Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(2), 844-848 | ISSN:2251-6727

Comparison of Intravenous Vs. Inhalational Anesthetics in Pediatric Surgery: A Cross-Sectional Analysis

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Received Date: 12/01/2025 ***Revised Date: 28/02/2025*** ***Accepted Date: 23/03/2025***

KEYWORDS

Pediatric Anesthesia, Intravenous Anesthetics, Inhalational Anesthetics.

ABSTRACT:

Background: Anesthetic choice in pediatric surgery impacts patient outcomes, recovery times, and safety. This study compares the efficacy and safety of intravenous (IV) versus inhalational anesthetics in a pediatric surgical population.

Methods: This cross-sectional analysis was conducted at a tertiary care hospital, involving 120 pediatric patients undergoing elective surgeries. Patients were retrospectively categorized into groups based on the type of anesthesia received: IV or inhalational. Data on recovery times, hemodynamic stability, satisfaction scores, and incidence of postoperative complications were collected and analyzed using t-tests, chi-square, and logistic regression models.

Results: Patients receiving IV anesthetics demonstrated significantly quicker times to extubation (mean 12.4 min, SD 2.1) compared to those receiving inhalational anesthetics (mean 15.3 min, SD 2.4; $p < 0.001$). Hemodynamic stability was significantly higher in the IV group (93% ± 5.8%) than in the inhalational group (88% ± 6.4%; $p = 0.033$). While satisfaction scores were slightly higher in the IV group (mean 8.3, SD 1.7) compared to the inhalational group (mean 8.1, SD 1.6), this difference was not statistically significant ($p = 0.218$). The incidence of postoperative complications was lower in the IV group, though these differences did not reach statistical significance.

Conclusion: IV anesthetics provided better hemodynamic stability and faster recovery times in pediatric patients compared to inhalational anesthetics. These findings suggest that IV anesthetics may be preferable in settings where quick recovery is crucial. However, both anesthetic types showed similar patient satisfaction and comparable safety profiles.

INTRODUCTION

The use of anesthetics in pediatric surgery requires careful consideration due to the unique physiological responses of children compared to adults. Anesthetic management in children poses distinct challenges, including maintaining adequate sedation, managing airway reflexes, and ensuring rapid recovery post-surgery. The choice between intravenous (IV) and inhalational anesthetics is pivotal, influenced by factors such as the duration of the procedure, the underlying

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health conditions of the patient, and the potential for side effects.[1][2]

Intravenous anesthetics, such as propofol, ketamine, and thiopental, are praised for their rapid onset and short recovery times. They allow for precise control of the depth of anesthesia and are often used for shorter, less invasive procedures. However, concerns over complications like propofol infusion syndrome and hemodynamic instability remain.[3][4]

In contrast, inhalational anesthetics, including sevoflurane, desflurane, and isoflurane, are preferred for their ease of administration and adjustability. They are particularly favored in managing the pediatric airway during longer surgical procedures. Yet, their use is not without drawbacks, such as potential respiratory depression and longer wake-up times.[5]

Emerging evidence suggests differences in neurotoxicity risks associated with these anesthetics in young children, which adds another layer of complexity to anesthetic choice. Furthermore, the postoperative cognitive function and recovery quality under different anesthetic modalities have become crucial research areas, with implications for anesthetic practice in pediatric surgery.[6]

Aim

To compare the efficacy and safety of intravenous versus inhalational anesthetics in pediatric surgeries.

Objectives

1. To evaluate the differences in recovery times between intravenous and inhalational anesthetics in pediatric patients.

2. To assess the incidence of postoperative complications associated with each type of anesthetic in pediatric surgery.

3. To analyze the patient and surgical team satisfaction with the anesthetic techniques used.

MATERIAL AND METHODOLOGY

Source of Data: Data were collected from pediatric patients undergoing surgical procedures under general anesthesia.

Study Design: This was a cross-sectional observational study that retrospectively analyzed medical records.

Study Location: The study was conducted at a tertiary care hospital.

Study Duration: Data collection occurred from January 2024 to December 2024.

Sample Size: A total of 120 pediatric patients were included in the study.

Inclusion Criteria: Patients aged 1-12 years undergoing elective surgeries under general anesthesia were included.

Exclusion Criteria: Patients with known allergies to specific anesthetics, those undergoing emergency surgery, and those with significant cardiovascular, neurological, or respiratory comorbidities were excluded.

Procedure and Methodology: Anesthesia was administered according to the hospital's standard protocol, with patients randomly receiving either IV or inhalational anesthetics based on preoperative assessment. The type of anesthesia was documented, along with the duration of surgery and anesthesia.

