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Incidence and Predictors of Perioperative Respiratory Adverse Events in Children Undergoing General Anaesthesia: A Prospective Observational Study.

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Abstract

Background: Perioperative respiratory adverse events are frequent complications of paediatric anaesthesia and can prolong recovery or require urgent airway intervention. ***Objectives:*** To determine the incidence, pattern, and independent predictors of perioperative respiratory adverse events in children undergoing general anaesthesia. ***Methods:*** This prospective observational study included 100 children aged 6 months to 14 years undergoing elective or emergency surgery under general anaesthesia at Prathima Institute of Medical Sciences, Karimnagar, Telangana, India, from October 2025 to April 2026. Preoperative respiratory history, passive smoke exposure, surgical factors, airway device, airway-instrumentation attempts, and anaesthesia duration were recorded. Respiratory events were observed from induction through post-anaesthesia care. Factors associated with events were assessed using chi-square testing and multivariable logistic regression. ***Results:*** At least one respiratory adverse event occurred in 28 children, corresponding to an incidence of 28.0% (95% confidence interval: 19.5-37.9%). Oxygen desaturation was most frequent (16.0%), followed by persistent coughing (11.0%), laryngospasm (8.0%), bronchospasm (7.0%), breath-holding (6.0%), and upper-airway obstruction (5.0%). Age below 3 years, recent upper respiratory tract infection, recurrent wheezing or asthma, parental smoking, higher ASA physical status, and repeated airway instrumentation were associated with events. Independent predictors were age below 3 years (adjusted odds ratio 2.68), recent upper respiratory tract infection (3.42), parental smoking (2.47), and multiple airway-instrumentation attempts (4.79). Most events resolved with basic airway measures; one child required reintubation. ***Conclusion:*** Respiratory adverse events affected more than one-quarter of children. Focused preoperative screening and experienced airway management are central to prevention and early control.

Keywords: paediatric anaesthesia; respiratory adverse events; laryngospasm; upper respiratory tract infection; passive smoking; airway management.

INTRODUCTION

Perioperative respiratory adverse events (PRAEs) remain among the most frequent and clinically important complications encountered during paediatric anaesthesia. They include oxygen desaturation, persistent coughing, breath-holding, upper-airway obstruction, laryngospasm, and bronchospasm. Although many episodes are brief, severe events can interrupt surgery, prolong post-anaesthesia care, lead to unplanned admission, or progress to cardiopulmonary deterioration. The multicentre APRICOT study identified respiratory complications as the dominant category of severe critical events in anaesthetised children, while systematic evidence has similarly shown that airway and respiratory problems account for a substantial proportion of acute severe paediatric anaesthetic complications.1,2

Children are particularly vulnerable because of age-dependent anatomical and physiological characteristics. A relatively large tongue, narrow compliant airway, high oxygen consumption, reduced functional residual capacity, and limited respiratory reserve permit rapid desaturation during airway obstruction or apnoea. Large prospective studies have reported that the risk of PRAEs declines with increasing age and is influenced by the anaesthetic technique, airway device, operator experience, and type of surgery.3,4 The frequency reported across studies varies widely because definitions, age ranges, procedure profiles, monitoring intervals, and inclusion of minor coughing or transient desaturation differ.

Preoperative respiratory status is a major component of risk assessment. Current or recent upper respiratory tract infection can produce mucosal oedema, increased secretions, and airway hyperreactivity that persist after clinical recovery. Reactive airway disease, recurrent wheezing, airway surgery, and environmental tobacco-smoke exposure further increase susceptibility.5,6 Risk tools such as the COLDS score combine current symptoms, onset, lung disease, airway device, and surgery type to support structured decision-making, although their predictive performance is moderate and requires clinical interpretation.7,8 Anaesthetic choices also modify risk. Intravenous propofol induction has been associated with fewer respiratory events in high-risk children than inhalational induction in some trials, whereas evidence comparing supraglottic airway devices with tracheal tubes is less definitive for major PRAEs.9-11

Recognition of modifiable predictors is especially important because many children present for surgery with several overlapping risk factors rather than a single isolated exposure. A practical risk profile can guide postponement decisions, the location of care, airway planning, availability of rescue drugs, and postoperative monitoring. Prospective data from Indian tertiary-care settings remain limited, despite substantial variation in paediatric case mix, preoperative respiratory infections, smoke exposure, staffing, and perioperative resources. Local estimates can help identify children who require enhanced preparation, experienced airway management, and extended postoperative observation. Therefore, the present study aimed to determine the incidence and clinical pattern of PRAEs among children undergoing general anaesthesia at a tertiary-care teaching hospital and to identify independent preoperative and intraoperative predictors of these events.

