



**COLLEGE OF MEDICINE AND HEALTH SCIENCE DEPARTMENT
OF ANESTHESIA AND ANESTHESIOLOGY**

**INCIDENCE OF POSTOPERATIVE RESPIRATORY ADVERSE EVENTS
AND PREDICTING FACTORS AMONG PEDIATRIC PATIENTS
OPERATED AT HAWASSA UNIVERSITY COMPREHENSIVE
SPECIALIZED HOSPITAL: SINGLE ARM PROSPECTIVE COHORT
STUDY**

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ANESTHESIA)**

HAWASSA, ETHIOPIA

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APPROVAL SHEET 1

DECLARATION

I, undersigned, declare that this research entitled Incidence of postoperative respiratory adverse events and predicting factors among pediatric patients operated in the Hawassa University Comprehensive Specilized Hospital is my original work, has not been presented in this university or others and an all sources of materials used for study have been fully acknowledged.

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We, member of the board of examiners of the final open defence have read and examine of the thesis entitled incidence of post-operative respiratory adverse events and predicting factors among pediatric patients operated at Hawassa University Comprehensive Specialized Hospital prepared by Tesfaye Asefa MSc student for of partial fulfillment of Masters of degree of science in Clinical anesthesia. This is there for, to certify that thesis has been accepted in partial fulfillment of requirement of degree.

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ABBREVIATION AND ACRONYM

ASA - American Society of Anesthesiologist

AOR-Adjusted Odd Ratio

BMI-Body Mass Index

CI-Confidence Interval

HUSCH-Hawassa University Specialized Comprehensive Hospital

ICU- Intensive Care Unit

OSA-Obstructive Sleep Apnea

PAE-Preoperative Adverse Events

PACU-Post Anesthesia Care Unit

PRAEs- Postoperative Respiratory Adverse Events

VACTREL anomalies -Vertebra,Anal atresia,Cardiac,Trcheaosophageal fistula with atresia,Radial dysplasia,Limb anomalies

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ABSTRACT

Background: Postoperative Respiratory Adverse Events (PREAs) is the impairment of the respiratory system that occurs with the combination of patient condition, anesthetics, and surgical factors. This may result in an extended hospital stay, financial strain on the family, and may increase morbidity and mortality. The objective of this study is to assess the incidence of postoperative respiratory adverse events and predicting factors among pediatric patients operated at Hawassa University Comprehensive Specialized Hospital from January 10-March 30, 2024.

Methods: A prospective cohort study was done with a total of 205 pediatric patients aged 0-15 years were included by using systematic random sampling. Data were collected by using structured questionnaire, entered into Epi-Data, and exported to SPSS version 26 for performing data analysis. Categorical data was analysed by using the chi-squared test, and normally distributed continuous data were analysed by using student t-test. Binary logistic regression was done to identify predicting factors of postoperative respiratory adverse events. Multivariable logistic regression was done in order to identify independent predicting factors of the postoperative respiratory adverse events. In the final model AOR and 95% CI were used to measure of the strength of association and statistical significance respectively, at p-value <0.05.

Results: Among a total of 205 patients operated on at Hawassa University Comprehensive Specialized Hospital, the incidence of postoperative respiratory adverse events was 35.6 % with the 95%CI (28.8 – 42.9). Intraoperative use of opioids (AOR: 2.9, 95% CI:1.24-6.8), spontaneous ventilation (AOR: 4.68, 95% CI: 1.94-11.28), upper respiratory tract infection (AOR: 5.03, 95% CI: 1.84-13.78), general anaesthesia with a cuffed endotracheal tube (AOR: 3.31, 95% CI: 1.23-8.91), age less than 1 month (AOR: 9.2, 95% CI: 1.1-77.2) and age less than 2 years (AOR:4.7,95% CI: 1.06-20.8) were independent predicting factors of postoperative respiratory adverse events.

Conclusion: The postoperative respiratory adverse event among pediatric patients operated at Hawassa University Comprehensive Specialized Hospital was high. Intraoperative use of opioids, spontaneous ventilation technique, patients that have an upper respiratory tract infection, general anesthesia with a cuffed endotracheal tube, and age less than two years were independent predicting factors postoperative respiratory adverse events.

Key words: *Adverse events, General anesthesia, Incidence, pediatrics predicting factors, postoperative respiratory adverse events, respiratory complication*

1. INTRODUCTION

1.1. Background

Adverse events are defined as alterations to a subject's health condition that result in undesirable, unintentional signs, symptoms, diseases, or laboratory abnormalities when using medications, whose occurrence is not due to a related, exactly underlying cause (1). Any episode of desaturation, partial or total airway blockage, continuous coughing, breath holding, bronchospasm, or stridor is considered as a respiratory adverse events (2,3). The term "postoperative respiratory adverse events" refers to the depreciation of the respiratory system resulting from a combination of surgical, anesthetic, and patient factors. These events are measured using devices such as capnography, pulse oximetry, and by severity scoring system (4–6).

Depending on the length of time and surgical treatments, the incidence of postoperative respiratory adverse events in pediatric patients might vary. These events may increase with ventilation strategies, the urgency of surgery, intraoperative anesthesia medication used, type of surgery, patients that have concurrent infections, airway irritation, age less than one year, being underweight or obese, and prolonged procedure (7–9).

Pediatric populations are more prone to morbidity and mortality due to their anatomical and physiological differences from adults, which exposes them to potentially catastrophic circumstances (10,11). These may be due to easily exposed to those adverse events related with the changes of hemodynamic instability, temperature regulation disturbance, easily distorted with airway instruments, medication biotransformation and distribution as well as positioning difficult during intubation(12).

Post-operative respiratory adverse events may be reduced by positioning the patient laterally during extubation, executing airway maneuvers such as chin lift and jaw thrust, decreasing stimulation during intubation, maintaining positive pressure ventilation, and deepening anesthesia during maintenance with propofol and using non-histamine releasing medication (3).

1.2. Statement of the Problem

According to reports, the incidence of postoperative respiratory adverse events ranges from 2.8% to 41% depending on the surgical procedure, timing, and anesthesia used (13–15). Studies by Daniel et al. and X. Zhang et al. report that the percentages of postoperative respiratory adverse events were 19.7% and 9.5%, respectively. According to the study by Daniel et al. found that postoperative respiratory adverse events were high following high-risk procedures (42%), patients undergoing major surgery (37%), patients under general anesthesia (85%), and patients getting neostigmine (69%) and intraoperative muscle relaxants (79%) (16,17).

Patients with upper respiratory tract infections, neuromuscular disorders, surgical operations, ASA categorization greater than II, prolonged anesthesia, obesity, and a history of asthma before surgery may experience a higher frequency of postoperative respiratory adverse events (8,18,19).

A 2010 Canadian study by Fung et al. found that obese children receiving upper airway surgery had a 75.5% incidence of postoperative respiratory adverse events compared with pediatrics' without obesity, or about 24.6% (6). Similarly, in 2022, Toya C. et al. conducted a study in California and found that obese children receiving adenotonsollectomy are at risk for postoperative respiratory complications, decreased oxygen saturation time (less than 90%) (20).

Pediatric patients with URTIs were more susceptible to postoperative respiratory complications, with the incidence of 14.8% and 7.9%, in symptomatic and asymptomatic children respectively. According to a Lee et al. 2020 study in Korea, children with recent URIs have a lower risk of perioperative readmission adverse events (RAEs) when surgery is performed at least 1-2 weeks after the URI symptoms have subsided and if there is confirmation that there is no aberrant preoperative chest picture. Furthermore, regardless of the existence of a URIT, the risk of perioperative RAEs drops by 8% for every year of age (21).

Study conducted in 2021 at West Africa by Irene Wulff et al. on the complex spine deformity revealed that the predictors of postoperative respiratory adverse events are age, spinal curve type, spinal curve etiology, FEV1, FVC, estimated blood loss, and duration of surgery. From study, the incidence of postoperative adverse events is common in the age range of 11–17, and postoperative re-intubation respiratory failure is high (22). A study conducted in North West Ethiopia by Yophtahe Woldegerima et al. in 2021 shows that age < 1 year, ASA ≥ 3, upper

respiratory tract infections, the presence of secretions in the upper airway, and airway-related procedures were predictors of PRAEs (23).

Postoperative respiratory adverse events can lead to financial burden, extended hospital stays, and readmissions. According to research by Western Pacific and associates, patients who experience postoperative respiratory adverse events are more likely to need to be readmitted to the hospital and need outpatient care. \$1053 is the additional expense linked to postoperative respiratory adverse events that happen within 30 days following surgery (24). Respiratory adverse events can cause dangerous hazardous cardiopulmonary arrest, brain damage from oxygen deprivation, brain death, cardiovascular complications, ICU admission for mechanical ventilation, prolonged hospital stays, increased costs, and a rise in morbidity and mortality if they are not recognized and treated.

