College of Health Sciences School of medicine, Department of Anesthesiology Critical Care and Pain Medicine

Incidence And Associated Factors Of Perioperative Respiratory Adverse Events Among Pediatric Patients Who Underwent Surgery Under General Anesthesia At Tikur Anbesa Specialized Hospital In Addis Ababa, Ethiopia 2024/25.

This Thesis is to be submitted to Addis Ababa University, department of Anesthesiology, Critical Care and Pain Medicine as part of the Partial Fulfillment of the Requirements for a Specialty certificate in Anesthesiology, Critical Care and Pain Medicine (ACCPM).

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DECLARATION

I, the undersigned investigator agreed to accept responsibility for the scientific, ethical, and technical conduct of the research project and provision of required progress reports as per terms and conditions of the research and publications office of the Addis Ababa University.

We declare that this thesis is our original document. We understand that plagiarism will not be tolerated and all directly quoted materials have been appropriately referenced.

Finally, the author surely declared that there is no competing interest.

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ACRONYMS AND ABBREVIATIONS

AOR	Adjusted odds ratio
ASA	American society of anesthesiologists
ACCPM	Anesthesia Critical Care and Pain Medicine
CI	Confidence interval
ETT	Endotracheal tube
GA	General Anesthesia
ICU	Intensive care unit
LMA	Laryngeal mask airways
LMICs	Low-middle income countries
OR	Operation Room
PACU	Post-anesthesia care unit
PRAE	Perioperative respiratory adverse events
SPSS	Statistical package for social sciences
Spo2	Oxygen saturation
TASH	Tikur anbesa specialized hospital
URTI	Upper respiratory tract infection

ABSTRACT

Background: Perioperative respiratory adverse events (PRAEs) are the most frequent complications in pediatrics which frequently result in morbidity and mortality. They are accountable for 75% of perioperative critical incidents and 33% of cardiac arrests.

Objective: To assess the incidence and associated factors of perioperative respiratory adverse events who underwent surgery under general anesthesia among pediatric patients at Tikur anbesa specialized hospital, Adiss Ababa,Ethiopia.

Methods: An institution based cross sectional study was conducted among 176 pediatric patients aged 0 to 12 years who underwent elective and emergency surgery over three month period. Systemic random sampling was used to select patients. Data was collected through structured questionnaires and medical record reviews. Analysis was done by using SPSS 25. Logistic regression was used to identify associated factors and a p-value < 0.05 at 95% confidence intervals was considered as statistical significance.

Result: The overall incidence of perioperative respiratory adverse events was 20% (n=36). ASA class 2 and 3 (AOR=8.7, 95%CI=2.74, 27.84) and (AOR=4.9, 95%CI=1.23, 19.77) respectively, upper respiratory tract infection (AOR=7.6, 95%CI=2.14, 27.16). and duration of surgery more than 1 hr (AOR=4.4, 95%CI=1.45, 13.28). were independent predictors for perioperative respiratory adverse events.

Conclusion: A significant level 20% of the study participants had preoperative respiratory adverse event. Factors that were associated with were history of Upper respiratory tract infection, increasing American society of anesthesiologist physical status and long duration of surgical procedure.

Keywords: *Perioperative respiratory adverse event, pediatric anesthesia, perioperative period, adverse event, risk factors.*

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1 INTRODUCTION

1.1 Background

Perioperative respiratory adverse events (PRAEs) are among the most frequent and serious complications encountered during anesthesia in pediatric patients, carrying significant implications for morbidity, mortality, and healthcare resource utilization. PRAEs encompass a range of critical respiratory complications, including oxygen desaturation, upper airway obstruction, laryngospasm, bronchospasm, apnea, stridor, and persistent coughing. These events are reported to account for approximately 75% of perioperative critical incidents and contribute to 30–70% of anesthesia-related cardiac arrests in children. Moreover, PRAEs are responsible for a substantial proportion of unplanned postoperative admissions to pediatric intensive care units and nearly half of anesthesia-related malpractice claims in this population.[1]

Critical incidents are more common in children than in adults 4.6% and 1.2%, respectively [2]. In children, the respiratory system is involved in the majority of events (46.5%) [1], [3]. Pediatric population is particularly vulnerable to PRAEs due to unique anatomical and physiological characteristics. Children have narrower airways, increased chest wall compliance, and higher oxygen consumption rates, which collectively reduce their margin of safety during periods of hypoventilation or apnea. These risks are further magnified in the presence of upper respiratory tract infections (URTIs), a common condition in pediatric patients, which can increase the risk of PRAEs by up to eleven-fold [4]. Additional patient-related risk factors such as younger age (especially under one year), high ASA physical status, obesity, and comorbid respiratory or cardiac conditions also contribute to the incidence of PRAEs [2], [5].

Procedural and anesthetic factors also play a significant role. Emergency surgeries, airway-related procedures, and the use of endotracheal intubation are known to increase the risk of adverse respiratory events. While improvements in anesthesia techniques, pharmacological agents, and monitoring technologies have significantly reduced perioperative mortality in high-income settings, PRAEs remain a persistent challenge particularly in resource-limited settings [6].

Globally, the reported incidence of PRAEs in pediatric patients ranges between 5% and 30%, depending on the patient population, case mix, and definitions applied. However, data from

low- and middle-income countries, including Ethiopia, are scarce. In such contexts, factors like limited availability of pediatric anesthesia expertise, shortages in advanced monitoring equipment, and a high burden of respiratory infections may amplify the risk and consequences of PRAEs. Yet, the true burden and risk profile of PRAEs in these settings remain under-investigated.

1.2 Statement of the Problem

Perioperative respiratory adverse events (PRAEs) remain a significant yet under-recognized contributor to poor surgical outcomes in pediatric patients, particularly in low-resource settings. While extensive global data highlight their contribution to perioperative morbidity and mortality, there is a notable scarcity of context-specific evidence from sub-Saharan Africa, including Ethiopia. The unique challenges of resource limited environments such as shortages of trained pediatric anesthesia providers, constrained access to advanced airway equipment, and high burdens of preventable comorbid conditions are likely to elevate both the frequency and severity of PRAEs[7], [8]. However, the absence of local research has rendered these assumptions speculative rather than evidence-based.

At Tikur Anbessa Specialized Hospital (TASH), Ethiopia's largest referral and teaching center, a substantial volume of pediatric surgeries are performed under general anesthesia. Yet, no systematic evaluation has been conducted to quantify the burden of PRAEs or to investigate the factors that predispose pediatric patients to these events in this specific setting. As a result, there is a critical gap in knowledge that limits the ability of clinicians and administrators to design targeted interventions aimed at improving perioperative safety in children.

Moreover, clinical decision-making in pediatric anesthesia often requires contextually relevant risk stratification tools, which are currently lacking. Factors such as surgical urgency, provider experience, patient comorbidities, and choice of airway device are known contributors to PRAEs in other settings[7], [8], [9], but their role in the Ethiopian healthcare context remains uncharacterized. Without local data to guide practice, anesthesia providers must rely on generalized guidelines that may not fully reflect the realities of their patient population or healthcare infrastructure.

