgement

The authors would like to acknowledge Yenepoya (Deemed to be University) for providing the necessary support and resources to conduct this study. No external funding was received for this research.

References

[1] Zilberman, P. (2024). Evolution of low-flow anaesthesia. Indian Journal of Anaesthesia, 68(7), 590-591.
[2] Baxter, A. D. (1997). Low and minimal flow inhalational anaesthesia. Canadian journal of anaesthesia, 44(6), 643-653.
[3] Amma, R. O., Ravindran, S., Koshy, R. C., & Krishna, K. J. (2016). A survey on the use of low flow anaesthesia and the choice of inhalational anaesthetic agents among anaesthesiologists of India. Indian Journal of Anaesthesia, 60(10), 751-756.
[4] Ryan, S. M., & Nielsen, C. J. (2010). Global warming potential of inhaled anaesthetics: application to clinical use. Anaesthesia & Analgesia, 111(1), 92-98.
[5] Samad, K., Yousuf, M. S., Ullah, H., Ahmed, S. S., Siddiqui, K. M., & Latif, A. (2025). Anaesthesia and its environmental impact: approaches to minimise exposure to anaesthetic gases and reduce waste. Medical Gas Research, 15(1), 101-109.
[6] Samarth, B. S. (2025). Low flow anaesthesia in India: Balancing clinical efficiency, economic viability, and environmental responsibility. IJMA, 8(4), 74-76.
[7] Tanner, M. (2025). High vs Low FiO2: Are Anaesthesia Providers Continuing to Practice Conservative Methods of Intraoperative FiO2 Administration? (Doctoral dissertation, Franciscan Missionaries of Our Lady University).
[8] Nair, B. G., Peterson, G. N., Neradilek, M. B., Newman, S. F., Huang, E. Y., & Schwid, H. A. (2013). Reducing wastage of inhalation anaesthetics using real-time decision support to notify of excessive fresh gas flow. Anaesthesiology, 118(4), 874-884.
[9] Ehrenwerth, J., Eisenkraft, J. B., & Berry, J. M. (2020). Anaesthesia Equipment E-Book: Principles and Applications. Elsevier Health Sciences.
[10] Harms, B. A. (2025). Operating Room to Ozone: Advancing Sustainability in Inhalational Anaesthesia–A QI Project (Doctoral dissertation, The University of Arizona).
[11] Feldman, J. M. (2012). Managing fresh gas flow to reduce environmental contamination. Anaesthesia & Analgesia, 114(5), 1093-1101.
[12] Grigoliia, G. N., Makhatadze, T. A., Sulakvelidze, R., Tutberidze, N., & Gvelesiani, L. G. (2007). Theory and practice of low-flow anaesthesia. Georgian Medical News, (145), 7-12.
[13] Dastan, R., Celik, H. K., & Doganay, Z. (2023). High, low, and minimal flow anaesthesia management: effects on oxygen reserve index and arterial partial oxygen pressure. J Coll Physicians Surg Pak, 33(11), 1223-8.
[14] Darrow, A. G. (2023). Environmental Stewardship in Anaesthesia: An Educational

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2026.0197
e ISSN: 2584-2854
Volume: 04 Issue: 05
May 2026
Page No: 1308 - 1313

[15] Intervention for Clinicians (Doctoral dissertation, The University of Arizona).
[16] Upadya, M., & Saneesh, P. J. (2018). Low-flow anaesthesia–underused mode towards "sustainable anaesthesia". Indian journal of anaesthesia, 62(3), 166-172.
[17] Baum, J. A., & Aitkenhead, A. R. (1995). Low-flow anaesthesia. Anaesthesia, 50, 37-44.
[18] Suttner, S., & Boldt, J. (2000). Low-flow anaesthesia: does it have potential pharmacoeconomic consequences? Pharmacoeconomics, 17(6), 585-590.
[19] Baum, J., & Stanke, H. G. (1998). Low Flow- und Minimal Flow-Anästhesie mit Sevofluran. Der Anaesthesist, 47(Suppl 1), S70-S76.
[20] Cherian, A., & Badhe, A. (2009). Low-flow anaesthesia at a fixed flow rate. Acta anaesthesiologica scandinavica, 53(10), 1348-1353.
[21] Carter, L. A., Oyewole, M., Bates, E., & Sherratt, K. (2019). Promoting low-flow anaesthesia and volatile anaesthetic agent choice. BMJ Open Quality, 8(3).
[22] Möllhoff, T., Burgard, G., & Prien, T. (1996). Low-flow and minimal-flow anaesthesia using the laryngeal mask airway. European journal of anaesthesiology, 13(5), 456-462.
[23] Cotter, S. M., Petros, A. J., Dore, C. J., Barber, N. D., & White, D. C. (1991). Low-flow anaesthesia: Practice, cost implications and acceptability. Anaesthesia, 46(12), 1009-1012.
[24] Nunn, G. (2008). Low-flow anaesthesia. Continuing Education in Anaesthesia, Critical Care & Pain, 8(1), 1-4.
[25] Kennedy, R. R., Hendrickx, J. F., & Feldman, J. M. (2019). There are no dragons: low-flow anaesthesia with sevoflurane is safe. Anaesthesia and Intensive Care, 47(3), 223-225.