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Comparison of Intravenous Anesthesia and Inhalational Anesthesia in Pediatric Patients: A Systematic Review

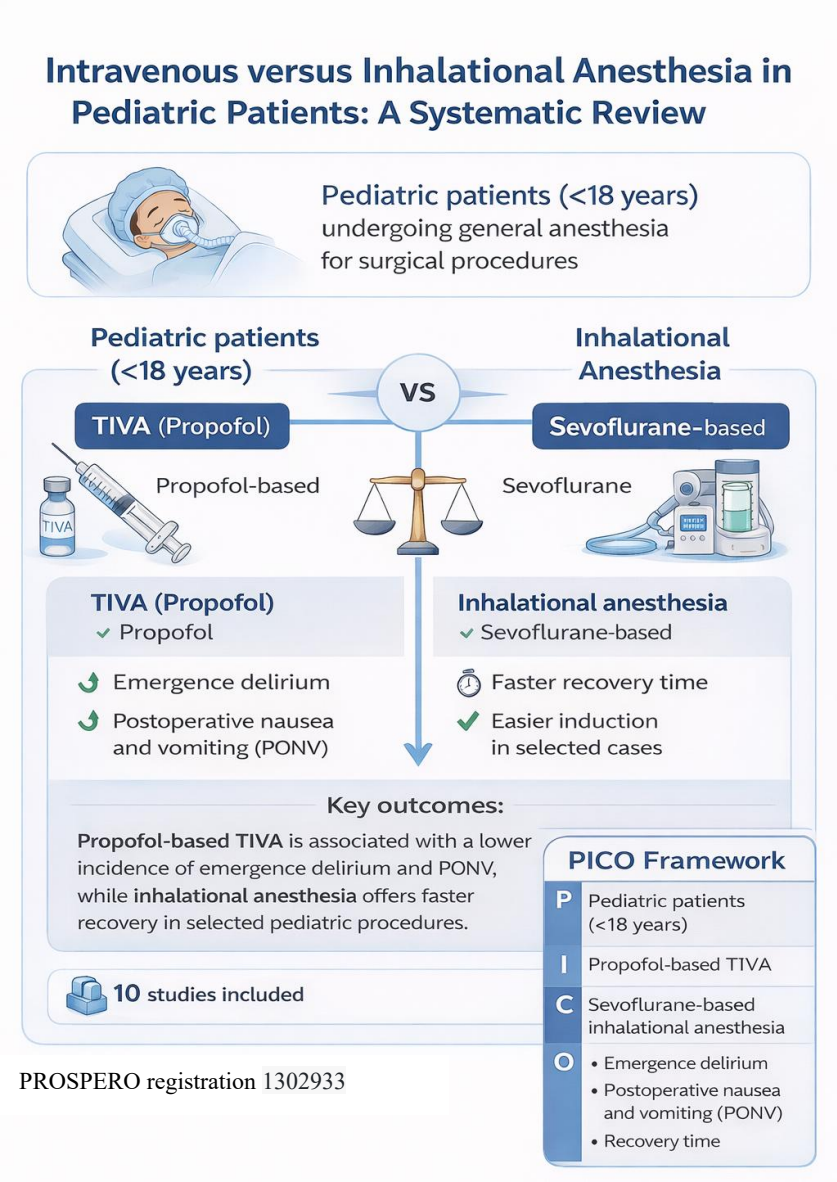
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Graphical Abstract



ABSTRACT

Background: *The administration of anesthesia in pediatric patients requires special consideration due to physiological differences compared to adults. General anesthesia in children can be performed using total intravenous anesthesia (TIVA) or inhalational anesthesia. The selection of an optimal anesthetic technique plays a crucial role in minimizing perioperative complications and improving clinical outcomes.*

Objective: *To evaluate and compare the effectiveness and safety of intravenous anesthesia versus inhalational anesthesia in pediatric patients.*

Methods: *A systematic review was conducted using PubMed Central, the Cochrane Library, and Google Scholar databases up to 2025. This systematic review was registered in the PROSPERO database (registration number: 1302933). Studies comparing propofol-based TIVA with inhalational anesthesia, particularly sevoflurane, in pediatric patients (<18 years) were included. Outcomes analyzed included emergence delirium (ED), postoperative nausea and vomiting (PONV), recovery time, and airway complications.*

Results: *Most studies demonstrated that propofol-based TIVA was associated with a lower incidence of ED and PONV compared to inhalational anesthesia. However, several studies reported faster recovery times with inhalational* anesthesia.

