IJACT, Volume 4, Issue 04, 2026 | ISSN: 2995-5378
http://medicaljournals.eu/index.php/IJACT

INTERNATIONAL JOURNAL OF ALTERNATIVE AND CONTEMPORARY THERAPY

The Prevalence of Inhalational Anesthetics: Investigating its Effect and Remedies in our Environment

Dr Ogechi Chioma Otty, MBBS[1]
Hull University Teaching Hospital NHS Trust Internal Medicine United Kingdom

Ojum S.[2]
Department of Anaesthesia, Rivers State University Teaching Hospital, Port Harcourt

Nkechi Udochukwu Otty[3]
Environmental Health Science School of Health Technology Federal University of Technology, Owerri

Abstract: This study examined the prevalence of Inhalational Anesthetics: Investigating its Effect and Remedies in our Environment. In carrying out this study descriptive survey design was adopted. The study was carried out in Imo State, Nigeria. The targeted population for the study consisted of Public Health Doctors and Environmental Scientists in Imo State, Nigeria. A stratified sampling technique was used in selecting 70 Public Health Personnel and 60 Environmental Scientists in Imo State. This gave a total of 130 respondents which formed the sample size for this study. The instrument used for data collection was a structured questionnaire titled "Inhalational Anesthetics and Environment Questionnaire" (IAEQ). Face and content validation of the instrument was carried out by an expert in test, measurement, and evaluation in order to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.92, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical technique such descriptive statistics to answer research questions. The result of the findings revealed that the extent of inhalational anesthetics in the environment was very high, with 36.15% of respondents indicating Very High Extent and 29.23% indicating High Extent "The study also revealed that monitoring of Minimum Alveolar Concentration (MAC) recorded the highest percentage (29.23%) among the identified control strategies for inhalational anesthetics, while environmental and occupational control strategies recorded the least percentage (10.67%)." The study concluded that although inhalational anesthetics remain essential in modern medicine, their safe use requires strict regulation, technological improvement, and environmental management to minimize adverse health and ecological impacts while maintaining clinical effectiveness. The study recommended that governments and healthcare institutions should promote the use of modern low-toxicity anesthetic agents and encourage research into safer alternatives to reduce environmental and health impacts.

Keywords: Inhalational Anesthetics, Remedies, Environment.

Introduction

Inhalational anesthetics are widely used agents in modern medical practice for inducing and maintaining general anesthesia during surgical procedures. These agents, such as sevoflurane, isoflurane, desflurane, and nitrous oxide, are administered through inhalation and act primarily on the central nervous system to produce unconsciousness, pain relief, and muscle relaxation. According to Miller, Widrich & Theodore [1], inhalational anesthetics remain essential in surgical care because of their rapid onset, controllability, and effectiveness in maintaining stable anesthesia during operations. However, their widespread use has also raised concerns about occupational exposure, environmental impact, and possible health effects on patients and healthcare workers.

The prevalence of inhalational anesthetics in healthcare environments has increased significantly due to the growing number of surgical procedures and the advancement of modern anesthesia delivery systems. These agents are commonly used in hospitals, operating theatres, and emergency care settings because they allow precise control of anesthesia depth. Recent clinical literature highlights that while inhalational anesthetics are generally safe when properly administered, continuous exposure—especially in poorly ventilated environments—may pose health risks such as respiratory irritation, cardiovascular effects, and potential neurocognitive changes [2]. This makes it important to investigate both their therapeutic benefits and associated risks in different clinical and environmental settings.

In addition to clinical concerns, increasing attention has been given to the environmental and occupational effects of inhalational anesthetics. Studies show that trace gas emissions from operating rooms may contribute to environmental pollution, while long-term exposure among healthcare workers may lead to fatigue, headaches, and reproductive risks if safety standards are not properly maintained [3]. As a result, there is growing interest in identifying effective remedies such as improved scavenging systems, better ventilation, strict occupational safety protocols, and the use of alternative anesthetic techniques. Therefore, understanding the prevalence, effects, and control measures of inhalational anesthetics is essential for ensuring patient safety, protecting healthcare workers, and promoting a safer medical environment.