Modern anesthesia medication, instruments, and monitoring systems may now reduce respiratory adverse events. There is a limited study conducted on post-operative respiratory adverse events. Identifying predicting factors in order to make recommendations for early prevention, diagnosis, and management is mandatory. The goal of this research was to assess the incidence of postoperative respiratory adverse events and the predicting factors in pediatric patients operated at Hawassa University Comprehensive Specialized from January 10- March 30, 2024.

1.3. Significance of the Study

Postoperative respiratory adverse events are catastrophic conditions that affect pediatrics after extubation. Knowing the incidence of postoperative respiratory adverse events will help to alarm and take action in order to prevent, diagnosis, and treat these adverse events. Thus, this study will help pediatrics undergoing surgery, which showed using the opioids' sparing technique for pain management, controlled ventilation, and laryngeal mask airway to assess the patient's condition might reduce PRAEs. Furthermore, it serves as baseline information for future research on postoperative respiratory adverse events. Additionally, it may alarm hospital administrators and policymakers to detect, diagnosis, prevention, management guidance, and standard of care for providing modern instruments and medications.

2. LITERATURE REVIEW

Postoperative respiratory adverse events are occurred frequently among pediatric population, especially pediatric undergoing airway procedure. It leads to prolonged hospital stay, increased costs and increased morbidity and mortality.

2.1. Incidence of Post-operative Respiratory Adverse Events among surgical pediatric patients

The Ohio State University study from 2016 found that the overall incidence of composite PRAE is 2.8%. The study used a two-cohort design, with a validation cohort and a derivation cohort. There were 10,155 individuals in the validation cohort and 8904 patients in the derivation cohort. A PRAE risk of 1.8% was associated with the validation cohort and 3.9% with the development group (25). A study conducted in China by Xeuwan et al. showed that the incidence of major PRAEs was 6.9% (26).

Adverse respiratory episodes are a common occurrence in pediatrics. In 2021, Hugo H. et al. carried out a retrospective cohort research in Colombia, which found that the incidence of the three primary postoperative respiratory adverse events was 1.44% for bronchospasm, 0.68% for laryngospasm, and 0.59% for postoperative respiratory depression (27).

De Wit et al.'s 2018 retrospective study conducted in Utrecht, Netherlands, demonstrates that there is no difference in the occurrence of postoperative respiratory complications for children aged 0–7 years when utilizing a cuffed versus an un-cuffed endotracheal tube. This study indicated that the incidence of postoperative respiratory complications utilizing cuffed tracheal tubes does not increase in the post-anesthesia care unit (PACU) (28).

In North West, Ethiopia, a study carried out in 2021 found a 26% incidence of perioperative respiratory adverse events. It was shown that desaturation was the most frequent adverse occurrence, happening 47.3% of the time. Partial obstruction of the upper airways (16.3%), breath holding (13.2%), chronic coughing (15.6%), laryngospasm (8.5%), and bronchospasm (1.6%) came next. Majority of adverse events were occurred after extubation(69.0%) (23).

One aspect of diminishing the risks and incidence of postoperative respiratory adverse events is creating a management strategy by assessing the anatomy of the airways prior to the procedure.

Due to stimulation and hyperactivity during intubation and repeated attempts, the most frequent complication is linked to airway-related issues (5,29).

2.2. Predicting factors of Postoperative Respiratory Adverse Events among surgical pediatric patients

Preoperatively raised red cell distribution width is linked to an increased risk of respiratory adverse events, which were found to be 20.4% in the post-anesthesia care unit and 22.3% during emergence from anesthesia, according to a 2017 prospective observational study conducted in Turkey by B. Kozhan and M.S. Lyisoy on the predictors of postoperative respiratory adverse events in pediatric patients who underwent adenotonsillectomy (14).

Predictors of the development of PRAEs may include age ≤ 3 years, ASA physical status II or III, morbid obesity, prior pulmonary problems, and surgery. With a total score ranging from 0 to 11 for all risk variables, each significant variable has a risk value between 0 and 3 (25).

A review and a case report done in Germany by Maximal David et al. in 2020 revealed that the incidence of postoperative respiratory adverse events after intra opioid use is variable, ranging from 0.13 to 0.46%. In an effort to lessen this issue, multiple investigators have offered recommendations. Among these are lowering the dosage of opioids when taken in combination with other medications and providing appropriate or close monitoring for severe drowsiness (30).

According to a retrospective cohort study carried out in Boston, USA, in 2019 by Scheffenbichler et al., an overdose of neuromuscular blocking drugs raises post-operative respiratory adverse events (PRAEs) by 17%. The PRAE for infants under 1 year is 7%, and for infants over 1 year, it is 10%. The reason for the occurrence of those events was the risk of neostigmine, which should not be used inappropriately because it cannot reverse deep block, and drug titration (31).

A study carried out in Western Australia found that children who were given inhalation anesthetic medication had a higher rate of perioperative respiratory adverse events than those who received intravenous induction (32). The incidence of desaturation events was lessened by using muscle relaxants in conjunction with regulated breathing to maintain a good respiratory condition during airway prosthesis. Due to the higher ventilation volume, the respiratory status of the controlled ventilation was improved, and there were fewer hypoxic episodes (33).

2.3. Conceptual Frame Work

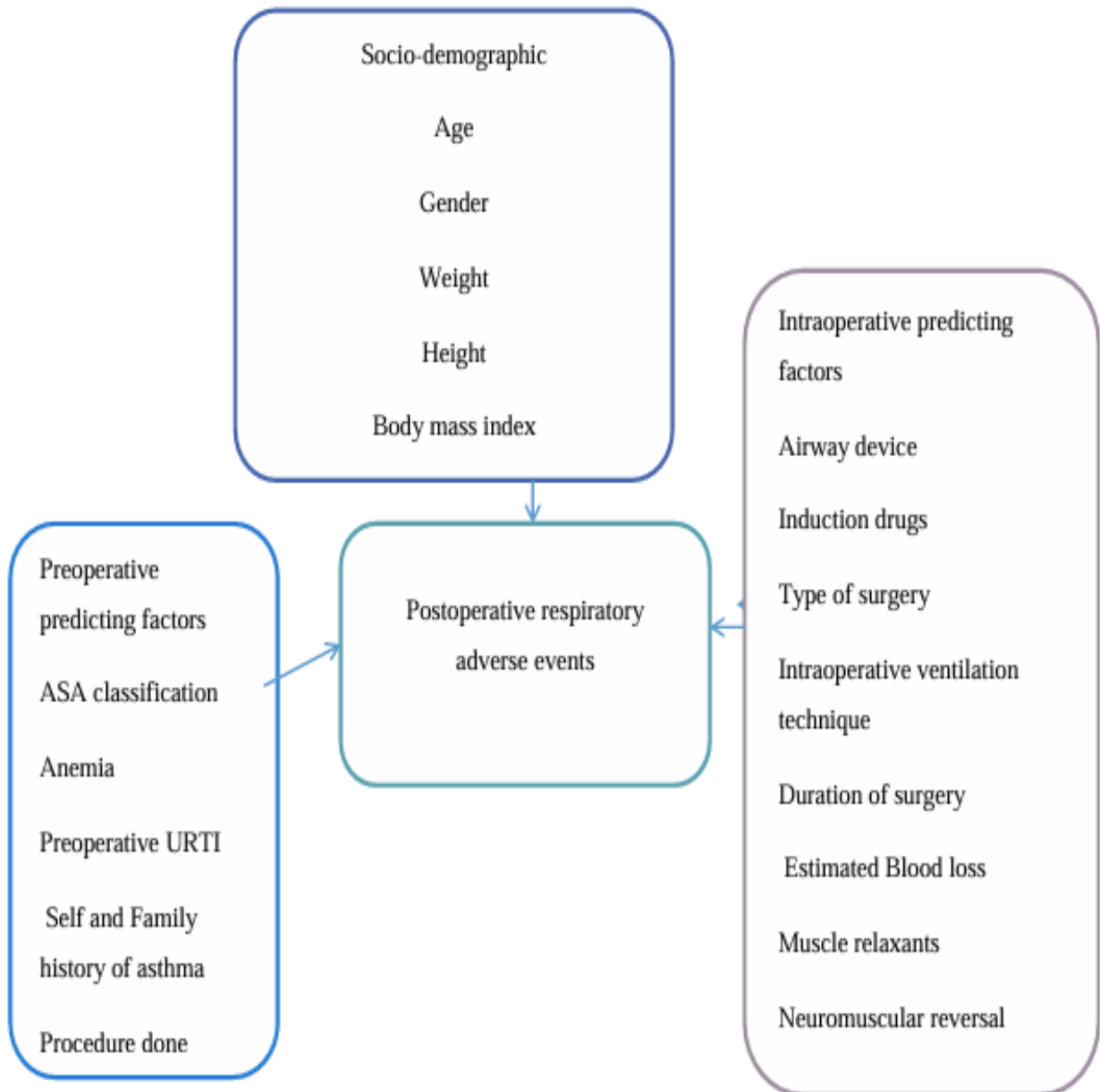


Figure 1: Conceptual frame work adopted from literature review

3. OBJECTIVES OF THE STUDY

3.1. General objective

- To assess the incidence of postoperative respiratory adverse events and predicting factors among pediatric patients operated at Hawassa University Comprehensive Specialized, 2024.