This lack of data not only hinders the implementation of evidence-based perioperative protocols but also poses a challenge to training, resource allocation, and quality improvement initiatives. The absence of a localized understanding of PRAE risk factors undermines efforts to reduce preventable complications, optimize perioperative care, and ensure safe surgical outcomes for children. There is thus an urgent need to generate empirical evidence on the incidence and determinants of PRAEs in this environment, as a foundation for informed clinical practice and healthcare policy.

1.3 Significance of the Study

This study has the potential to make a meaningful contribution to pediatric anesthesia safety by generating local, context-specific evidence on perioperative respiratory adverse events (PRAEs) a leading cause of morbidity and mortality in children undergoing surgery. While PRAEs have been well-documented in high-income countries, their patterns, contributing factors, and impact in low-resource settings such as Ethiopia remain largely unknown. By focusing on pediatric surgical patients at Tikur Anbessa Specialized Hospital (TASH), this research aims to provide essential epidemiological insight that can inform both clinical practice and health policy.

A key significance of this study lies in its potential to improve the early recognition and prevention of PRAEs. Accurate identification of children at increased risk based on both patient- and procedure related factors can enable timely intervention, reduce the likelihood of respiratory complications, and enhance perioperative care. In environments where access to advanced technologies is limited, data-driven risk stratification is especially critical to guide clinical decision-making and optimize the use of available resources.

Moreover, findings from this research can support the development of locally adapted guidelines, protocols, and training programs tailored to the specific challenges faced by anesthesia providers in Ethiopia. This can lead to improvements in preoperative assessment, intraoperative monitoring, and postoperative care, ultimately reducing the rate of preventable complications and unplanned ICU admissions.

In addition, the study will provide valuable evidence for hospital administrators and policymakers regarding the burden and determinants of PRAEs. This information is vital for planning resource allocation, enhancing staff capacity, and prioritizing patient safety initiatives in pediatric perioperative care.

By bridging the current knowledge gap, this research contributes not only to clinical practice but also to national efforts aimed at improving surgical outcomes, minimizing anesthesia-related risks, and strengthening the overall quality of pediatric healthcare delivery in Ethiopia.

2. LITERATURE REVIEW

In prospective observational study done at pediatric teaching Hospital, France to determine preoperative anesthesia morbidity in children between 2000 to 2002.Data was collected intraoperatively and at PACU. The study found that incidence of respiratory adverse event was 53%. The incidents were more frequent in infants, ENT surgery, and child with ASA3 [5].

A prospective study conducted at Geneva University, Switzerland, between 1999 and 2000 analysed the incidence and risk factors of perioperative respiratory adverse events (PRAEs) in 800 children aged 1 to 14 years who underwent elective surgery. The study found that PRAEs occurred in 21% of cases intraoperatively and in 13% of cases in the post-anesthesia care unit (PACU). Significant risk factors identified included anesthesia not administered by a pediatric anesthesiologist, which was associated with a 1.7-fold increased risk of PRAEs (95% CI: 1.13–2.57), and undergoing ENT surgery, which was associated with a 1.57-fold increased risk (95% CI: 1.01–2.44) [6].

A prospective study conducted in 1999 at Belgrade Children's Hospital, Serbia, investigated the incidence and risk factors of respiratory adverse events in 682 children ranging from neonates to 14 years of age. The overall incidence of respiratory adverse events was 5.8%. Breath-holding and airway obstruction were the most common events, occurring predominantly during extubation. Significant risk factors identified included age under one year, the presence of an upper respiratory tract infection (URTI), and emergency procedure [10].

A cohort study conducted at Wilhelmina Children's Hospital, Netherlands, between 2007 and 2013 examined anesthesia-related critical incidents during the perioperative period in children aged 0 to 18 years. The study found that the respiratory system was involved in the majority of incidents (46.5%). Higher rates of adverse incidents were observed in children younger than one year, those classified as ASA physical status III or IV, and those undergoing emergency procedures [3].

A prospective multicenter observational study conducted from 2014 to 2015 investigated the incidence of critical perioperative respiratory adverse events during ENT surgeries across 261

facilities in 33 European countries. The study reported an overall incidence of respiratory adverse events of 3.93% (95% CI: 3.46–4.48%), based on observations recorded from the time of induction to the first hour following surgery [11].

A multicenter prospective descriptive study involving 25,098 pediatric patients in Thailand found that the most common adverse event was desaturation, defined as peripheral oxygen saturation (SpO_2) below 90%. Respiratory complications were more frequent in patients with an American Society of Anesthesiologists (ASA) physical status of III to V compared to those classified as ASA I or II. Most respiratory events occurred during the induction of anesthesia (67%). The study also concluded that the incidence of respiratory adverse events was higher in children under one year of age [2].

A prospective observational study conducted at a tertiary university hospital in Thailand investigated the incidence and risk factors of perioperative adverse events in 130 neonates and infants undergoing general anesthesia for non-cardiac surgery. The overall incidence of adverse events was 33.6%. The most common respiratory event was insufficient ventilation due to endotracheal tube leakage (15.4%), followed by multiple attempts at endotracheal intubation (14.6%) and desaturation (11.5%). The study identified low body weight (<2,500 g), ASA physical status ≥II, and the presence of respiratory or cardiovascular comorbidities as significant risk factors for perioperative adverse events [12].

A study conducted in Switzerland involving 831 children with recent respiratory tract infections examined the association between airway management and perioperative respiratory adverse events. The use of laryngeal mask airways (LMA) was significantly associated with laryngospasm, coughing, and desaturation, particularly following tracheal extubation. These complications were more frequent in children with recent infections. Age was identified as an independent risk factor for airway complications. Additionally, multiple intubation attempts were significantly linked to an increased occurrence of adverse events [13].

A retrospective chart review was conducted at a tertiary pediatric hospital in the USA from 2008 to 2011 to determine the incidence and risk factors of perioperative respiratory adverse events in 300 patients who underwent palatoplasty. The study reported an incidence of

respiratory adverse events of 23%. The most common events were hypoxia, defined as peripheral oxygen saturation (SpO_2) below 80%, and postoperative upper airway obstruction. Patients with craniofacial abnormalities were found to be at significantly higher risk. Additionally, prolonged surgical duration was strongly associated with the occurrence of respiratory adverse events [14].

A cross-sectional study conducted in 2022 at Rahima Moosa Mother and Child Hospital in Johannesburg, South Africa, examined 206 children aged 0 to 12 years undergoing anesthesia. The study found that the overall incidence of critical events was 34%, with respiratory incidents accounting for 11% of cases. The most common respiratory complications were desaturation and airway obstruction. Younger age and the use of endotracheal tubes (ETT) were identified as significant risk factors for respiratory adverse events [15].