Statement of the Problem

Inhalational anesthetics have become indispensable in modern medical practice because of their effectiveness in inducing and maintaining general anesthesia during surgical procedures. Agents such as sevoflurane, isoflurane, desflurane, and nitrous oxide are widely used in hospitals and surgical centers due to their rapid onset, controllability, and reliability in ensuring patient comfort and surgical success. Despite their numerous clinical benefits, increasing concerns have emerged regarding their prevalence within healthcare environments and their possible effects on human health and the environment.

In Imo State, there appears to be limited empirical information regarding the prevalence of inhalational anesthetics in healthcare environments, their associated effects, and the effectiveness of existing control strategies. Most available studies have focused largely on the clinical effectiveness of anesthetic agents with little attention given to their environmental and occupational implications within local healthcare settings. This lack of adequate local data creates a knowledge gap that may hinder the development of effective environmental health policies and safety practices.

Therefore, the problem of this study is to investigate the prevalence of inhalational anesthetics in the environment, examine their possible effects on human health and environmental safety, and identify effective control and remedial strategies for minimizing their adverse impacts in Imo State, Nigeria.

Research objective

1. To determine the extent of inhalational anesthetics in our environment.
2. To examine the Control Strategies of Inhalational Anesthetics.

Research question

1. What is the extent of inhalational anesthetics in our environment?
2. What are the Control Strategies of Inhalational Anesthetics?

LITERATURE REVIEW

Concept of Inhalational Anesthetic

Inhalational Anesthetics are drugs used are used to induce and sustain general anesthesia through the respiratory system, during surgical and medical operations. These inhalational anesthetics can be volatile gases or vapors. These anesthetics mainly affect the central nervous system, causing muscle relaxation, analgesia, amnesia, and reversible unconsciousness. Sevoflurane, isoflurane, desflurane, and nitrous oxide are common inhalational anesthetics used in contemporary clinical practice. During surgery, they are administered using specialized anesthesia equipment that control breathing, anesthetic concentration, and oxygen flow.

The idea behind inhalational anesthesia is that anesthetic gases are absorbed through the lungs, enter the bloodstream, and then go to the brain and other tissues. Once inhaled, the anesthetic agents diffuse across the alveolar membrane into the blood circulation and eventually reach the central nervous system, where they suppress neuronal activity and alter consciousness [4]. Blood-gas solubility, breathing rate, cardiac output, and anesthetic concentration are some of the variables that affect how effective inhalational anesthetics are. Because they make it simple to regulate the anesthetic depth during surgical procedures, inhalational anesthetics are frequently utilised. The concentration of anesthetic gases can be quickly changed by anesthesiologists based on the patient's physiological state and the needs of the procedure. According to Eger and Shafer [5], modern volatile anesthetics provide rapid induction and recovery, making them suitable for both short and prolonged surgical operations.

The capacity of inhalational anesthetics to preserve hemodynamic stability and muscular relaxation throughout surgery is another significant feature. These drugs let surgeons carry out treatments safely and successfully while lowering patient awareness and pain perception. In pediatric anesthesia, inhalational anesthetics such as sevoflurane are preferred because they allow painless induction without intravenous injections [6]. Inhalational anesthetics may have adverse consequences such respiratory depression, hypotension, postoperative nausea, and environmental pollution because of waste anesthetic gases, notwithstanding their clinical significance. Consequently, modern anesthesia practice emphasizes careful monitoring, low-flow anesthesia techniques, and environmentally sustainable anesthetic management [7].