3.2. Specific objectives

- To determine the incidence of postoperative respiratory adverse events among pediatric patients operated at Hawassa University Comprehensive Specialized Hospital, 2024.
- To identify factors predicting postoperative respiratory adverse events among pediatric patients operated at Hawassa University Comprehensive Specialized Hospital, 2024.

Research question:

- ✚ What is the incidence of postoperative respiratory adverse events among pediatric patients operated at HUSCH?
- ✚ What are the factors predicting postoperative respiratory adverse events among pediatric patients underwent surgery under general anesthesia?

4. METHODS AND MATERIALS

4.1. Study Period and Area

The study was conducted at Hawassa University Comprehensive Specialized Hospital, which is located about 275 km from Addis Ababa, Ethiopia, from January 10 to March 10, 2024. It is one of the universities in southern Ethiopia that provides services in different specialties and teaches health professionals in different sectors. There are 6 major operation rooms, two caesarean section operation rooms, two orthopedics, and ophthalmology operation rooms found in the hospital.

4.2. Study Design

A single-arm prospective cohort study was employed to assess the incidence of PRAEs at HUSCH.

4.3. Population

4.3.1. Source Population

All pediatric patients who undergo surgery at Hawassa University Comprehensive Specialized Hospital.

4.3.2. Study Population

All pediatric patients who were operated under general anesthesia in Hawassa University Comprehensive Specialized Hospital during data collection.

4.4. Inclusion and Exclusion criteria

4.4.1. Inclusion criteria

Pediatric patients who were operated under general anesthesia in HUCSH during data collection.

4.4.2. Exclusion criteria

ASA \geq III

Pediatrics that have congenital anomalies (e.g., VACTREL syndrome) and neurological anomalies like Chiari malformation

Pediatrics preoperatively on oxygen, with acute respiratory distress and who required mechanical ventilation

Severe head injury

Major trauma (cause prolonged disability or death)

4.5. Sample size Determination and Sampling Technique

4.5.1. Sample size determination

The sample size was calculated by single population formulae

$$n = z^2 \times p(1-p) / d^2$$

Where $z=0.96$ that of 95% CI

$P=0.5(50\%)$, since no previous study

$d=0.05$ =margin of error

From this $=0.96^2 \times 0.5 \times 0.5 / 0.05^2 = 384$

By finite population correction formulae, $n = n / 1 + n / N = 384 / 1 + 384 / 356 = 186$, with consideration of non-response rate our sample size is 205

Where N =number of pediatrics underwent under general anesthesia from January to March, 2024 at HUSH.

n =sample size

4.5.2. Sampling technique and procedure

All pediatric patients who met inclusion criteria were incorporated into study by systematic random sampling. The situational analysis on the pediatrics operated at Hawassa University comprehensive Specialized Hospital from January to March, 2023 were 356. The K interval of taking study participants are determined by $K = N / n = 356 / 186 \sim 2$.

4.6. Variables

4.6.1. Dependent variables

Postoperative respiratory adverse events

4.6.2. Independent variables

Socio-demographic data: age, sex, weight, height, BMI.

Preoperative predicting factors: ASA classification, anemia, family history of asthma, and preoperative upper respiratory infection, types of procedure.

Intraoperative predicting factors: airway device, intraoperative medication use, type of surgery, intraoperative ventilation techniques, and estimated blood loss.

4.7. Operational Definition

Postoperative respiratory adverse events are defined as content of the following terms.

Breath holding: Breath holding: cessation of breathing for more than 15 seconds and associated with a heart rate < 80 beats per minute (23).

Laryngospasm: Partial or complete airway obstruction and chest rigidity respond to positive pressure ventilation after airway maneuver's, bag mask ventilation or suxamethanium chloride (34).

Desaturation : O₂ saturation <95% regardless of oxygen administration (35).

Coughing: greater than 1-2 coughing for 10 seconds.

Respiratory depression: if the patient's respiratory rate is ≤ 5 breaths per minute with oxygen saturation $\leq 85\%$ of ≥ 3 minutes (36).

Airway obstruction: postoperative symptom of cough, stridor, retraction, inspiratory breathing, cyanosis, or score ≥ 1 (37).

Postoperative stridor: a high-pitched barky cough or hoarseness sound develops in the first hours after extubation (38) .

Pediatrics: defined as age classified as 0–15 years old(39). Pediatrics: age classification: 0-1month, 1month-2 years, 2 years-12 years, above 12 years (40,41).

Anemia: a clinical scenario in which hemoglobin levels are < 10 mg/dl for children aged <1 month, <11 mg/dl for 1 month–2 years, <11.5 mg/dl for children aged 2–12 years, and <12 mg/dl for 12–15 years (42,43).

Body mass index: underweight if <2 percentile for age less than 1 month and <5th percentile for age >1 month; normal between 2nd and 85th percentile for age <1 month and between 5th and 85th percentile for age >1 month; overweight if between 85th and 95th percentile for age > 1 month and >85th for age <1 month; obese if >95th percentile for age > 1 month (44,45).

Emergence from anesthesia: It is a combination of deleterious of idea, mental status and association with delirium after anesthesia within 5 minute after extubation (46).

4.8. Data Collection Technique and Tool

Data was collected after training had been given for data collectors (two nurse's professionals, two anesthesia professionals, and one MSc anesthesia supervisor). Data was collected by using a structured questionnaire. The data collected included socio-demographic data such as age, gender, weight, height, and body mass index.

Preoperative predicting factors included ASA classification, history of upper respiratory tract infection, preoperative haemoglobin, preoperative haematocrit, procedure done for the patient, and self- and family history of asthma were reviewed from preoperative anesthesia record chart and patient record chart. Intraoperative predicting factors included were duration of surgery, induction drugs, maintenance medication (inhalational and neuromuscular relaxants), reversal of muscle relaxants given, analgesia (opioid, caudal block ,combined caudal and paracetamol or combined caudal and opioid, and others(TAP block, sciatic nerve block, and diclofenac)), type of procedure (ophthalmology surgery, general paediatric surgery, ENT surgery, neurosurgery and others(Orthopaedics, plastics, maxillofacial surgery thoracic and upper abdominal surgery), technique of ventilation(Spontaneous ventilation, controlled ventilation, airway device(face mask, laryngeal mask airway device, un-cuffed endotracheal tube, cuffed endotracheal tube), tube size, laryngeal mask airway size, estimated blood loss, and fluid type were obtained from the anaesthesia record chart.

The presence of postoperative respiratory adverse events was recorded during the follow-up period, which started from the emergence of anesthesia to the admission and patient stay in the post-anesthesia care unit and neonatal intensive care unit over 60 minutes, by using the scoring systems described in Table 1 and pulse oximetry for oxygen desaturation. The occurrence (any episode ≥ 1 score) of laryngospasm, desaturation/hypoxemia, stridor, cough, breath-holding, continuous coughing, and respiratory depression were considered as PRAEs (Table 1).

Table 1: Postoperative respiratory adverse events assessment scoring system

	Severity Score(47)				
	0	1	2	3	
Laryngospasm	None	Partial obstruction requiring positioning only	Partial obstruction requiring positive ventilation	Complete obstruction requiring muscle relaxants	
Breath holding	None	>15 seconds	15-30 seconds	>30 seconds	
Desaturation	95-100	90-94	80-89	<80	
Respiratory depression	No	≤5 breath/min	<5 breath/min	<3 breath/min	
Cough	No	1-2 cough	3-4 cough	Continuous coughing	
Secretion	No	Minimal suctioning	Moderate suctioning(one suctioning)	More than one suctioning	
Bronchospasm	No	Wheezing on inspiratory phase	Wheezing of Expiratory phase and inspiratory phase	Difficult to ventilate and responds to bronchodilators	

Note: 0: no postoperative adverse events, 1: Mild, 2: moderate, 3: severe PRAEs

Continued Table 1

	Severity Score			
	Respiratory events	0	1	2
Air way obstruction (37)	Cough	None	Horsness	Barking cough
	Stridor	None	Inspiratory	Both inspiratory and expiratory
	Retraction	None	Suprasternal	Suprasternal and sub sternal and intercostal
	Cyanosis	None	<95% at room air	<95 with 40% of oxygen
	Inspiratory breath sound	None	Harsh with rhonchi	Delayed
Stridor		None	Inspiratory	Both inspiratory and expiratory

Note: for Airway obstruction if combination of all parameters is” 0 “is no PRAEs,if combination of all parameters’ is ≥ 1 taken as PRAEs.