A hospital-based cross-sectional study conducted in 2020 at the University of Gondar Comprehensive Specialized Hospital and Tibebe Ghion Specialized Hospital in Northwest Ethiopia involved 210 pediatric patients. The study found an overall incidence of 26.2% (CI: 20.5–30.9). Significant factors associated with perioperative respiratory adverse events included age under one year, ASA class 3 or higher, upper respiratory tract infections, the presence of oropharyngeal secretions, and airway-related procedures [16].

A hospital-based cross-sectional study conducted in 2021 at Jimma University Specialized Hospital in Ethiopia aimed to assess the incidence and associated factors of perioperative serious adverse events in pediatric surgical patients under the age of 14. The study reported an overall incidence of 3.7% for perioperative serious adverse events, with 20% of these events attributed to the respiratory system.

Conceptual Framework

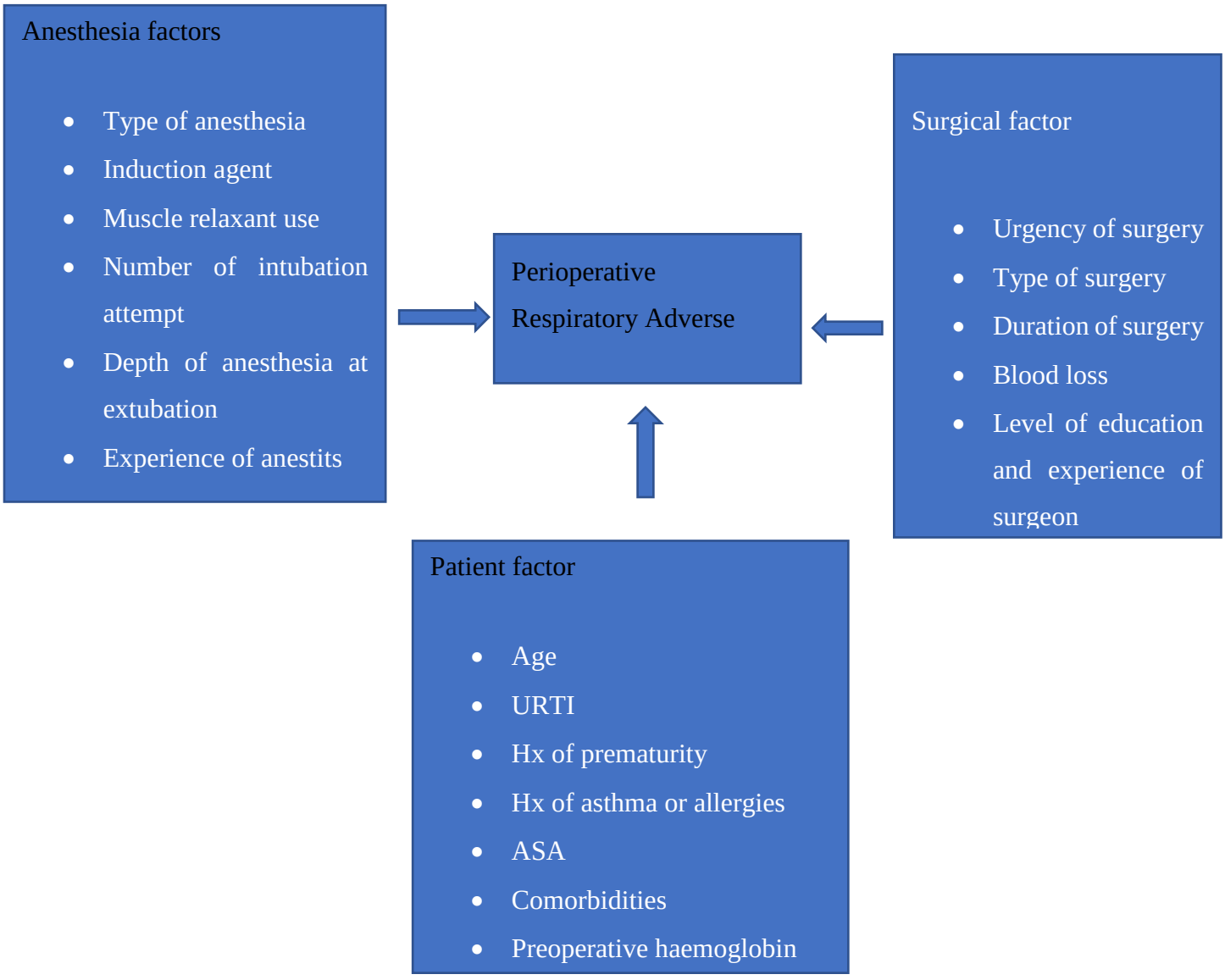

Figure 1: Conceptual framework illustrating patient, anesthetic, and surgical factors associated with perioperative respiratory adverse events in pediatric patients undergoing surgery under general anesthesia.

3 OBJECTIVES

3.1 General objective

- ✓ To assess the incidence and associated factors of perioperative respiratory adverse events in pediatrics surgical patients in TASH, Addis Ababa,Ethiopia.

3.2 Specific objective

- ✓ To determine incidence of perioperative respiratory adverse events in pediatrics patients who undergo surgery under general anesthesia in TASH, Addis Ababa, Ethiopia from Dec to Feb 2024/25.
- ✓ To identify associated factors of perioperative respiratory adverse events in pediatrics patients who undergo surgery under general anesthesia in TASH, Addis Ababa, Ethiopia from Dec to Feb 2024/25.

4. METHODOLOGY

4.1 Study Area

The study was conducted at Addis Ababa university, college of health science, Tikur Anbessa Hospital. It is the largest referral hospital in the country and an institution where specialized clinical services that are not available in other public or private institutions are rendered to the whole nation.

4.2 Study design and Period

Institutional based cross-sectional study was conducted from Dec1,2024- Feb28,2025.

4.3 Source population

All pediatric surgical patients who underwent surgery at Tikur Anbessa hospital.

4.4 Study population

All pediatric patients aged 0-12 who underwent surgery under GA surgery at Tikur Anbessa specialized Hospital under the specified time period was included in this study.

4.5: Inclusion and exclusion criteria**:**

4.5.1 Inclusion criteria

- ✓ Pediatric patients (0-12 years) from ASA1 to ASA 4 scheduled for elective or emergency surgery under general anesthesia
- ✓ Patients whose parents/guardians provide informed consent for participation.

4.5.1 Exclusion criteria

- ✓ Patients with acute respiratory distress
- ✓ Preoperative oxygen saturation <90% or preoperatively on oxygen support
- ✓ Patients transferred directly to ICU

- ✓ severe shock requiring vasopressors
- ✓ Patients who were operated for more than one time during the study period

4.6 Sample Size Determination and Technique

4.6.1 Sample Size Determination

The sample size was determined using a single population proportion formula ($n = Z^2 P (1-P)/d^2$) using 26.2 % incidence of PRAE from the previous study, 95% CI and 5% margin of error. Where: n = sample size, Z = Z value at 95% confidence level (standard 1.96) and d = tolerance of error 5% or (0.05). Therefore, based on the formula, n = (1.96)2×0.262(1-0.262)/ (0.05)2= 298.