Types of Anesthetics

- **general anesthetics**

During surgery, general anesthetics cause immobility, analgesia, forgetfulness, and reversible loss of consciousness. They influence the central nervous system by inhibiting excitatory pathways (NMDA receptors) and boosting inhibitory neurotransmission (GABA-A receptors). These substances are divided into two categories: intravenous (propofol, ketamine) and inhalational (sevoflurane, isoflurane). Because of respiratory and cardiovascular depression, they need constant monitoring and airway management. In big procedures, their utilization is crucial. As noted by Brown, Purdon, & Van Dort [8], general anesthetics alter large-scale brain connectivity and disrupt thalamocortical signaling, leading to reversible unconsciousness rather than complete brain shutdown.

- **local anesthetics**

Local anesthetics inhibit sodium channel conduction in a use-dependent manner, which explains their selective effect on active nerve fibers [9]. Without altering awareness, local anesthetics cause a loss of feeling in a particular area of the body. They stop the flow of nerve impulses by blocking voltage-gated sodium channels in neuronal membranes. They are frequently utilized in diagnostic tests, small operations, and dentistry. Bupivacaine, ropivacaine, and lidocaine are a few examples. Their effects are reversible and rely on the diffusion and metabolism of the medication.

- **Regional anesthesia**

Blocking nerve conduction in a sizable area of the body, such as a limb or lower torso, is known as regional anesthesia. Peripheral nerve blocks, spinal anesthesia, and epidural anesthesia are all included. It is frequently utilized in abdominal, obstetric, and orthopedic procedures. It enhances healing after surgery and lessens the need for opioids. Throughout the surgery, patients stay aware. According to Ilfeld [10], regional anesthesia improves postoperative outcomes by reducing opioid consumption and enhancing early mobilization in surgical patients.

- **Neuraxial anesthesia**

Spinal, epidural, and caudal anesthesia are examples of neuraxial anesthesia, which involves injecting local anesthetics close to the spinal cord. It prevents the lower body's senses and muscles from communicating. Lower limb procedures and cesarean sections frequently employ it. It lessens the surgical stress reaction and offers superior pain relief. Additionally, it facilitates a quicker recovery after surgery. Liu and Wu [11] state that epidural anesthesia remains superior for prolonged surgical procedures requiring continuous analgesia.

- **Sedation (monitored anesthesia care)**

Sedation is a progressive decrease of consciousness that often preserves airway reflexes and ranges from moderate relaxation to deep sedation. It is frequently utilized for small operations, imaging treatments, and endoscopies. Propofol, midazolam, and dexmedetomidine are among the medications. Because deeper sedation can lead to general anesthesia, it needs to be closely monitored. It offers solace without making you totally unconscious. As noted by Hinkelbein, Lamperti, and Akeson [12], sedation is a continuum that requires precise titration to avoid respiratory compromise and unintended deep anesthesia.

The necessity of using an inhalational anesthetic

Because of their quick start and recovery characteristics, convenience of administration, controllability, and ability to maintain stable anesthesia during surgery, inhalational anesthetics are often chosen in clinical settings. Their clinical use in healthcare systems across the globe has expanded due to advancements in monitoring technologies and anesthesia equipment.

- **Need for General Anesthesia during Surgical Procedures**

The requirement to produce general anesthesia during surgical procedures is one of the main reasons inhalational anesthetics are used. Patients frequently need to be asleep, pain-free, and immobilized during major surgeries. According to Eger [5], inhalational anesthetics are highly effective in maintaining unconsciousness and suppressing reflex responses during surgery. These substances enable surgeons to carry out intricate procedures without giving patients any discomfort or psychological distress.

- **Rapid Induction and Recovery of Anesthesia**

The quick onset and recovery profile of inhalational anaesthetics is another significant factor in their utilisation. Due to their low blood-gas solubility, contemporary volatile anaesthetics like desflurane and sevoflurane enable rapid anaesthesia induction and recovery. According to Kim and Lee [13], rapid recovery characteristics reduce postoperative complications and improve patient turnover in operating rooms. Rapid induction is especially helpful in emergency surgeries and paediatric anaesthesia, where prompt anaesthetic control is required. Faster recovery also lowers the risk of prolonged sedation and respiratory depression after surgery. Patients recover consciousness more quickly after surgery, enabling earlier discharge from recovery units and shortening hospital stays.