Conclusion: *TIVA offers advantages in reducing the incidence of ED and PONV in pediatric patients, while inhalational anesthesia remains superior in terms of ease of induction and recovery time under certain clinical conditions.*

Keywords: *pediatric anesthesia, TIVA, inhalational anesthesia, propofol, sevoflurane.*

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INTRODUCTION

Pediatric anesthesia poses distinct challenges compared with adult anesthesia, primarily due to differences in physiological and psychological characteristics, as well as an increased risk of airway-related complications. These factors contribute to a higher incidence of perioperative adverse events, thereby emphasizing the importance of selecting an appropriate anesthetic technique to ensure patient safety and optimize clinical outcomes. General anesthesia in pediatric patients may be administered using either total intravenous anesthesia (TIVA) or inhalational anesthesia. TIVA has gained increasing attention because of its favorable recovery profile, whereas inhalational anesthesia remains widely used due to the ease of induction without the requirement for intravenous access.[1,2]

Previous studies have demonstrated that inhalational anesthesia, particularly with sevoflurane, is associated with a higher incidence of emergence delirium and postoperative nausea and vomiting.[1-3] In contrast, intravenous anesthesia has been reported to reduce the occurrence of these complications; however, its use may be limited by challenges in venous access and the potential for hemodynamic instability. Therefore, a systematic review is warranted to comprehensively compare the efficacy and safety of intravenous and inhalational anesthesia techniques in pediatric patients.

METHODS

Study Design

This study was conducted as a systematic review of published studies comparing intravenous anesthesia and inhalational anesthesia in pediatric patients.

Participants and Study Samples

The study population comprised pediatric patients aged <18 years who underwent general anesthesia. The samples included randomized controlled trials (RCTs) and quantitative studies that met the predefined inclusion criteria.

Inclusion Criteria

Inclusion and Exclusion Criteria

1. Studies involving pediatric patients aged <18 years.
2. Studies comparing total intravenous anesthesia (TIVA) with inhalational anesthesia.
3. Studies reporting clinical outcomes, including emergence delirium, postoperative nausea and vomiting

(PONV), recovery time, or perioperative complications.

Exclusion Criteria

1. Animal studies.
2. Single case reports.
3. Narrative reviews, editorials, or non-original research articles.

Procedure

A comprehensive literature search was conducted using the PubMed Central, Cochrane Library, and Google Scholar databases to identify relevant articles published up to 2025. This systematic review was conducted in accordance with a predefined protocol and registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration 1302933).The study selection process was performed through sequential screening of titles and abstracts, followed by full-text review of eligible articles.

Variables

The primary variables analyzed included emergence delirium, postoperative nausea and vomiting (PONV), recovery time, and airway-related complications.

Statistical Analysis

Data were extracted descriptively and analyzed qualitatively. No quantitative meta-analysis was performed.

ETHICAL APPROVAL

PROSPERO registration 1302933.

RESULTS

Data were extracted descriptively and analyzed qualitatively. A total of ten studies that met the inclusion criteria were included in this systematic review. The majority of the included studies employed a randomized controlled trial design.

The most commonly used intravenous anesthetic agent was propofol, whereas the primary inhalational anesthetic agent was sevoflurane.