Situational analysis of pediatric surgery tells us an average of 114 procedures were done per month at TASH.

The population to be studied is less than 10000 (342 in our case) so we were applying the next formula

nf =n/(1+n/N)

n = required sample size (298)

N = the estimated population size (342)

nf= sample size when the population studied is under 10000

nf = 298/(1+298/342) = 160

by adding 10% nonresponse rate = 176

4.6.2 Sampling Technique

A systematic random sampling technique was utilized to select pediatric patients by using skip interval of K= N/n 342/176 = 2. The first patient was selected randomly.

Study variables

Dependent variable

- ➢ Perioperative respiratory adverse event

Independent variable

Patient factors: Age, Sex, ASA classification, history of asthma, allergy, respiratory infection, passive smoking, Comorbidities,preoperative Hemoglobin.

Anesthetic factors: Techniques of anaesthetic induction, type of airway used, use of muscle relaxant, depth of anaesthesia, number of airway insertion attempts and experience of anaesthesia provider.

Surgical factors: Site of surgery, duration, urgency of surgery, experience of surgeon and blood loss.

4.7. Operational definition

Perioperative period: is the time from the induction of anaesthesia to discharge from pacu

Perioperative Respiratory Adverse Events (PRAEs): the occurrences of any episode of one or a combination of hypoxemia, coughing, breath holding, laryngospasm and bronchospasm in the perioperative period [16].

Laryngospasm: Complete airway obstruction associated with muscle rigidity of the abdominal and chest walls and it need requirement of positive pressure ventilation or administration of succinylcholine [1], [6], [17].

Bronchospasm: Increased respiratory effort, particularly during expiration and wheeze on auscultation or requires bronchodilators [1], [17].

Desaturation or hypoxemia: peripheral arterial oxyhemoglobin saturation (SPO2) <95% more than 30 seconds measured by pulse oximetry if patients are in 100% oxygen and SPO2 <90% in atmospheric air. Oxygen saturation was recorded when the patients were calm and the pulse oximeter showed consistent readings with no movement artefact [1], [5].

Partial upper airway obstruction: Presence of airway obstruction in combination with a snoring noise, an inspiratory stridor or respiratory efforts or paradoxical abdominal movement or both. They can be effectively relieved by airway maneuvers [5].

Coughing: A series of pronounced, persistent coughs lasting >5 seconds [1].
Breath holding or apnea: if the patient had apnea more than 15 seconds or irregular breathing

or if the apnea is associated with bradycardia or cyanosis [17].
Multiple attempt: if required multiple intubation attempts (>2 times) for tracheal intubation.

Active or current upper respiratory tract infection (URTI) defined as patient present with a minimum of two URI symptoms: rhinorrhea, sore or scratchy throat, sneezing, nasal congestion, malaise, cough, or fever, T>38°C [17].

Recent URI included those who did not fulfill the criteria for a URTI at the time of surgery but had a history of URTI within 4 weeks before surgery [17].

Acute respiratory distress (RDS) is characterized by tachypnea, intercostal and subcostal retractions, nasal flaring, grunting, and cyanosis in room air and requires high flow oxygen [18].

Oropharyngeal secretions:presence of secretion that requires suctioning of more than once [14].

Airway related surgery: surgical procedures involving the airway which includes ENT and maxillofacial procedures like adenotonsillectomy, cleft palate repair, direct laryngoscopy, and bronchoscopy [14].

Post anesthesia care unit: place where patient is admitted after surgery and anesthesia to be followed by professionals.

Awake extubation: Removing ET tube/LMA after eye opening, facial grimace, movement other than coughing, purposeful movement, adequate oxygenation, reversal of neuromuscular blockade.

Deep extubation: The ET tube/LMA is removed before wake-up and before the return of upper airway reflexes.

Scoring system for each of respiratory adverse events

Each complication was scored based on its severity, ranging from 1 (no complication) to 4 (most severe complication). Patients who received an endotracheal tube (ETT) or a laryngeal mask airway (LMA) were assessed at five different time points, while those managed with a face mask were assessed at three time points. Consequently, depending on the type of airway device used, patients could receive a composite complication score ranging from 5 to 20 for ETT or LMA, and from 3 to 12 for face mask use. The scoring system used for complications is based on a previously published scale and is detailed in the table below [4].

Table 1: perioperative respiratory adverse events severity scoring in pediatric patients who underwent surgery under general anesthesia

Parameters	Severity score			
	1 (no adverse event	2	3	4(severe advers events)
SpO2(%)	95-100	90-94	80-89	<80
Cough(n)	None	1 or 2	3 or 4	Continuous
Breath holding(s)	None	<15	15-30	>30
Laryngospasm	None	Partial obstruction require reposition only	Partial obstruction require CPAP	Complete obstruction require muscl relaxant
Bronchospasm	None	Expiration phase only	Expiration and inspiration phase	Difficult to ventilate: treatment needed
Secretions	None	Minimal no suctioning	Moderate one suctioning	Copious more than on suctioning

4.8. Data Collection Tools

Data was collected using a semi-structured questionnaire developed specifically for the study. The questionnaire included both closed and open-ended questions, addressing demographic information as well as perioperative, intraoperative, and postoperative details. Data collection began at induction and continued until the patient was discharged from the PACU, with the ACCPM residents and anesthetists responsible for gathering the data.

4.9. Data Quality Assurance

To ensure data quality, data collectors received training on the study protocols and questionnaire administration. Regular supervision and monitoring were implemented during data collection to maintain consistency and completeness. Double data entry and validation were performed to minimize errors.

4.10. Data Processing and Analysis

Data was entered into a secure database using software such as SPSS version 25. Descriptive statistics were used to summarize the demographic characteristics of the study population, including age, sex, type of surgery, duration of surgery, and ASA physical status. Bivariate and Multivariable logistic regression analysis were performed to identify independent predictors of PRAEs. The odds ratio (OR) and its corresponding 95% confidence interval (CI) were calculated for each independent variable. Adjusted odds ratios (AOR) with corresponding 95% confidence intervals (CI) was calculated to assess the strength of associations

4.11. Ethical Considerations

Ethical approval was obtained from the institutional review board of participating hospitals prior to the commencement of the study. Informed consent was sought from the guardians of all participating pediatric patients. Participation was voluntary, and confidentiality was maintained throughout the study process by anonymizing data and secure storage of all research materials. Participants was entitled to withdraw from the study at any time without any consequence on their medical care.

5. RESULT

5.1 Sociodemographic and preoperative characteristics of the study participants

A total of 176 pediatric patients who underwent surgery under anesthesia participated in the study, resulting in a 100% response rate. Forty-three percent of the study participants were in the 1-5 year age group, and 58% were male. Thirteen percent of the participants had a history of upper respiratory tract infection (URTI), and 54.5% were classified as ASA class I. Twenty-six percent of the participants had comorbid conditions, with neurological disease accounting for 45.7%, followed by cardiac disease (41.3%). Additionally, 29% of the participants had a preoperative hemoglobin level of less than 12%, as shown in the table below.