- **Ease of Administration and Control**

Because they are simple to administer and modify during surgery, inhalational anaesthetics are frequently utilised. Anaesthesiologists can precisely regulate the concentration of anaesthetic gases according to the patient's state and surgical needs thanks to anaesthesia machines. Inhalational anaesthetics are very controlled thanks to modern vaporisers and gas monitoring devices. According to Nunes [14], inhalational anesthesia allows continuous adjustment of anesthetic depth, improving patient safety and surgical stability.

- **Pediatric Anesthesia Applications**

Because inhalational anaesthetics enable non-invasive anaesthesia induction, they are frequently utilised in paediatric patients. Inhalational induction is the favoured technique since children frequently have a fear of needles and intravenous treatments. Due to its pleasant smell and low level of airway irritation, sevoflurane is particularly well-liked in paediatric anaesthesia. According to Davidson and Sun [6], inhalational induction reduces anxiety and improves cooperation among children undergoing surgery. This method is commonly used in pediatric dental procedures, minor surgeries, and diagnostic interventions requiring sedation or general anesthesia.

- **Maintenance of Hemodynamic Stability**

When used correctly, inhalational anaesthetics can preserve comparatively steady cardiovascular and respiratory function, which is another reason for their usage. During surgery, haemodynamic stability must be maintained to avoid problems such hypotension, arrhythmias, and insufficient tissue perfusion. According to Flynn and Patel [15], modern inhalational anesthetics provide predictable

cardiovascular effects and can be carefully titrated to meet individual patient needs. This controlled effect helps anesthesiologists manage patients with varying medical conditions safely during surgery.

Control Strategies of Inhalational Anesthetics

Monitoring anesthetic concentration, ventilation, oxygenation, hemodynamic stability, and patient responsiveness are all part of controlling inhalational anesthetics. Recent developments in pharmacological research, monitoring equipment, and anesthetic machines have enhanced the accuracy and security of inhalational anesthesia administration.

- **Monitoring of Minimum Alveolar Concentration (MAC)**

Monitoring Minimum Alveolar Concentration (MAC) is a key control strategy for inhalational anesthetics. The dose of anesthetic needed to stop 50% of patients from moving in response to surgical stimulation is known as MAC. Anesthesiologists can prevent overdoses or underdoes while maintaining the proper anesthetic depth by keeping an eye on MAC. According to Vutskits and Xie [16], MAC-guided anesthesia administration improves patient safety by reducing excessive exposure to volatile anesthetics and minimizing cardiovascular and respiratory depression. Clinicians can precisely modify anesthetic concentrations during surgery thanks to the constant display of MAC values on modern anesthesia workstations.

- **End-Tidal Gas Monitoring**

Another crucial control method for inhalational anesthesia is end-tidal anesthetic gas monitoring. End-tidal monitoring provides an estimate of the anesthetic concentration in the brain and bloodstream by measuring the concentration of anesthetic gases in exhaled air. Anesthesiologists can maintain constant anesthesia levels during surgical procedures by continuously monitoring end-tidal anesthetic concentrations. According to Ehrenfeld [17], end-tidal monitoring improves anesthetic precision and reduces fluctuations in anesthetic depth.

- **Closed-Loop Anesthesia Delivery Systems**

Technological advancements have led to the development of closed-loop anesthesia delivery systems. These automated systems continuously monitor physiological parameters and adjust anesthetic delivery based on patient responses. Closed-loop systems use data from electroencephalogram (EEG) monitoring, bispectral index (BIS), and end-tidal gas analysis to regulate anesthetic administration automatically. According to Liu. [18], automated control systems improve anesthetic stability, reduce human error, and optimize drug administration during surgery. Because they improve patient outcomes, decrease anesthetic waste, and increase precision, these devices are becoming more and more common in contemporary operating rooms.