4.9. Data Processing and Analysis

The data was imported into Epi-Data version 4.6 and exported to SPSS Window version 26 for data processing and analysis after the questionnaire's completeness was manually checked and coded. Reliability of data collection tools were checked by using Cronbach alpha ($\alpha = 0.73$, indicating data were reliable). Descriptive categorical data was presented using frequency and percent, and normally distributed continuous data was presented using the mean and standard deviation. The Kolmogorov and Shapiro-Wilk tests were used to assess normally distributed data. Categorical data was analysed using the chi square test, and continuous data was analysed using the independent sample t-test.

Binary logistic regression was used to identify predictors’ of postoperative respiratory adverse events. Bivariate logistic regression analysis was conducted to select the variables fit for multivariable analysis and to obtain crude association. The variable with a P value less than 25% on bivariate logistic regression analysis to determine independent predictors and adjusted association by controlling confounders. Model fitness was checked by the Hosmer-Lemeshow goodness of fit test with a p value >0.05 , and multicollinearity was checked by using the variance

inflation factor (VIF<10) and tolerance >10%.In the final model Adjusted odd ratio (AOR) and 95% confidence interval (CI) were used to measure the strength of association and statistical significance respectively, at p value less than 0.05.

4.10. Data Quality Control

Data was collected in the form of a structured questionnaire after the pre-test was done at Wollaita Sodo University Comprehensive Specialized Hospital. Training was given to the data collector and supervisor after the pretest was done in order to assure data reliability and validity. A pretest was done on 5% (10) of the sample population, and possible adjustments were applied. During data collection regular supervision and follow-up were done.

4.11. Dissemination plan

A copy of the research paper will be prepared and disseminated to the College of Medicine and Health Sciences, Department of Anesthesia and Anesthesiology, Hawassa University Comprehensive Specialized Hospital. It will be published and presented to conference.

4.12 Ethical Consideration

An ethical clearance to conduct this study was obtained from the Hawassa University institutional board review Ref. No. (IRB/065/16). After the aim and benefits of the study were explained, written informed consent was obtained from each family member, relative, and legal guardian after translated to Sidamigna, Amharic, and Afan Oromo. The confidentiality of the participants was maintained.

5. RESULTS

5.1. Socio-demographic characteristics of pediatric patients operated at HUCSH

A total of 205 pediatric patients were included in the study, with a **93%** response rate. More than half (60.5%) of the study participants were males, and the rest were females. 134 (65.4%) were aged between 2 and 12 years old, and those who were aged less than one month were 10 (4.8%). More than half (54.6%) of participants had a normal BMI, and less than one-fourth (19%) were obese (Table 2).

Table 2: Socio-demographic characteristics of pediatric patients operated at HUSCH, 2024 (n=205)

Variables	Categories	Frequency (%)	PRAEs, frequency (%)	
			Yes (n= 73)	No (n= 132)
			73(35.6%)	132(64.4%)
Age	0-1month	10(4.8)	6(60)	4(40)
	1month-2 years	42(20.5)	16(38.1)	26(61.9)
	2-12 years	134(65.4)	47(35.1)	87(64.9)
	12-15 years	19(9.3)	4(21.1)	15(78.9)
Gender	Male	124(60.5)	51(41.1)	73(58.9)
	Female	81(39.5)	22(27.2)	59(72.8)
BMI	Underweight	40(19.5)	17(42.5)	23(62.5)
	Normal	112(54.6)	30(26.8)	82(73.2)
	Overweight	14(6.8)	5(35.7)	9(64.3)
	Obesity	39(19)	21(53.8)	18(46.2)

5.2. Preoperative predicting factors of PRAEs among pediatric patients operated at HUCSH

The majority (83.4%) of the study participants were ASA 1, and the rest were ASA 2 (16.6%). Less than one-fourth (14.6%) of study participants had an upper respiratory tract infection, while the majority (85.4%) of them had no upper respiratory tract infection. The majority of study participants were operated on as electives (80.5%), and less than one-fourth (19.5%) were operated on as emergencies. Less than one-fourth (19%) of participants had a personal or family history of asthma, but the majority (81%) of participants had no personal or family history of asthma. The mean and standard deviation for hemoglobin and hematocrit of the study participants were 12.5 ± 1.6 and 35.2 ± 4.27 , respectively (Table 3).

Table 3: Cross tabulation of preoperative predicting factors among pediatric patients operated at HUSCH, 2024 (n=205)

Variables	Categories	Frequency (%)	PRAEs (n=205)	
			Yes =73 73(35.6)	No =132 132(64.4)
ASA	ASA 1	171(83.4)	57(33.3)	114(66.7)
	ASA 2	34(16.6)	16(47.1)	18(52.9)
Upper respiratory tract infection	Yes	30(14.6)	19(63.3)	11(36.7)
	No	175(85.4)	54(30.9)	121(69.1)
Self and family history of asthma	Yes	39(19)	19(48.7)	20(51.3)
	No	166(81)	54(32.5)	112(67.5)
Procedure done	Elective	165(80.5)	55(33.3)	110(66.7)
	Emergency	40(19.5)	18(45)	22(55)
Preoperative haemoglobin		12.5 ± 1.6	12.3 ± 1.5	12.6 ± 1.6
Preoperative haematocrit		35.2 ± 4.27	34.7 ± 4.5	35.6 ± 4.2

5.3. Intraoperative predicting factors of postoperative respiratory adverse events among pediatric patients operated at HUSCH

The majority (86.3%) of study participants were operated on within less than two hours, and the rest were operated on for more than two hours. About 124 (60.5%) patients were induced with propofol and greater than one-fourth (31.2%) with both ketamine and propofol, but only 17 (8.3%) were induced with ketamine alone. More than half (57.1%) of participants were maintained with isoflurane, and the remaining were with halothane. Nearly three-fourths (72.2%) of participants were taking neuromuscular relaxants, and 27.8% were not taking neuromuscular relaxants. Among study participants who were taking neuromuscular relaxants for maintenance, more than half (60.1%) were maintained with suxamethonium chloride; while more than one-third (39.9%) were maintained with vecronium bromide (Table 4).

Table 4: Cross tabulation of intraoperative predicting factors among pediatric patients operated at HUSCH, 2024 (n=205)

Variables	Items	Frequency (%)	PRAEs (n=205), frequency (%)	
			Yes =73	No =132
			73(35.6)	132(64.4)
Duration of surgery	<2 hours	177(86.3)	59(33.3)	118(66.7)
	>2 hours	28(13.7)	14(50)	14(50)
Iv Induction	Propofol	124(60.5)	45(36.3)	79(62.7)
	Ketamine	17(8.3)	3(17.6)	14(82.4)
	Ketamine and Propofol	64(31.2)	25(39.1)	39(60.9)
Inhalational	Halothane	88(42.9)	24(27.3)	64(62.7)
	Isoflurane	117(57.1)	49(41.9)	68(58.1)
Neuromuscular relaxants given	Yes	148(72.2)	57(38.5)	91(61.5)
	No	57(27.8)	16(28.1)	41(61.5)

Continued Table 4

Variables	Items	Frequency (%)	PRAEs (n=205).frequency (%)	
			Yes	No
Muscle relaxants given for maintenance	Suxamethanium chloride	89(60.1)	31(34.8)	58(65.2)
	Vecronium bromide	59(39.9)	18(30.5)	41(69.5)
Reversal given	Yes	59(28.8)	25(42.4)	34(57.6)
	No	148(71.2)	48(32.9)	98(67.1)
Analgesia given	Opioids	72(35.1)	35(48.6)	37(51.4)
	Caudal block	9(4.4)	3(33.3)	6(66.7)
	Paracetamol	95(46.3)	25(26.3)	70(73.7)
	Caudal block and opioid	8(3.9)	3(37.50)	5(62.50)
	Caudal block and paracetamol	13(6.3)	5(38.5)	8(61.5)
	Others (TAP block, Sciatic nerve block, and diclofenac)	8(3.9)	2(25)	6(75)
Type of surgery done	Ophthalmology	73(35.6)	27(37.0%)	46(63.0%)
	General surgery	68(33.2)	23(37)	46(63)
	ENT	42(20.5)	18(42.9)	24(57.1)
	Neurosurgery	14(6.8)	4(28.6)	10(71.4)
	Others(Orthopedics, plastic surgery,maxillo-facial surgery)	8(3.9)	1(12.5)	7(87.5%)