Table 2: The sociodemographic characteristics of the study participants among surgical pediatric patients at TASH.

Variable	frequency	Percent
Age of the children		
<1month	14	8
1month-1years	31	17.6
1-5 years	76	43.2
5-12 years	55	31.3
Sex of the participants		
Male	102	58
Female	74	42
History of URTI		
Yes	23	13.1
No	153	86.9
History of prematurity		
No	176	100
History of asthma or allergies		
Yes	19	10.5
No	157	89.2
ASA classification		
I	96	54.5
II	52	29.5
III	28	15.9
Comorbidity		
Yes	46	26.1
No	130	73.9
Types of comorbid disease (n=46)		
Cardiac disease	19	41.3
Neurologic condition	21	45.7
Respiratory disease	3	6.5
Other	3	6.5

Preoperative haemoglobin		
<12	51	29
≥12	125	71
Passive smoking		
No	176	0

5.2 Intraoperative related characteristics of the study participants

Sixty-nine percent of the procedures were elective, and 72.2% of the anesthesia techniques used were general anesthesia with endotracheal tube (ETT). Propofol was used to induce anesthesia in 61% of the cases, and 51.1% of the cases were maintained with isoflurane. Muscle relaxants were used in 68% of the cases, with suxamethonium accounting for 75.8% of the muscle relaxants used. Ninety-six percent of the participants required no more than two intubation attempts, and 39.8% of the surgeries had a duration of one hour or less. Eighty-eight percent of the participants experienced blood loss of less than 100 ml and underwent awake extubation.

Table 3: Intraoperative related characteristics of the study participants

Variable	frequency	Percent
Urgency of surgery		
Emergency	54	30.7
Elective	122	69.3
types of ansthesia technique		
GA with face Mask	6	3.4
GA with ETT	127	72.2
GA with LMA	43	24.4
Induction agent		
Ketofol	57	32.4
Propofol	108	61.4
Ketamine	8	4.5
Halothane	3	1.7
Maintenance		

Halothane	75	42.6
Isoflurane	90	51.1
isoflurane and ketamine	2	1.1
isoflurane and propofol	5	2.8
isoflurane, propofol and ketamine	4	2.3
Muscle relaxant used		
Yes	120	68.2
No	56	31.8
Type of relaxant (n=120)		
Atracurium	1	0.8
Sux	91	75.8
Vec	28	23.4
Muscle relaxant for maintained		
Atracurium	1	.6
Not used	115	65.3
Sux	3	1.7
Vec	57	32.4
Number of airways intubation attempt		
≤2	169	96
>2	7	4
Duration of surgery in hours		
<1	70	39.8
≥1	106	60.2
Blood loss during surgery in ml		
<100	155	88.1

100-500	17	9.7
>500	4	2.3
Depth of anaesthesia at extubation		
Awake extubation	155	88.1
Deep extubation	21	11.9

5.3 The Types of case performed surgery procedure

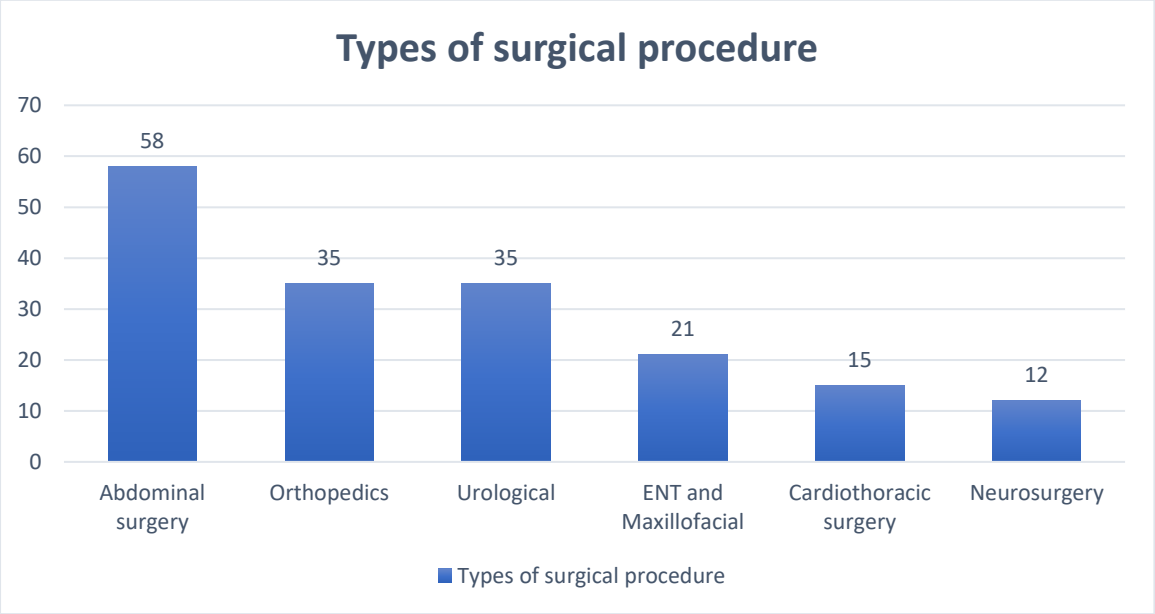

Figure 2: The types of cases performed surgical procedure.

5.4. The health provider related characteristics

Thirty-three percent of the anaesthesia providers were residents and 77.3% of them having 1 to 5 years of experience of. Fifty-three percent of the surgeon were subspecialist and 66.5% of the surgeon had 1-5 years of experience.

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Table 4: The health provider related characteristics

variable	Frequency	Percent
anaesthesia provider information		

Bachelor’s Degree	9	5.1
Master’s degree trainee	26	14.8
Anesthesia resident	58	33.0
Consultant anesthesiologist	36	20.5
Pediatric anesthesiologist	47	26.7
anaesthesia provider experience		
<1yrs	16	9.1
1-5yrs	136	77.3
5-10yrs	24	13.6
surgeon level of education		
senior resident	72	40.9
general surgeon	11	6.3
Sub Specialist Surgeon	93	52.8
surgeon experience in years		
1-5	117	66.5
5-10	46	26.1
>10	13	7.4

5.5 The characteristics of Perioperative Respiratory Adverse Events

The findings of the study showed that 20% (n=36) of the participants experienced at least one episode of an adverse event, as illustrated in the figure below."