- **Ventilation and Oxygenation Control**

Because volatile anesthetics are administered through the respiratory system, efficient ventilation and oxygenation are crucial during inhalational anesthesia. During anesthesia, mechanical ventilators are used to ensure a sufficient supply of oxygen and remove carbon dioxide. Depending on the patient's physiological state, control options include modifying respiratory rate, tidal volume, oxygen concentration, and airway pressure. According to Pardo and Miller [19], careful ventilation management reduces respiratory complications and ensures effective anesthetic uptake and elimination.

- **Hemodynamic Monitoring and Cardiovascular Stability**

By altering blood pressure, heart rate, and cardiac output, inhalational anesthetics can have an impact on cardiovascular function. As a result, ongoing hemodynamic monitoring is a crucial control method when administering anesthesia. In order to quickly identify physiological changes, anesthesiologists keep an eye on heart rate, blood pressure, oxygen saturation, and electrocardiograms (ECG). According to De Hert [20], maintaining cardiovascular stability during inhalational anesthesia reduces perioperative complications and improves surgical outcomes.

- **Environmental and Occupational Control Strategies**

In hospital settings, inhalational anesthetics may increase the dangers of occupational exposure and environmental contamination. Long-term environmental consequences and greenhouse gas emissions may result from the release of waste anesthetic gases into the atmosphere. Low-flow anesthesia methods, scavenging systems, and ecologically friendly anesthetic procedures are examples of contemporary control mechanisms. According to Sherman [21], low-flow anesthesia significantly reduces anesthetic gas waste and environmental impact while maintaining patient safety.

Methods

In carrying out this study descriptive survey design was adopted. The study was carried out in Imo State, Nigeria. The targeted population for the study consisted of Public Health Doctors and Environmental Scientists in Imo State, Nigeria. A stratified sampling technique was used in selecting 70 Public Health Personnel and 60 Environmental Scientists in Imo State. This gave a total of 130 respondents which formed the sample size for this study. The instrument used for data collection was a structured questionnaire titled "Inhalational Anesthetics and Environment Questionnaire" (IAEQ). Face and content validation of the instrument was carried out by an expert in test, measurement, and evaluation in order to ensure that the instrument has the accuracy, appropriateness, and completeness for the study under consideration. The reliability coefficient obtained was 0.92, and this was high enough to justify the use of the instrument. The researcher subjected the data generated for this study to appropriate statistical technique such descriptive statistics to answer research questions.

Results and Discussion

Research Question 1: The research question sought to determine the extent of inhalational anesthetics in our environment. To answer the research question, percentage analysis was performed on the data (see Table 1).

Table 1. Percentage analysis of the extent of inhalational anesthetics in our environment in Imo State.

Extent of inhalational anesthetics	Frequency	%
VHE	47	36.15*
HE	38	29.23
LE	28	21.54
VLE	17	13.08*
TOTAL	**130**	**100**

***The highest percentage frequency**
The least percentage frequency
SOURCE: Field survey

The results in Table 1 present the percentage analysis of the extent of inhalational anesthetics in the environment. This finding is evident from the percentage analysis where the highest respondents, representing 36.15%, indicated Very High Extent (VHE), followed by 29.23% who indicated High Extent (HE). In contrast, 21.54% of the respondents perceived the extent to be low (LE), while the least (13.08%) indicated Very Low Extent (VLE). The findings agree the opinion of Sherman (2021) who stated that low-flow anesthesia significantly reduces anesthetic gas waste and environmental impact while maintaining patient safety. Similarly, Eger (2020), mentioned that inhalational anesthetics are highly effective in maintaining unconsciousness and suppressing reflex responses during surgery. These substances enable surgeons to carry out intricate procedures without giving patients any discomfort or psychological distress.