Regarding intraoperative analgesia given, nearly half (46.3%) of patients had taken paracetamol, and greater than one-third (35.1%) had taken opioids, but only nine (4.4%) had caudal block alone, and eight (3.9%) were managed with other analgesia techniques

Continued Table 4

Variables	Items	Frequency (%)	PRAEs (n=205).frequency (%)	
			Yes=73	No=124
			73(35.6)	124(64.4)
Ventilation technique	Controlled ventilation	116(56.6)	35(30.2)	81(69.8)
	Spontaneous ventilation	89(43.4)	38(42.7)	51(57.3)
Airway device	General anesthesia with LMA	69(33.7)	19(27.5)	50(72.5)
	General anesthesia with un cuffed endotracheal tube	11(5.3)	6(54.5)	5(45.5)
	General anesthesia with cuffed endotracheal tube	120 (58.5)	47(39.2)	73(60.8)
	Face mask	5(2.4)	1(20)	4(80)
Estimated blood loss	Null (no bleeding)	14(6.8)	5(37.5)	9(62.5)
	<50ml	17(8.3)	5(29.4)	12(70.6)
	50-100ml	62(30.2)	25(40.3)	37(59.7)
	100-150ml	90(43.9)	28(31.1)	62(68.9)
	>200ml	22(10.7)	10(45.5)	12(54.5)

Continued Table 4

Variables	Items	Frequency (%)	PRAEs (n=205), frequency (%)	
			Yes =73	No=124
			73(35.6)	124(64.4)
Fluid type	Normal saline	181(88.3)	64(43.6)	117(56.4)
	Ringer lactate	10(4.9)	3(30)	7(70)
	Glucose and normal saline	14(6.8)	6(50)	8(50)
Tube size	2.5-3	20(16.3)	7(35)	13(65)
	3-3.5	11(8.9)	8(72.7)	3(27.3)
	3.5-4	11(8.9)	3(27.3)	8(72.7)
	4-4.5	31(25.2)	8(25.8)	23(74.2)
	4.5-5	41(33.3)	12(29.3)	29(70.7)
	5.5-6	9(4.4)	4(44.4)	5(55.6)
LMA size		2.07±0.32	2.09±0.29	2.04±0.34

Regarding the types of procedures conducted, ophthalmological surgery accounted for 73 (35.6%), general surgery 68 (33.2%), ENT 42 (20.5%), and neurology 14 (6.8%). Related to mode of ventilation, 89 (43.4%) of study participants were spontaneously ventilated, and 116 (56.6%) were mechanically ventilated (Table 4).

Greater than half (58.5%) of study participants were intubated by using a cuffed endotracheal tube, and 9 (4.4%) were intubated with an un-cuffed endotracheal tube, while about one third (33.7%) of study participants airways were managed by using laryngeal mask airways. About one-third (33.3%) of participants were intubated with a tube size within the range of 4-4.5 cm internal diameter (ID). Only 9 (4.4%) of patients were intubated by using a 5–6 cm ID. The mean and standard deviation of the LMA size used were 2.07 ± 0.32 . Nearly half (43.9%) were

bleeding about estimated blood loss in the range of 100–150 ml, and only 14 (6.8%) had null estimated blood loss. Regarding the intraoperative fluid given, the majority (88.3%) of patients were given normal saline, and only 10 (4.9%) were given ringer lactate (Table 4).

5.4. Incidence of postoperative respiratory adverse events among pediatric patients operated at HUCSH.

The incidence of Postoperative respiratory adverse events among paediatric patients operated at HUCSH was 73 (35.6%) with the 95%CI (28.8 – 42.9) (Figure 2).

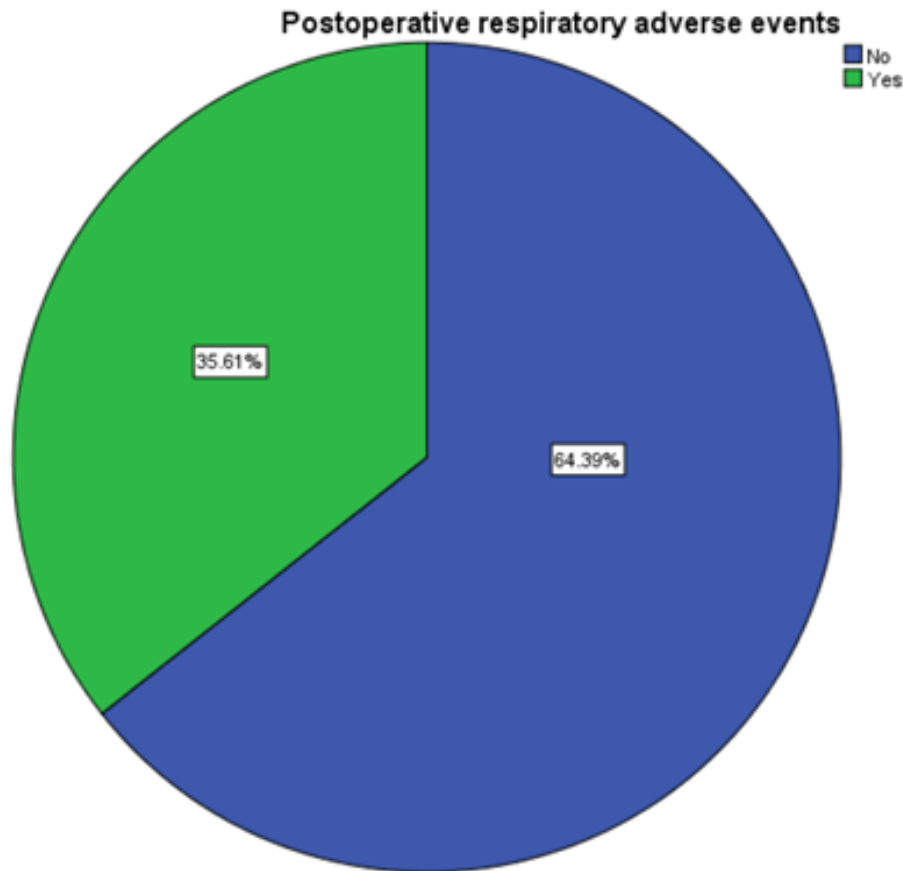


Figure 2: Incidence of postoperative respiratory adverse events among pediatric patients operated at Hawassa University Comprehensive Specialized Hospital, 2024 (n=205)

5.4.1. Follow up time of postoperative respiratory adverse events among pediatric patients operated at HUSCH

Among the total of 73 pediatric patients that manifested PRAEs, the incidence was high in the first 1–5 minutes: 40 (54.7%) after extubation, followed by 5 minutes after the post-anesthesia care unit, which was 16%. But it was not constant over time during follow-up time. 9.6% during admission time and 16% after 5 minutes 2.7% after 10 minutes, 6.8% at 15 minutes, and 2.7 at 60 minutes at the post-anesthesia care unit (Figure 3).