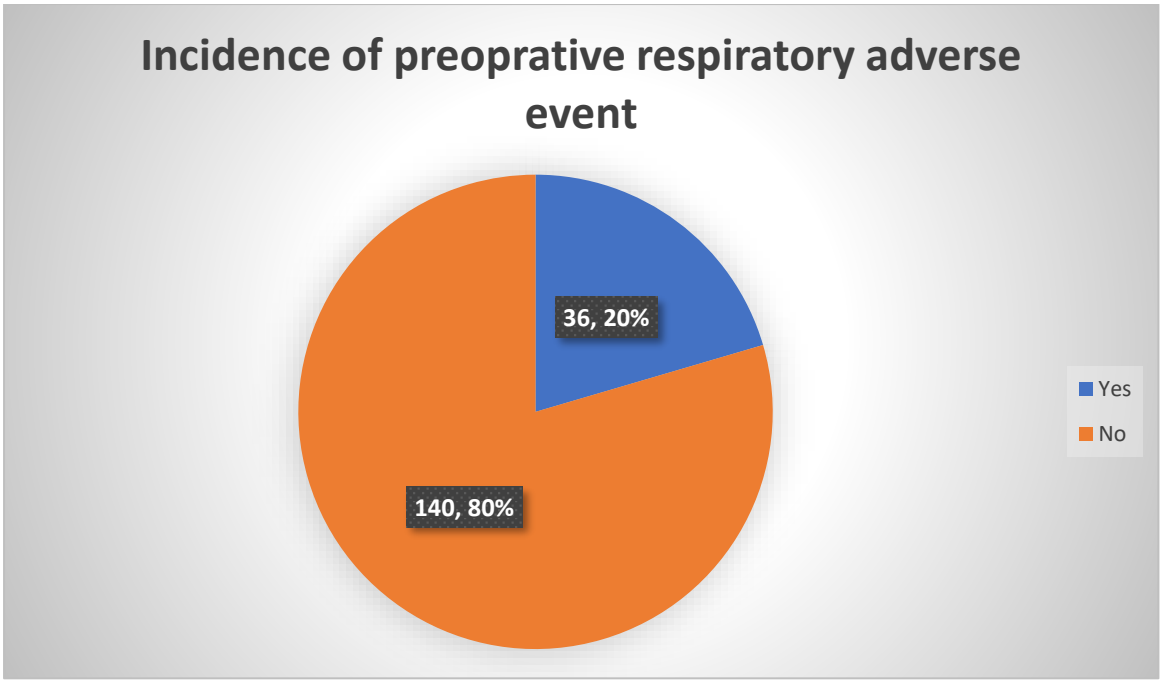

Figure 3 :The incidence of preoperative adverse event among surgical patients at TASH.

Regarding the specific characteristics of adverse events, 10.8% of the participants experienced desaturation. Of those, 52.6% had a desaturation level of 80-89%, and 57.9% of desaturation events occurred during the extubation period. Nineteen percent of the cases had oropharyngeal secretions, with 63.6% having minimal secretion. Four percent of the participants experienced laryngospasm, and 1.7% had bronchospasm. Medical intervention was required in 10.8% of the adverse events, with oxygen support accounting for 21.1%, followed by deep anesthesia (10.5%) and CPAP (10.5%).

Table 5: The characteristics of Perioperative Respiratory Adverse Events

Variable	Response	Frequency	percent
Presence of desaturation	Yes	19	10.8
	No	157	89.2
Level of desaturation(n=19)	<80	6	31.6
	80-89	10	52.6
	90-94	3	15.8
Time of desaturation	Extubation	11	57.9
	Induction	4	21.1

	Intraoperative	3	15.8
	PACU	1	5.3
Presence of oropharyngeal secretion	Yes	33	18.8
	No	143	81.3
Amount of secretion during suctioning(n=33)	Minimal	21	63.6
	Moderate	12	36.4
Presence of Breath holding	Yes	14	8
	No	162	92
Time of breath holding(n=14)	Extubation	6	42.8
	Induction	8	57.2
Duration of breath holding	<15seconds	7	50
	15-30seconds	7	50
Presence of Partial upper airway obstruction	Yes	9	5.1
	No	167	94.9
Presence of Persistent coughing	Yes	5	2.8
	No	171	97.2
Presence of Laryngospasm	Yes	7	4
	No	169	96
Time of laryngospasm occur(n=7)	Induction	2	28.6
	Extubation	4	57.1
	Intraoperative	1	14.3
Presence of Bronchospasm	Yes	3	1.7
	No	173	98.3
End-tidal CO2 change more than 10 mmHg from the patient's baseline	Yes	7	4
	No	169	96

The presence of an unexpected change of more than 30% in heart rate, blood pressure, or respiratory rat	Yes	4	2.3
	No	172	97.7
Intervention done	Yes	19	10.8
	No	157	89.2
Types of intervention (n=19)	Analgesics(opioid)	1	5.3
	CPAP	2	10.5
	Deepen Anesthesia	2	10.5
	Oxygen	4	21.1
	Re-intubation	8	41
	Reposition	1	5.3
	Vasopressor	1	5.3

5.6 The determinant factors of Perioperative Respiratory Adverse Events

The age of the participants, history of upper respiratory tract infection (URTI), ASA class, comorbidities, preoperative hemoglobin levels, urgency of surgery, and duration of surgery were all found to be associated with preoperative respiratory adverse events (PRAE) based on bivariate logistic regression. Multivariate logistic regression revealed that participants with a history of URTI had a 7.6 times increased risk of PRAE compared to those without a history of URTI (AOR = 7.6, 95% CI = 2.14, 27.16). Participants in ASA class II and III had an 8.7 times (AOR = 8.7, 95% CI = 2.74, 27.84) and 4.9 times (AOR = 4.9, 95% CI = 1.23, 19.77) higher risk of PRAE, respectively, compared to those in ASA class I. Additionally, participants whose surgical procedure duration was 1 hour or longer had a 4.4 times increased risk of PRAE compared to those with a surgery duration of less than 1 hour (AOR = 4.4, 95% CI = 1.45, 13.28).

Table 6:shows the bivariate and multivariate associations between preoperative respiratory adverse events and independent variables among pediatric surgical patients at TASH.

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Variable	PRAE		P-value	COR with 95%CI	P-value	AOR with 95%CI
	Yes	No				
Age						
<1month	5	9	0.117	2.8(0.77, 10.48)	0.865	1.2(0.19, 7.35)
1month-1years	6	25	0.726	1.2(0.39, 3.84)	0.217	0.40(0.09, 1.71)
1-5years	16	60	0.501	1.4(0.55, 3.36)	0.734	0.82(0.26, 2.61)
5-12 years	9	46	1		1	
History URTI						
Yes	12	11	0.000	5.9(2.32, 14.82)	0.002	**7.6(2.14, 27.16)**
No	24	129	1		1	
ASA classification						
I	7	89	1		1	
II	19	33	0.000	7.3(2.82, 19.01)	0.000	**8.7(2.74, 27.84)**
III	10	18	0.000	7.1(2.37, 21.02)	0.024	**4.9(1.23, 19.77)**
Comorbidity						
Yes	17	29	0.002	3.4(1.58, 7.41)	0.078	2.6(0.90, 7.28)
No	19	111	1		1	
Preoperative hemoglobin level in mg/dl						
<12	17	34	0.008	2.8(1.31, 5.96)	0.771	0.86(0.32, 2.36)
≥12	19	106	1		1	
Urgency of surgery						
Emergency	18	36	0.006	2.9(1.36, 6.15)	0.274	1.8(0.63, 5.13)
Elective	18	104	1		1	
Duration of surgery						
<1hr	9	61	1		1	
≥1hr	27	79	0.046	2.3(1.02, 5.26)	0.009	**4.4(1.45, 13.28)**

6. DISCUSSION

In this study, the incidence of preoperative respiratory adverse events was 20% (n = 36). This finding is higher than that reported in a study conducted at the University of Belgrade in Serbia (5.8%), studies from Europe (3.9%) and South Africa (11%) [3], [5], [10], [11], [15], [16]. However, it is lower than the incidence reported at the University of Gondar Hospital and Tibebe Ghion Hospital in Ethiopia (26.2%), Wilhelmina Children's Hospital in the Netherlands (46.5%), and the Pediatric Teaching Hospital in France (53%) [3], [5], [16]. The result is also slightly lower than that found at the University Hospital of Geneva in Switzerland (21%) and The Children's Hospital of Philadelphia in the USA (23%) [6], [14].