The reviewed studies demonstrated that intravenous anesthesia, particularly with propofol, was associated with a lower incidence of postoperative nausea and vomiting (PONV) and fewer adverse effects compared with inhalational anesthesia. [5-7] In contrast, inhalational anesthesia with agents such as sevoflurane was associated with faster recovery compared with intravenous anesthesia

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Author and Year	Study Design	Sample Size	Intervention	Comparator	Primary Outcomes	Key Finding
Scheiermann et al. 2018	Meta-analysis of RCT	762	Propofol TIVA	Sevofluran	PONV, EA	PONV and EA was lower in the TIVA group
Sheikhzade et al. 2020	Quantitative	80	Propofol TIVA	Sevofluran	Recovery time PONV	Faster recovery with inhalational anesthesia. Lower incidence of PONV with TIVA.
Roodneshin et al. 2023	Quantitative	60	Propofol TIVA	Sevofluran	EA PONV	PONV, EA was lower in the TIVA
Sarhan et al. 2024	RCT	105	Propofol TIVA	Inhalasi Sevofluran	PONV EA	PONV, EA was lower in the TIVA
Wu et al. 2020	Randomized Single Blind	86	Propofol	Sevofluran	Recovery time	Faster recovery with inhalational anesthesia
Amiri et al. 2020	RCT	105	TIVA	Inhalational Anestheisa	PONV	PONV, EA was lower in the TIVA
Xiao et al. 2022	RCT	1113	Propofol	Sevofluran	EA	PONV, EA was lower in the TIVA
Hamad et al. 2025	RCT	73	Propofol	Sevofluran	PONV, EA	PONV, EA was lower in the TIVA
Xu et al. 2023	RCT	194	Propofol	Sevofluran	PONV, EA	PONV, EA was lower in the TIVA
Subramanian et al. 2024	RCT	70	Propofol	Sevofluran	PONV	PONV, EA was lower in the TIVA
Zhang et al.2023	RCT	137	Propofol	Sevofluran	PO, EA	PONV, EA was lower in the TIVA

Table 1. Summary of Included Studies[4-14]

DISCUSSION

The findings of this systematic review indicate that intravenous anesthesia, particularly with propofol, consistently reduces the incidence of adverse effects and postoperative nausea and vomiting compared with inhalational anesthesia. These effects are likely attributable to the intrinsic antiemetic properties of propofol and its more stable sedative effects on the central nervous system.

A study conducted by Wu et al. (2020) reported faster recovery times with

inhalational anesthesia, especially in short surgical procedures.[5] This phenomenon is primarily related to the pharmacokinetic characteristics of volatile anesthetic agents, which are rapidly eliminated via pulmonary exhalation. Nevertheless, this advantage must be carefully weighed against the higher risk of emergence agitation associated with inhalational anesthesia, particularly sevoflurane.

Overall, no significant differences were observed in terms of airway-related complications between the two anesthetic techniques. Therefore, the choice of anesthetic technique should be individualized, taking into consideration the patient's clinical condition, the type and duration of surgery, and the expertise of the anesthesiologist.

Strengths, Limitations, and Future Directions

The primary strength of this systematic review lies in its comprehensive comparison of intravenous and inhalational anesthesia in pediatric patients using evidence derived predominantly from randomized controlled trials. However, several limitations should be acknowledged. These include heterogeneity among included studies with respect to anesthetic protocols, outcome definitions, and surgical procedures, as well as the absence of a quantitative meta-analysis. Future studies with standardized outcome measures and larger sample sizes are warranted to further elucidate the comparative effectiveness and safety of these anesthetic techniques.

CONCLUSION

Total intravenous anesthesia (TIVA) in pediatric patients provides significant benefits in reducing the incidence of emergence delirium and postoperative nausea and vomiting compared with inhalational anesthesia. Inhalational anesthesia continues to play an important role in specific clinical settings, particularly due to its ease of induction and suitability for short procedures. The selection of anesthetic technique should be individualized and guided by evidence-based practice.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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ETHICAL APPROVAL

PROSPERO registration 1302933.

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