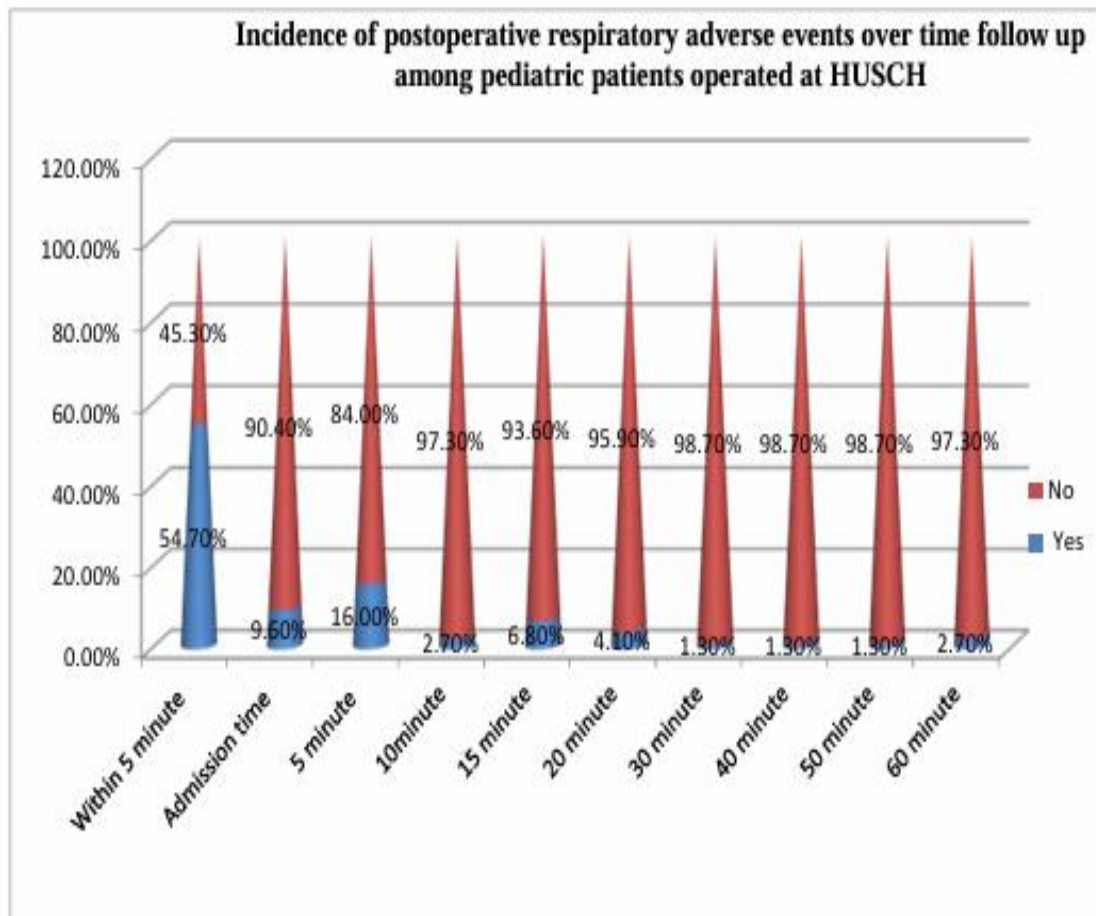


Figure 3: Proportion of postoperative respiratory adverse events follow up time among pediatric patients at HUCSH, 2024 (n=205)

Note: Within 5 minute after shows time of emergence from anesthesia

From the episodes that occurred during follow-up time, the most adverse events were oxygen desaturation (72.5%), followed by airway obstruction (32.29%), secretion (25%), and laryngospasm (15.6%) in the first one to five minutes during the emergence period. The incidence of desaturation, secretion airway obstruction, and breath holding was 42.86%, 28.6%, 16.5%, and 14.3% during admission time to the post-anesthesia care unit or neonatal intensive care unit. At one hour in the post-anesthesia unit and neonatal unit only patient had airway obstruction about 2.7 (Figure 4).

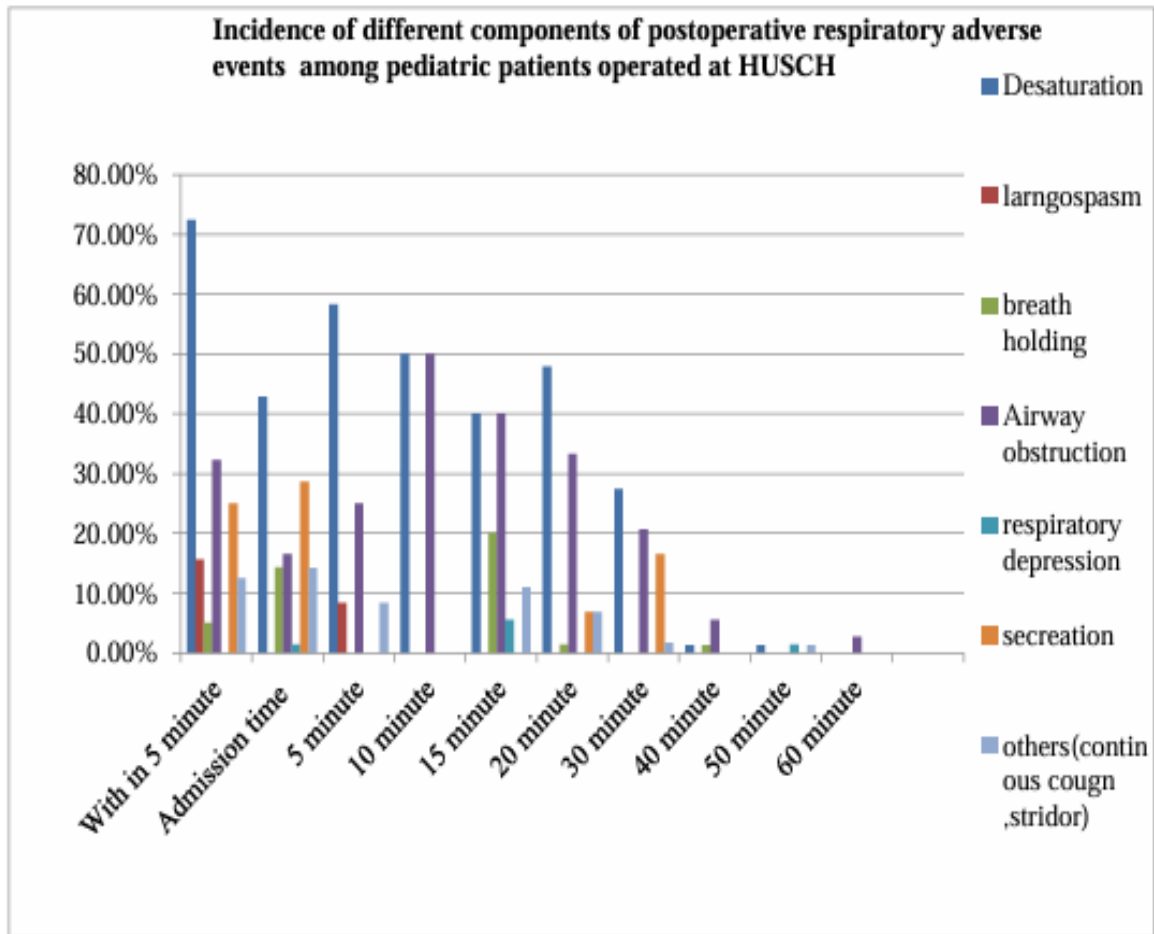


Figure 4: Proportion of different components of postoperative respiratory adverse events among pediatric patients operated at HUSCH, 2024 (n=205)

5.5.1. Predicting factors of postoperative respiratory adverse events among pediatric patients operated at HUSCH

Binary logistic regression was conducted to identify factors predicting postoperative respiratory adverse events. Bivariate logistic regression was conducted to select candidate variables for multivariate logistic regression and was determined with crude association. Hence, gender, age, body mass index, American society of anesthesiologists, duration of surgery, patient taking neuro-muscular relaxant drugs, patient taking inhalational drugs, upper respiratory tract infection, self and family history of asthma, intraoperative analgesia given, airway device, ventilation technique, type of surgery, neuromuscular reversal drugs, and preoperative

haemoglobin were factors significantly predicting postoperative adverse events at a P value less than 25% (Table 5).

Table 5: Results of Bi-variable logistic regression of factors predicting of postoperative respiratory events among pediatric patients operated at HUSCH, 2024 (n=205)

Variable	Categories	Frequency (%)	PRAEs(n=205)		COR(95%CI)	P Value
			Yes =73	No =132		
			73(35.6)	132(64.4)		
Gender	Female	81(39.5)	22(27.2)	59(72.8)	0.53(0.29-0.97)	0.042
	Male	124(60.5)	51(41.1)	73(58.9)	1	
Age	<1 month	10(4.8)	6(60)	4(40)	8.75(1.5-50.1)	0.015
	1month -2 year	42(20.5)	16(38.1)	26(61.9)	3.4(0.88-10.9)	0.08
	2year-12 year	134(65.4)	47(35.1)	87(64.9)	1.8 (0.56-5.7)	0.33
	12-15 year	19(9.3)	4(21.1)	15(78.9)	1	
BMI	Underweight	40(19.5)	17(42.5)	23(62.5)	1	
	Normal	112(54.6)	30(26.8)	82(73.2)	0.5(0.23-1.05)	0.07
	Overweight	14(6.8)	5(35.7)	9(64.3)	0.75(0.21-2.65)	0.66
	Obesity	39(19)	21(53.8)	18(46.2)	1.58(0.65-3.84)	0.31
ASA classification	ASA1	171(83.4)	57(33.3)	114(66.7)	1	
	ASA 2	34(16.6)	16(47.1)	18(52.9)	1.78(0.84-3.74)	0.13