These differences could be attributed to several factors. One major reason may be variations in the demographic characteristics of the study populations. For instance, some studies included children up to 18 years of age, and a decrease of 8%–11% in the risk of PRAEs has been observed with each additional year of age [6]. Additionally, inconsistencies in the definitions and diagnostic criteria used to identify PRAEs across studies could lead to variations in reporting. Differences in perioperative care standards between high-income and low-income settings may also contribute, as developed countries often have access to advanced monitoring equipment, improved pain management protocols, and highly trained personnel. Furthermore, the presence of pediatric anesthesiologists in some hospitals may enhance the recognition and management of PRAEs."

Oxygen desaturation was observed in 10.8% of patients, making it the most common perioperative respiratory adverse event (PRAE) identified in this study. Most desaturation episodes occurred within the 80–89% range and were predominantly noted after tracheal extubation. This finding is consistent with studies conducted at the University of Gondar and Tibebe Ghion Specialized Hospital in Ethiopia [16], as well as a study from Serbia [10]. Similarly, a multi-center study in Thailand reported desaturation as the most common respiratory adverse event; however, in that study, desaturation occurred more frequently during the intraoperative period rather than during emergence from anesthesia [11]. This may be attributed to reduced respiratory drive caused by residual anesthetic agents and opioids, as well as shallow breathing due to postoperative pain, all of which can impair effective ventilation and oxygenation.

Breath-holding was observed in 8% of the study population, which is consistent with findings from the University of Gondar and Tibebe Ghion Specialized Hospital in Ethiopia (7.6%) and

a study conducted in Serbia [10], [16]. It occurred predominantly during the extubation period. This may be attributed to the effects of inhaled anesthetic agents, which can weaken respiratory muscles and reduce chest wall stability in children. The highly compliant pediatric chest wall may then exhibit paradoxical movement, leading to a reduction in functional residual capacity [10].

The incidence of upper airway obstruction and persistent coughing in our study was 5.1% and 2.8%, respectively. These results are lower than those reported in a study conducted at the University of Gondar and Tibebe Ghion Specialized Hospital in Ethiopia, which found incidences of 10% and 7.1%, respectively [16]. This difference may be attributed to the presence of pediatric anesthesiologists in our setting, who were involved in approximately 21% of the cases. Their specialized expertise likely contributed to the early identification and prompt management of PRAEs. Moreover, children who were not anesthetized by pediatric anesthesiologists were found to have a 1.7 times higher likelihood of experiencing perioperative respiratory adverse events [6]. However, the incidence of persistent coughing in our study is higher than that reported in a Serbian study, which documented only 3 cases among 682 patients [10]. This discrepancy might be due to variations in the definition of persistent coughing.

The incidence of laryngospasm in this study was 4%, with most cases occurring during the extubation phase, followed by the induction period. This finding is consistent with a systematic review by Regli et al., which reported an incidence ranging from 0.1% to 16%, with a 4% occurrence in the general pediatric population [19]. However, the incidence observed in our study is slightly lower than that reported in a previous study conducted in Ethiopia, which found a rate of 5.7% [16]. This difference may be attributed to variations in anesthetic techniques, provider experience, or improved airway management practices in our setting.

In this study, the incidence of bronchospasm was 1.7%, occurring in 3 out of 176 pediatric patients. This finding is slightly higher than the incidence reported in a previous study conducted in Ethiopia, which was 1% (2 out of 225 patients). The slight variation may be attributed to differences in sample size, patient characteristics, or perioperative management.

Participants with a history of upper respiratory tract infection (URTI) had a 7.6-fold increased risk of experiencing perioperative respiratory adverse events (PRAEs) compared to those without such a history (AOR = 7.6, 95% CI: 2.14–27.16). This finding is consistent with studies conducted at the University of Gondar Hospital and Tibebe Ghion Hospital in Ethiopia [16], Belgrade Hospital in Serbia [10], and the University of Michigan in the United States [4]. This association may be explained by the fact that children with a recent URTI often have inflamed and hyperreactive airways, predisposing them to laryngospasm, bronchospasm, and coughing. Additionally, the smaller caliber of pediatric airways and increased respiratory secretions can further exacerbate airway obstruction and oxygen desaturation. Furthermore, certain anesthetic agents can irritate the airways or depress protective reflexes, increasing the risk of significant perioperative respiratory complications.

Study participants classified as ASA class II and III had 8.7 times (AOR = 8.7, 95% CI: 2.74–27.84) and 4.9 times (AOR = 4.9, 95% CI: 1.23–19.77) increased odds of experiencing perioperative respiratory adverse events (PRAEs), respectively, compared to those in ASA class I. This finding is consistent with studies conducted at the University of Gondar and Tibebe Ghion Hospitals in Ethiopia [16], as well as in France, Thailand, and the Netherlands [2], [3], [5]. This association may be attributed to the fact that higher ASA classifications typically indicate the presence of underlying systemic diseases. Such conditions often compromise cardiopulmonary reserve, limiting the patient's ability to tolerate hypoxia or apnea. Additionally, altered physiology in these patients may lead to exaggerated or prolonged effects of anesthetic drugs. These factors collectively contribute to the increased risk of perioperative respiratory complications in patients with higher ASA classifications.

Study participants whose surgical procedures lasted ≥1 hour had a 4.4 times increased likelihood of experiencing perioperative respiratory adverse events (PRAEs) compared to those whose surgeries lasted less than 1 hour (AOR = 4.4, 95% CI: 1.45–13.28). This finding is consistent with a study conducted in Switzerland [13]. The increased risk may be attributed to prolonged exposure to anesthetic agents during longer surgeries, which can suppress

respiratory drive and delay recovery. Additionally, the extended use of airway devices such as endotracheal tubes or laryngeal mask airways (LMAs) may cause airway irritation, edema, or trauma, potentially leading to complications such as laryngospasm, stridor, or postoperative airway obstruction. Furthermore, hypothermia, which is more common during extended procedures, can impair respiratory muscle function and suppress protective airway reflexes. These combined effects make prolonged surgeries a significant risk factor for perioperative respiratory adverse events in children.

7. CONCLUSION AND RECOMMENDATION

7.1 conclusion.