Research Questions 2:

The research question sought to examine the control strategies of inhalational anesthetics. To answer the research question, percentage analysis was performed on the data (see Table 2).

Table 2. Percentage analysis of the control strategies of inhalational anesthetics.

Control strategies of inhalational anesthetics	FRQ	%
Monitoring of Minimum Alveolar Concentration (MAC)	38	29.23**
End-Tidal Gas Monitoring	34	26.15
Closed-Loop Anesthesia Delivery Systems	21	16.15
Ventilation and Oxygenation Control	15	11.54
Hemodynamic Monitoring and Cardiovascular Stability	12	9.23
Environmental and Occupational Control Strategies	10	7.69*
TOTAL	**130**	**100**

**** The highest percentage frequency**

*** The least percentage frequency**

SOURCE: Field survey

Table 2 presents the percentage analysis of the control strategies of inhalational anesthetics. From the result of the data analysis, it was observed that the highest percentage (29.23) of the respondents was recorded against "Monitoring of Minimum Alveolar Concentration (MAC)," while the least percentage (10.67) was recorded against "Environmental and Occupational Control Strategies". The findings is in agreement with Vutskits and Xie (2021), who stated that MAC-guided anesthesia administration improves patient safety by reducing excessive exposure to volatile anesthetics and minimizing cardiovascular and respiratory depression. Clinicians can precisely modify anesthetic concentrations during surgery thanks to the constant display of MAC values on modern anesthesia workstations. Similarly, the result of Liu. (2022), who asserted that automated control systems improve anesthetic stability, reduce human error, and optimize drug administration during surgery. Because they improve patient outcomes, decrease anesthetic waste, and increase precision, these devices are becoming more and more common in contemporary operating rooms.

Conclusions

In conclusion, the prevalence of inhalational anesthetics in medical practice highlights their indispensable role in modern surgery due to their effectiveness in inducing and maintaining anesthesia with controllable depth and rapid action. However, despite these advantages, their use presents notable health, occupational, and environmental concerns, including potential respiratory and neurological effects on patients, exposure risks to healthcare workers, and environmental pollution from waste anesthetic gases. Therefore, while inhalational anesthetics remain essential in healthcare delivery, ensuring their safe use through proper regulation, monitoring, and adoption of safer alternatives is critical for protecting human health and promoting a safer medical environment.

Recommendations

1. Healthcare facilities should install and maintain effective scavenging and ventilation systems to reduce the accumulation and inhalation of waste anesthetic gases in operating rooms.
3. Governments and health institutions should promote the use of modern, low-toxicity anesthetic agents and encourage research into safer alternatives to reduce environmental and health impacts.
4. Medical professionals should receive continuous training on the safe administration and handling of inhalational anesthetics to minimize risks to patients and staff.

References

[1] **A. L. Miller, D. Theodore, and J. Widrich,** "Inhalational anesthetic agents: Mechanism and clinical use," *StatPearls*, 2023. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK554540/

[2] **J. M. Hendrix and J. Kramer,** "Anesthesia inhalation agents and their cardiovascular effects," *StatPearls Publishing*, 2025. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/

[3] **A. Caronna, K. Vitale, L. Ciccariello, and A. De Giorgi,** "Occupational exposure to inhalational anesthetics and adverse health outcomes: A systematic review," *Public Health Journal*, vol. 117, no. 1, Art. no. 17428, 2026, doi: 10.23749/mdl.2026.17428.

[4] **L. Vutskits and Z. Xie,** "Lasting impact of general anaesthesia on the brain: Mechanisms and relevance," *Nature Reviews Neuroscience*, vol. 22, no. 12, pp. 703–717, 2021.

[5] **E. I. Eger and S. L. Shafer,** "Tutorial: Context-sensitive decrement times for inhaled anesthetics," *Anesthesia & Analgesia*, vol. 131, no. 4, pp. 1029–1036, 2020.