Continued Table 5

Variables	Items	Frequency (%)	PRAES(n=205), frequency(%)		COR(95%CI)	P Value
			Yes =73	No=124		
			73(35.6)	124(64.4)		
Duration of surgery	<2 hours	177(86.3)	59(33.3)	118(66.7)	1	
	>2 hours	28(13.6)	14(50)	14(50)	2.0 (0.895-4.47)	0.091
Patient take neuromuscular relaxants	Yes	148(72.2)	57(38.5)	91(61.5)	1	
	No	57(27.8)	16(28.1)	41(61.5)	1.61(0.825-3.12)	0.16
Inhalational anesthesia	Halothane	88(42.9)	24(27.3)	64(62.7)	1	
	Isoflurane	117(57.1)	49(41.9)	68(58.1)	1.92(1.1-3.49)	0.03
Upper respiratory tract infection	No	30(14.6)	19(63.3)	11(36.7)		
	Yes	175(85.4)	54(30.9)	121(69.1)	2.6(1.1-6.1)	0.03
Procedure	Elective	165(80.4)	55(33.3)	110(66.7)	1	
	Emergency	40(19.6)	22(55)	18(45)	1.64(0.81-3.3)	0.17
Self and family history of asthma	No	166(81)	54(32.5)	112(67.5)	1	
	Yes	39(19)	19(48.7)	20(51.3)	1.97(0.97-4.0)	0.06
Preoperative hemoglobin		12.48±1.6	12.3±1.5 2	12.6±1.6	0.87(0.72-1.04)	0.12

Continued Table 5

Variables	Items	Frequency (%)	PRAEs (n=205), frequency (%)		COR(95% CI)	P value
			Yes =73	No=124		
			73(35.6)	124(64 .4)		
Analgesia given	Paracetamol	95(46.3)	25(26.3)	70(73.7)	1	
	Opioid	72(35.1)	34(47.2)	38(52.8)	2.65(1.38-5.1)	0.003
	Caudal block	9(4.4)	3(33.3)	6(66.7)	1.4(0.33-6.02)	0.65
	Combined caudal and opioid	8(3.9)	3(37.5)	5(62.5)	1.7(0.37-7.55)	0.5
	Combined caudal and paracetamol	13(6.3)	5(38.5)	8(61.5)	1.75(0.52-5.85)	0.36
	Others	8(3.9)	2(25)	6(75)	0.93(0.18-4.9)	0.94
Airway device	General anesthesia with LMA	69(33.7)	19(27.5)	50(72.5)	1	
	General anesthesia with cuffed endotracheal tube	120 (58.5)	47(39.2)	73(60.8)	1.7(0.89-3.22)	0.1
	General with un cuffed endotracheal tube	11(5.3)	6(54.5)	5(45.5)	3.16(0.86-11.6)	0.08
	Face mask	5(2.4)	1(20)	4(80)	0.69(0.9-3.22)	0.72

1. Reference

Continued Table 5

Variable	Items	Frequency (%)	PRAEs (n=205), frequency (%)		COR(95 %CI)	P value
			Yes=73	No=124		
			73(35.6)	124(64.4)		
Ventilation technique	Controlled ventilation	116(56.6)	35(30.2)	81(69.8)	1	0.06
	Spontaneous ventilation	89(43.4)	38(42.7)	51(57.3)	1.74(0.97-3.1)	
Types of surgery	Others (plastic, maxilla-facial, orthopedics surgery)	8(3.9)	1(12.5)	7(87.5%)	1	0.197
	Ophthalmology	73(35.6)	27(37.0%)	46(63.0%)	4(0.48-35.2)	
	General surgery	68(33.2)	23(37)	46(63)	3.6(0.4-30.9)	
	ENT	42(20.5)	18(42.9)	24(57.1)	5.3(0.6-46.6)	
	Neurosurgery	14(6.8)	4(28.6)	10(71.4)	2.8(0.26-30.7)	
Neuromuscular reversed given	No	59(28.8)	25(42.4)	34(57.6)	1	0.2
	Yes	148(71.2)	48(32.9)	98(67.1)	0.66(0.35-1.2)	

Note: 1 reference

5.5.2. Independent predictors of postoperative respiratory adverse events among pediatric patients operated at HUSCH

Multivariable logistic regression was fitted to identify independent predictors of postoperative respiratory adverse events and to control confounders. Hence, intraoperative administrations of opioid analgesics, history of upper respiratory tract infection, ventilation technique used, patient intubation with a cuffed endotracheal tube, and age less than 2 years were independent predictors of postoperative respiratory adverse events at a P value less than 0.05 (Table 6).

Pediatrics age less than one month 9.2 times (AOR: 9.2, 95%CI: 1.1-77.2) and who were less than 2 years were 4.7 times (AOR: 4.7, 95% CI: 1.06-20.8) manifested PRAEs than older children (12-15). Pediatrics who had an upper respiratory tract infection were 5.03 times (AOR: 5.03, 95% CI: 1.84–13.78) more likely to develop postoperative respiratory adverse events when compared to pediatrics that had no upper respiratory tract infection. Pediatric patients who take opioids intraoperatively were 2.9 times (AOR: 2.9, 95% CI: 1.24-6.8) more likely to manifest postoperative respiratory adverse events than patients taking paracetamol. Pediatrics' managed under spontaneous ventilation technique were 4.68 times (AOR: 4.68, 95%CI: 1.94–11.28) more likely to develop postoperative respiratory adverse events than those managed under volume-controlled technique. Patients who were intubated with a cuffed endotracheal tube were 3.31 times (AOR: 3.31, 95% CI: 1.23–8.91) more likely to develop postoperative respiratory adverse events when compared to LMA insertion (Table 6).

Table 6: Results of multivariable logistic regression of factors independently predicting of postoperative respiratory adverse events among pediatric patients operated at HUSCH, 2024 (n=205)

Variables	Items	AOR(95%CI)	P value
Age	0-1month	9.2 (1.1-77.2)	0.048
	1 month-2 years	4.7(1.06-20.8)	0.038
	2-12 years	1.78(0.47-6.91)	0.4
	12-15 years	1	
Analgesia given	Paracetamol	1	
	Opioid	2.9(1.24-6.8)	0.014
	Caudal block	5.61(0.86-36.5)	0.07
	Combined caudal and opioids	5.08(0.82-31.5)	0.08
	Combined and paracetamol	1.37(0.26-7.19)	0.7
	Others (diclofenac, sciatic nerve block, and TAP)	2.6(0.38-17.5)	0.33
Upper respiratory tract infection	No	1	
	Yes	5.03 (1.84-13.78)	0.002
Ventilation technique	Controlled ventilation	1	
	Spontaneous ventilation	4.68(1.94-11.28)	0.001
Airway device	LMA	1	
	General anesthesia with cuffed endotracheal tube	3.31(1.23-8.91)	0.018
	General anesthesia with un-cuffed endotracheal tube	1.96(0.27-14.27)	0.5
	Face mask	0.63(0.03-12.8)	0.76

1=reference

6. DISCUSSION

In the current study, the reported incidence of post-operative respiratory adverse events was 35.6%, with a 95% CI of 28.8–42.9. The study conducted in Turkey by B. Kozanhan and M.S. Iyisoy et al. in the USA and Ontario, Canada, which revealed that the incidence of post-operative respiratory adverse events was 29.97%, 31%, and 41%, respectively, was in line with our studies (8,14,15).

The finding of the present study is relatively higher than those of the study conducted in China, which reported 6.9% (26). The possible explanation for this discrepancy may be due to the type of surgical procedure conducted and the difference in outcome assessment, as we included both minor and major postoperative respiratory adverse events, whereas in the previous studies only major adverse events were reported. Similarly, the finding of the current study was higher than those of the study conducted by Atsampileros, Murto, Barrowman, et al., who reported that postoperative respiratory adverse events was 17.6% (48). The difference in these studies may be due to population differences and the difference in the study design (the previous study was a retrospective study).

Studies done in Pakistan showed an occurrence of airway obstruction (20%), followed by secretion (15%), oxygen desaturation (10%), laryngospasm (6.6%) during emergence from anesthesia but cough (5.6%), and oxygen desaturation (6.6%) during the post-anesthesia care unit (49). In our studies, oxygen desaturation was (72.5%), followed by airway obstruction (32.29%), secretion (25%), and laryngospasm (15.6%) during the emergence from anesthesia. The proportion of desaturation, secretion, airway obstruction, and breath holding were 42.86%, 28.6%, 16.5%, and 14.3% respectively, during admission time to the post-anesthesia care unit or neonatal intensive care unit. The difference between the studies may be due to difference in airway devices used during surgery, duration of surgery and the age of the participants. Nonetheless, the current study is consistent with a study conducted in Western Australia, which found that after extubation, the rates of airway blockage, desaturation, coughing, and laryngospasm were 33%, 37%, 20%, and 7% respectively, in the PACU (50).