A significant proportion (20%) of the study participants experienced preoperative respiratory adverse events (PRAEs). The factors that contributed to PRAEs were a history of upper respiratory tract infections (URTI), increasing ASA class, and longer duration of the surgical procedure.

7.2. Recommendation

To reduce the significant level of PRAE in high-risk pediatric, the recommendation of this study might be

- ✓ A thorough pre-anesthetic evaluation should be conducted to identify and address potential risk factors. These patients must be managed by experienced anesthetists who are well-equipped to anticipate and handle respiratory complications. Hospital management should prioritize the allocation of trained personnel and necessary resources to support safe pediatric anesthesia practices.
- ✓ Policymakers should ensure the availability of essential pediatric anesthesia equipment and monitoring tools to improve safety during surgery. National protocols for the prevention and management of PRAEs should be developed and implemented to standardize care and reduce complications.
- ✓ Multicenter studies with larger sample sizes and extended study periods are recommended to better understand the full scope of contributing factors to perioperative respiratory adverse events. Future research should also explore outcomes in patients requiring ICU admission.

8. STRENGTHS AND LIMITATIONS.

This study identified a significant incidence of perioperative respiratory adverse events (PRAEs) and highlighted key risk factors that align with existing literature, thereby strengthening the validity of the findings. It included a representative sample of pediatric patients across various age groups, comorbidities, surgical types, and urgency levels, making the results broadly applicable. The study also addressed important perioperative factors specific to pediatric patients and utilized objective tools such as $ETCO_2$ monitoring, enhancing its reliability. However, its cross-sectional design limits the ability to establish causal relationships between risk factors and outcomes. Additionally, being a single-center study, restricting follow-up to the post-anesthesia care unit (PACU) period and excluding patients admitted to the ICU may underestimate the true burden of PRAEs and limit generalizability.

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ANNEXES

Questionnaire: Perioperative Respiratory Adverse Events in Pediatric Surgical Patients

Section 1: Demographics and General Information

Age of Patient:

☐ 0 day-1month ☐ 1month -1 years ☐ 1-5years ☐ 6-12 years

Sex:

☐ Male ☐ Female

Weight (kg):

Height (cm):

Section 2: Preoperative Information

5 .History of Upper Respiratory Tract Infections (URTI):

☐ Yes (active/recent) ☐ No

History of Prematurity (Born before 37 weeks of gestation):

☐ Yes ☐ No

History of Asthma or Allergies:

☐ Yes ☐ No

ASA Classification:

☐ I ☐ II ☐ III ☐ IV

Presence of Comorbidities :

☐ Cardiac Disease

☐ Respiratory Disease (e.g., chronic lung disease)

☐ Neurological Condition

☐ Other (Specify): _____

☐ None

Preoperative Hemoglobin Level : _____ g/d

Passive Smoking Exposure:

☐ Yes ☐ No

Section 3: Intraoperative Data

12. Urgency of surgery: A. Elective B. Emergency

13.Type of Surgery:

I. General Surgery(specify)_____

II. Orthopedics (specify)_____

III. Urology surgery(specify)_____

IV. Neurosurgery(specify)_____

V. ENT (specify)_____

VI.Others (specify)_____

14. Type of anesthesia technique

☐ GA with ETT

☐ GA with LMA

☐ GA with Face Mask

15.Induction agent A. intravenous_____mg

B. inhalational_____agent

16. Maintenance A. Intravenous_____mg

B. inhalational_____

17. Muscle relaxant used. Induction_____mg.

Maintenance_____mg

18.Intraoperative Analgesia medication_____

A. Route_____ B. dose in milligram/microgram

19.Number of Airway Intubation Attempts:

☐ ≤2 ☐ >2

20.Duration of Surgery:

☐ <1 hour ☐ >1 hours

21.Blood Loss During Surgery:

☐ <100 mL ☐ 100-500 mL ☐ >500 mL

22.Depth of Anesthesia at Extubation:

☐ Awake Extubation ☐ Deep Extubation

23. Anesthesia Provider Information

Level of Education:

☐ Bachelor's Degree

☐ Master's Degree trainee

☐ Anesthesia Resident

☐ Consultant Anesthesiologist

☐ Pediatric Anesthesiologist

Experience……..years

Surgeon's Level of Education:

☐ Senior Resident

☐ General Surgeon

☐ Sub Specialist Surgeon

Experience……..years

Section 4: Perioperative Respiratory Adverse Events

25. Desaturation During Anesthesia and PACU

Does desaturation occur?

☐ Yes

☐ No

If yes, what was the lowest SpO2 recorded that persisted for more than 30 seconds?

☐ 90–94%

☐ 80–89%

☐ <80%

When does desaturation occur?

☐ Induction

☐ Intraoperative

☐ Extubation ☐ pacu

26.Oropharyngeal Secretion

Does the patient have oropharyngeal secretion?

☐ Yes

☐ No

If yes, what was the estimated amount of secretion during suctioning?

☐ Minimal

☐ Moderate

☐ Copious

27. Breath Holding

Does breath holding occur during anesthesia?

☐ Yes

☐ No

If yes, when does breath holding occur?

☐ Induction

☐ Intraoperative

☐ Extubation ☐ pacu

Duration of breath holding:

☐ <15 seconds

☐ 15–30 seconds

☐ >30 seconds

28. Partial Upper Airway Obstruction

Does partial upper airway obstruction occur?

☐ Yes

☐ No

If yes, when does it occur?

☐ Induction

☐ Intraoperative

☐ Extubation ☐ pacu

29. Persistent Coughing (>5 seconds)

Does persistent coughing occur during anesthesia?

☐ Yes

☐ No

If yes, when does coughing occur?

☐ Induction

☐ Intraoperative

☐ Extubation ☐ pacu

30. Laryngospasm

Does laryngospasm occur during anesthesia?

☐ Yes

☐ No

If yes, when does laryngospasm occur?

☐ Induction

☐ Intraoperative

☐ Extubation ☐ pacu

31. Bronchospasm

Does bronchospasm occur during anesthesia?

☐ Yes

☐ No

If yes, when does bronchospasm occur?

☐ Induction

☐ Intraoperative

☐ Extubation ☐ pacu

32. End-Tidal CO2 Changes

Does end-tidal CO2 change more than 10 mmHg from the patient’s baseline?

☐ Yes

☐ No

If yes, when does this change occur?

☐ Induction

☐ Intraoperative

☐ Extubation

33. Unexpected Changes in Vital Signs

Does an unexpected change in heart rate, blood pressure, or respiratory rate of more than 30% occur?

☐ Yes

☐ No

If yes, which parameters are affected?

☐ Heart Rate

☐ Blood Pressure

☐ Respiratory Rate

34. Management of Adverse Respiratory Events

Which interventions were given?

☐ Oxygen

☐ Reposition

☐ Airway Maneuvers

☐ CPAP

☐ Deepen Anesthesia

☐ Muscle Relaxant

☐ Bronchodilator

☐ Re-intubation

☐ Suctioning