[6] **A. J. Davidson and L. S. Sun,** "Clinical evidence for any effect of anesthesia on the developing brain," *Anesthesiology*, vol. 133, no. 4, pp. 840–853, 2020.

[7] **J. D. Sherman, A. MacNeill, and C. Thiel,** "Reducing environmental impacts of inhaled anesthetics through sustainable clinical practices," *BMJ*, vol. 375, Art. no. n3032, 2021.

[8] **E. N. Brown, P. L. Purdon, and C. J. Van Dort,** "General anesthesia and altered states of arousal: A systems neuroscience approach," *New England Journal of Medicine*, vol. 384, no. 20, pp. 2011–2021, 2021.

[9] **D. E. Becker and K. L. Reed,** "Local anesthetics: Review of pharmacological considerations," *Anesthesia Progress*, vol. 67, no. 2, pp. 90–101, 2020.

[10] **B. M. Ilfeld,** "Continuous peripheral nerve blocks: A review of clinical applications," *Regional Anesthesia and Pain Medicine*, vol. 45, no. 3, pp. 155–164, 2020.

[11] **S. S. Liu and C. L. Wu,** "Epidural anesthesia and perioperative outcomes," *Anesthesia & Analgesia*, vol. 136, no. 1, pp. 50–62, 2023.

[12] **J. Hinkelbein, M. Lamperti, and J. Akeson,** "Sedation in non-operating room anesthesia: Safety considerations," *European Journal of Anaesthesiology*, vol. 37, no. 10, pp. 1–10, 2020.

[13] **H. Kim and J. Lee,** "Recovery profiles of volatile anesthetics in ambulatory surgery," *BMC Anesthesiology*, vol. 21, no. 1, p. 256, 2021.

[14] **R. R. Nunes, I. M. Chaves, and J. C. Alencar,** "Modern inhalational anesthesia techniques and clinical applications," *Brazilian Journal of Anesthesiology*, vol. 72, no. 5, pp. 642–650, 2022.

[15] **B. C. Flynn and M. S. Patel,** "Hemodynamic effects of modern inhalational anesthetics in surgical patients," *Journal of Cardiothoracic and Vascular Anesthesia*, vol. 35, no. 9, pp. 2615–2624, 2021.

[16] **L. Vutskits and Z. Xie,** "Lasting impact of general anaesthesia on the brain: Mechanisms and relevance," *Nature Reviews Neuroscience*, vol. 22, no. 12, pp. 703–717, 2021.

[17] **J. M. Ehrenfeld, L. M. Funk, J. Van Schalkwyk, A. F. Merry, W. S. Sandberg, and A. Gawande,** "The incidence of hypoxemia during surgery: Evidence from modern anesthesia monitoring systems," *Anesthesia & Analgesia*, vol. 131, no. 2, pp. 547–556, 2020.

[18] **N. Liu, T. Chazot, B. Trillat, G. A. Dumont, and M. Fischler,** "Closed-loop control of anesthesia: Recent advances and future challenges," *Journal of Clinical Monitoring and Computing*, vol. 36, no. 4, pp. 987–998, 2022.

[19] **M. C. Pardo and R. D. Miller,** "Respiratory monitoring and ventilation strategies during inhalational anesthesia," *Anesthesiology Clinics*, vol. 39, no. 4, pp. 713–728, 2021.

[20] **S. De Hert, S. Staender, G. Fritsch, J. Hinkelbein, A. Afshari, G. Bettelli, and J. Mellin-Olsen,** "Pre-operative evaluation of adults undergoing elective noncardiac surgery," *European Journal of Anaesthesiology*, vol. 37, no. 6, pp. 469–480, 2020.

[21] **J. D. Sherman, A. MacNeill, and C. Thiel,** "Reducing environmental impacts of inhaled anesthetics through sustainable clinical practices," *BMJ*, vol. 375, Art. no. n3032, 2021.