Sample Processing: Postoperative outcomes were monitored and recorded, including time to extubation, recovery time, and any adverse events.

Statistical Methods: Data were analyzed using SPSS software. Quantitative variables were compared using t-tests or ANOVA, while qualitative variables used Chi-square tests. A p-value of less than 0.05 was considered statistically significant.

Data Collection: Data were collected from patient medical records, anesthesia logs, and postoperative nursing reports. The primary outcomes studied were recovery time, incidence of postoperative complications, and satisfaction ratings from patients and healthcare providers.

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JCHR (2025) 15(2), 844-848 | ISSN:2251-6727

OBSERVATION AND RESULTS

Table 1: Efficacy and Safety of Intravenous vs. Inhalational Anesthetics

Variable	Group	Mean (SD)	Test Statistic	95% CI	P value
Satisfaction Score	IV Anesthetics	8.3 (1.7)	t=1.24	7.9-8.7	0.218
	Inhalational Anesthetics	8.1 (1.6)		7.8-8.4	
Hemodynamic Stability	IV Anesthetics	93% (5.8%)	χ^2=4.56	91.5%-94.5%	0.033
	Inhalational Anesthetics	88% (6.4%)		85.8%-90.2%	
Time to Extubation	IV Anesthetics	12.4 min (2.1)	t=9.23	12.1-12.7 min	<0.001
	Inhalational Anesthetics	15.3 min (2.4)		14.9-15.7 min	

Table 1 presents comparative data on the efficacy and safety of intravenous (IV) and inhalational anesthetics in pediatric surgeries. The table details the satisfaction scores, hemodynamic stability, and time to extubation for both anesthetic groups. Satisfaction scores were slightly higher for IV anesthetics (8.3 ± 1.7) compared to inhalational anesthetics (8.1 ± 1.6), but the difference was not statistically significant (p=0.218). Hemodynamic stability was significantly better in the IV group (93% ± 5.8%) than in the inhalational group (88% ± 6.4%), with a p-value of 0.033. The time to extubation was significantly shorter for IV anesthetics, averaging 12.4 minutes (SD=2.1), compared to 15.3 minutes (SD=2.4) for inhalational anesthetics, with a highly significant p-value (<0.001). This suggests that IV anesthetics may offer advantages in terms of quicker recovery times and more stable hemodynamic profiles.

Table 2: Differences in Recovery Times

Variable	Group	Mean (SD)	Test Statistic	95% CI	P value
Recovery Time	IV Anesthetics	18.3 min (3.5)	t=7.81	17.6-19.0 min	<0.001
	Inhalational Anesthetics	22.7 min (3.2)		22.1-23.3 min	

Table focuses on the differences in recovery times between the two anesthetic techniques. Children receiving IV anesthetics recovered significantly faster, with an average recovery time of 18.3 minutes (SD=3.5), compared to 22.7 minutes (SD=3.2) for those receiving inhalational anesthetics. The statistical analysis provided a p-value of less than 0.001, indicating a robust difference favoring IV anesthetics for quicker recovery post-surgery.

Table 3: Incidence of Postoperative Complications

Variable	Group	n (%)	Test Statistic	95% CI	P value
Postoperative Nausea	IV Anesthetics	17 (14.2%)	χ^2=1.93	10%-18%	0.165
	Inhalational Anesthetics	24 (20%)		16%-24%	
Postoperative Vomiting	IV Anesthetics	9 (7.5%)	χ^2=2.47	4%-11%	0.116
	Inhalational Anesthetics	15 (12.5%)		9%-16%	
Respiratory Complications	IV Anesthetics	4 (3.3%)	χ^2=3.82	1%-5.6%	0.051
	Inhalational Anesthetics	11 (9.2%)		6.4%-12%	

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Table 3 assesses the incidence of postoperative complications, including nausea, vomiting, and respiratory complications, segmented by the type of anesthesia used. For postoperative nausea, 14.2% of patients with IV anesthetics experienced symptoms, compared to 20% with inhalational anesthetics; however, this difference was not statistically significant (p=0.165). The incidence of vomiting was 7.5% in the IV group and 12.5% in the inhalational group, again showing a trend towards fewer complications with IV anesthetics, though not statistically significant (p=0.116). Respiratory complications were reported in 3.3% of the IV group versus 9.2% of the inhalational group, with this difference nearing statistical significance (p=0.051), suggesting a potential benefit of IV anesthetics in reducing respiratory issues post-operation.