Pediatrics aged less than one month were 9.2 times (1.1–77.2) and those aged less than 2 years were 4.7 times (1.06–20.8) more likely to experienced postoperative respiratory adverse events

than older children (12–15). The finding of the current study is similar to those of the study conducted in Canada, which explained that children under 3 years were 4 times more likely to have postoperative respiratory adverse events than older children (12–15) (51). The possible explanation for these events is that younger children were more exposed to postoperative respiratory adverse events due to anatomical, physiological, pharmacological, and immunological changes relative to older children. These changes can expose younger pediatrics to adverse events due to immaturity control of breathing, higher flow resistance and airway collapsibility, increased chest wall compliance, reduced gas exchange, and increased work of breathing (41).

The study participants who had a history of upper respiratory tract infection were 5.03 times (AOR: 5.03, 95% CI: 1.84–13.78) more likely to develop postoperative respiratory adverse events. The results of this study align with a study conducted in Korea, which reported that patients with upper respiratory tract infections had 2–7 times more postoperative respiratory adverse events than patients without upper respiratory tract infections (21). This may be due to the upper respiratory tract infection-induced upper airway hyperactivity, increased closing volume, and impaired diffusion capacity. Because viruses that cause upper respiratory infection invade the upper respiratory tract mucosa and tissue, which may cause hyperactivity and inflammation (52).

Study participants who were taken intra-opioid analgesics were 2.9 times (AOR: 2.9, 95% CI: 1.24-6.8) more likely to manifest postoperative respiratory adverse events compared to those study participants who were taken paracetamol. The finding of the current study is in line with studies in the USA by T. Voepel-Lewis et al., which revealed that among 25 children who were taken opioids, 68% experienced oxygen desaturation, 28% experienced postoperative respiratory depression (28%), and had a 4 times higher oxygen requirement than the non-opioid group (53). Similarly, the current finding is supported by the finding of study conducted in Korea, which demonstrated that the risk of developing postoperative respiratory adverse effects was 2-3 times higher than that of paracetamol or paracetamol combined with an opioid (54). A possible explanation for this may be due to the opioid effect decreasing central drive to the respiratory muscles and upper airway dilatation, reducing airway tone, as well as reduced central chemosensitivity to hypoxia and hypercapnia (55).

Patients who were intubated with a cuffed endotracheal tube were 3.31 times (AOR: 3.31, 95% CI: 1.23–8.91) more likely to experience of postoperative respiratory adverse events when compared to LMA insertion. This study is in agreement with a previous study, which elaborated that the use of LMA significantly reduced perioperative respiratory adverse events compared to endotracheal intubation (56). This may be due to the airway stimulation during intubation with an endotracheal tube, laryngoscopy, and associated suctioning with intubation and extubation, which results in hyperactivity of the upper airway, anatomical distortion, and mechanical impairments of the airway structures, especially during extubation.

The study participants managed under spontaneous ventilation technique were 4.68 times (AOR: 4.68, 95%CI: 1.94–11.28) more likely to develop postoperative respiratory adverse events than those managed under controlled ventilation technique. This study is in collaboration with a finding from a study conducted by Mashadi et al. in Iran, which showed that patients managed by controlled ventilation had fewer respiratory adverse event manifestations than those managed under spontaneous ventilation (57). The possible reason for this is due to the possibility of higher respiratory effort and ineffective gas exchange during spontaneous ventilation.

6.1. Strength and Limitation of Study

Strength: The studies assess the incidence of postoperative respiratory adverse events and their predicting factors, which were not conducted in our country previously, so they are used as base line data for future research.

Limitation of studies: In the current study, oxygen desaturation was measured by pulse oximetry; this may cause oxygen saturation over or under recorded due to artifacts.

The studies focused on the incidence of postoperative respiratory adverse events and predicting factors; no concentration or dose of intraoperative medication was considered for all drugs.

There was no capnography in the recovery room to detect hypoventilation or hyperventilation.

7. CONCLUSION AND RECOMMENDATION

The postoperative respiratory adverse events among pediatric patients operated at HUSCH were high. Intraoperative using the opioids, spontaneous ventilation technique, being intubated with an endotracheal tube, having an upper airway respiratory tract infection, and being aged less than two years were significantly predictors of postoperative respiratory adverse events. So controlling of these events may reduce postoperative respiratory adverse events.

For anesthesia professionals and others clinicians

We recommended that anesthesia professionals should give attention on the preoperative condition of pediatric patients who come to surgery in order to reduce postoperative respiratory adverse events.

We suggested that anesthetists' use of controlled ventilation may reduce postoperative respiratory adverse events.

We recommend that using the opioid sparing technique for intraoperative pain management or using opioids with other analgesia technique might lessen the postoperative respiratory adverse events.

Using a laryngeal mask airway for patients who undergo a short procedure without an emergency may reduce postoperative respiratory adverse events.

For policymakers

Our study shows that the use of opioids may enhance postoperative respiratory adverse events, so policymakers should understand the issue and target enhancing opioid sparing techniques among pediatrics by dispenses the modern medication of analgesia, which lessens postoperative adverse events.

For researchers

Future researchers may investigate further studies on each component of postoperative respiratory adverse events and address the limitations raised in this study.

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Annex I: Information sheet and Consent

Hello greeting, I am.....

I am going to do research on the title **Post-operative Respiratory Adverse Events and Predicting Factors among Pediatric Patients operated in the Hawassa University Comprehensive Specialized Hospital** for the fulfillment of a Master’s of Science in Advanced Clinical Anesthesia at Hawassa University College of Medicine and Health Science. So I would like to ask some questions related to studying. The aim of this questionnaire is to gather information on postoperative respiratory adverse events and their predicting factors. Your participation will make the study successful. You are neither benefiting nor harming by participating in this activity. Your confidentiality will be kept, and your information will be very useful for the study.

Do we have your permission to continue?

- 1. If yes, signature of participant.....and continue to the next page
- 2. If no, skip to next participant

Informed consent certified by interviewer

Date of interview.....

Name of interviewer.....signature.....

Supervisor.....signature

Principal investigator.....signature.....

Date of check in.....

Annex II: Questionnaire

Section 1: demographic characteristics

Table 7: Questionnaire on socio-demographic characteristics

S.No	Questions	Response	Code
101	Age in years/age in month	
102	Sex	1 male 2 female	
103	Weight(in kg)		
104	Height(in m or cm)		
105	BMI(Kg/m ²)		
106	Weight for height, Weight for age, height for weight		

Section 2: Predicting factors

Table 8: Questionnaire on predicting factors of postoperative respiratory adverse events

201	ASA	1.ASA I 2 ASAI	code
202	Duration of surgery	1 <2 hour 2 >2 hour	
203	Induction drugs	1 propofol 2 ketamine 3 ketamine + propofol 4 others	
204	Inhalational drugs	
205	Neuromuscular relaxants	1.yes, 2 no	
206	Name of neuromuscular relaxants	1.suxamethanium 2.vecronium 3 others	
207	Analgesics given?	1 opioid 2.caudal block 3.paracetamol suppository 4.combined opioid and caudal 5.combined caudal and paracetamol	

		5.others	
208	Does patient has preoperative URTI?	1.no 2.yes	
209	Self and family history of asthma?	1.yes ,2 no	
210	Type of surgery	1.Opthamology ,2 General surgery,3.neurology, 4ENT 5.Others	
211	Procedure done	1.Emergency,2.Elective	
212	Ventilation technique	1.Spontaneous ventilation 2 Controlled ventilation	
213	Airway device	1. Face mask, 2. LMA, 3. endotracheal tube (cuffed)/uncuffed,	
214	Tube size	-----ID mm	
215	LMA size	
216	Pre operative Hgb		
217	Preoperative hematocrit		
218	Fluid given	1.normal saline,2 ringer lactate 3,glucose	
219	Estimated blood loss		

Section 3: Postoperative respiratory adverse events

Tick if yes and tick X if your answer is no for the following events

Table 9: Questionnaire on Postoperative respiratory adverse events per-time

Items	Categories	within 5 minute after extubati on	Admiss ion time	5 min	10 min	15 mi n	20 min	30 mi n	4 0 m in	50 min	60 mi n
301	Does the patient manifest o2 saturation <95% ?										
302	Does the patient manifest wheezing or trouble breathing?										
303	If the patients manifest the above events (Q NO.302 do patients take bronchodilators										
304	Does cessation of breathing with bradycardia >15 seconds?										
305	Does the patients manifest total or partial airway obstruction										
306	If the patients manifest above events (Q NO.305),										

	Does airway maneuver done?, PPV given?										
307	Does respiratory rate < 5 minute ?										
308	Does patient manifest more than two coughing?										
309	Does the patients manifest secretion require more than one suction?										
310	Does the patient manifest airway obstruction	Cough									
		Stridor									
		cyanosis									
		Inspiratory sound									
		Chest retraction									
311	Does the patient manifest stridor?										