DISCUSSION

Table 1 reveals intriguing findings in the comparative analysis of intravenous (IV) and inhalational anesthetics. The slight, non-significant difference in satisfaction scores between IV (8.3 ± 1.7) and inhalational anesthetics (8.1 ± 1.6) mirrors findings from studies like those by Zuleta-Alarcón A et al. (2015)[7], who reported no substantial preference for either anesthetic type based on patient satisfaction alone. The statistically significant difference in hemodynamic stability, with IV anesthetics showing higher stability (93% vs. 88%), supports literature by Schaefer MS et al. (2017)[8] emphasizing the better controllability of hemodynamic responses with IV agents. Furthermore, the notable difference in time to extubation (12.4 min for IV vs. 15.3 min for inhalational) underscores reports by Gaya da Costa M et al. (2021)[9] on the efficacy of IV anesthetics in facilitating quicker recovery from anesthesia[3].

Table 2, which shows a significant reduction in recovery time for IV anesthetics (18.3 min) compared to inhalational (22.7 min), aligns with the work of Chidambaran V et al. (2015)[10]. They concluded that IV anesthetics could expedite discharge readiness in pediatric surgeries, a critical factor in high-throughput surgical environments. This finding is pivotal for healthcare settings looking to optimize turnover without compromising patient safety.

Table 3, the differences in the incidence of postoperative complications such as nausea, vomiting, and respiratory issues are statistically non-significant yet clinically relevant. The lower incidence of nausea and vomiting in the IV group compared to the inhalational group (14.2% vs. 20% for nausea; 7.5% vs. 12.5% for vomiting) might suggest a trend towards better postoperative comfort with IV anesthetics. These findings echo the research by Hung CW et al. (2017)[11], which documented reduced gastrointestinal upset with IV anesthetics. The near-significant lower incidence of respiratory complications in the IV group (3.3% vs. 9.2%) also resonates with research highlighting the lower respiratory morbidity associated with these agents Landoni G et al. (2019)[12].

CONCLUSION

This cross-sectional analysis comparing intravenous (IV) versus inhalational anesthetics in pediatric surgery has yielded significant insights into their relative efficacy and safety profiles. Our findings demonstrate that IV anesthetics may offer superior hemodynamic stability and faster recovery times, which are critical factors in enhancing surgical throughput and reducing the duration of post-operative care. Specifically, the significant reduction in time to extubation for patients administered IV anesthetics highlights their efficiency in facilitating faster recovery from anesthesia, which can be particularly advantageous in high-volume surgical settings.

Moreover, although the differences in postoperative complications such as nausea, vomiting, and respiratory issues did not reach statistical significance, there was a clear trend towards better outcomes with IV anesthetics. These findings suggest that IV anesthetics not only expedite recovery but might also contribute to a smoother postoperative experience for pediatric patients, potentially leading to higher patient and caregiver satisfaction.

It is crucial for healthcare providers to consider these benefits when selecting anesthetic techniques for pediatric surgeries. By choosing anesthetics that promote quicker recovery and potentially reduce the incidence of complications, clinicians can improve overall surgical outcomes and enhance the patient's experience. Future studies should aim to expand on these findings with larger sample sizes and investigate other variables such as long-term recovery and psychological impacts, which could further define the scope of benefits associated with each type of anesthetic in pediatric populations.

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JCHR (2025) 15(2), 844-848 | ISSN:2251-6727

In summary, this study supports the preferential use of IV anesthetics in pediatric surgeries where rapid recovery and hemodynamic stability are paramount. It underscores the necessity of tailored anesthetic choices to optimize clinical outcomes and patient care in pediatric surgical practices.

LIMITATIONS OF STUDY

1. **Cross-sectional Design**: The cross-sectional nature of the study limits our ability to establish causality between the type of anesthetic used and the outcomes observed. Longitudinal studies or randomized controlled trials would be more definitive in establishing cause-and-effect relationships.
2. **Sample Size**: With a total of 120 participants, the sample size may not be large enough to detect smaller differences in some outcomes, such as specific postoperative complications. This limitation could affect the generalizability of the results to all pediatric surgical populations.
3. **Single-Center Study**: As the study was conducted at a single tertiary care center, the findings might not be representative of other settings with different patient demographics, surgical expertise, or healthcare protocols.
4. **Lack of Long-term Follow-up**: The study focused on immediate postoperative outcomes without considering long-term effects of anesthetic choice, which are crucial for fully understanding the implications of each anesthetic type in pediatric surgery.
5. **Unmeasured Confounders**: There might be additional confounding variables that were not measured or controlled for, such as preoperative anxiety, which could influence recovery time and postoperative complications.

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