METHODOLOGY

Study design and setting: This prospective, hospital-based observational study was conducted in the Department of Anaesthesiology at Prathima Institute of Medical Sciences, Karimnagar, Telangana, India, from October 2025 to April 2026. The manuscript was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology recommendations.14

Participants: Children aged 6 months to 14 years who underwent elective or emergency surgical procedures under general anaesthesia were screened consecutively. Children receiving general anaesthesia with either endotracheal intubation or a supraglottic airway device were eligible. Children with active lower respiratory tract infection, preoperative ventilatory support, or procedures completed exclusively under regional anaesthesia were excluded. Parents or legal guardians who declined participation were also excluded.

Sample size and sampling: Using an anticipated PRAE incidence of 21%, a 95% confidence level, and an absolute precision of 8%, the minimum calculated sample was approximately 100 children. Consecutive eligible participants were recruited until the required sample was achieved.

Data collection: Preoperative data included age, sex, body weight, ASA physical status, symptoms of upper respiratory tract infection during the preceding 2 weeks, recurrent wheezing or physician-diagnosed asthma, and exposure to parental smoking. Perioperative variables included urgency and category of surgery, intravenous or inhalational induction, airway device, number of airway-instrumentation attempts, and duration of anaesthesia. Airway management and anaesthetic drugs were selected by the attending anaesthesiologist according to clinical requirements.

Outcome definitions and observation: The primary outcome was the occurrence of at least one PRAE from induction until discharge from the post-anaesthesia care unit. Events comprised persistent coughing, breath-holding longer than 15 seconds, oxygen saturation below 90%, clinically diagnosed partial or complete laryngospasm, bronchospasm with wheeze or increased airway pressure requiring treatment, and upper-airway obstruction requiring repositioning, jaw thrust, or an airway adjunct. The phase of the first event and all interventions were recorded prospectively by a trained observer. More than one event could be documented in the same child.

Statistical analysis: Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± standard deviation, and categorical variables as number and percentage. Group comparisons used Pearson's chi-square test. Variables with $p<0.10$ on univariable analysis and clinical relevance were considered for a parsimonious multivariable logistic regression model. Adjusted odds ratios with 95% confidence intervals were reported. Model calibration was assessed using the Hosmer-Lemeshow test, and $p<0.05$ was considered statistically significant.

Ethical considerations: Necessary Permissions were obtained before starting the study. Written informed consent was obtained from a parent or legal guardian before enrolment.

RESULTS

Participant recruitment

During the study period, 106 children scheduled to undergo surgical procedures under general anaesthesia were assessed for eligibility. Six children were excluded: three had active lower respiratory tract infection, two underwent procedures under regional anaesthesia without general anaesthesia, and one parent declined participation. The remaining 100 children were enrolled and included in the final analysis. Complete preoperative, intraoperative, and postoperative respiratory outcome data were available for all participants.

Demographic and perioperative characteristics

The mean age of the study population was 5.8 ± 3.6 years, with an age range of 6 months to 14 years. Thirty-five children (35.0%) were younger than 3 years, 58 (58.0%) were males, and the mean body weight was 19.6 ± 10.8 kg. Sixty-two children (62.0%) belonged to ASA physical status I, 34 (34.0%) to grade II, and four (4.0%) to grade III. Recent upper respiratory tract infection was reported in 22 children (22.0%), recurrent wheezing or bronchial asthma in 14 (14.0%), and parental smoking exposure in 31 (31.0%). Endotracheal intubation was used in 72 children, multiple airway-instrumentation attempts were required in 11, and the mean duration of anaesthesia was 74.3 ± 31.6 minutes (Table 1).

Table 1. Demographic, clinical, and perioperative characteristics of the study participants

Characteristic	Value (n=100)
Age, years	5.8 ± 3.6
Age <3 years	35 (35.0%)
Male sex	58 (58.0%)
Body weight, kg	19.6 ± 10.8
ASA physical status I	62 (62.0%)
ASA physical status II	34 (34.0%)
ASA physical status III	4 (4.0%)
Recent upper respiratory tract infection	22 (22.0%)
Recurrent wheezing/bronchial asthma	14 (14.0%)
Exposure to parental smoking	31 (31.0%)
Elective surgery	88 (88.0%)
Emergency surgery	12 (12.0%)
ENT or airway surgery	18 (18.0%)
General surgery	32 (32.0%)
Urological surgery	18 (18.0%)
Orthopaedic surgery	16 (16.0%)
Other procedures	16 (16.0%)
Intravenous induction	55 (55.0%)
Inhalational induction	45 (45.0%)
Endotracheal intubation	72 (72.0%)
Supraglottic airway device	28 (28.0%)
Multiple airway-instrumentation attempts	11 (11.0%)
Duration of anaesthesia, minutes	74.3 ± 31.6
Duration of anaesthesia >90 minutes	24 (24.0%)

Values are presented as mean ± standard deviation or number (percentage). ASA: American Society of Anesthesiologists; ENT: ear, nose, and throat.

Incidence and pattern of perioperative respiratory adverse events

At least one PRAE was recorded in 28 children, giving an overall incidence of 28.0% (95% confidence interval: 19.5-37.9%). Ten children experienced more than one event. Oxygen desaturation was the most frequent event, occurring in 16 children (16.0%), followed by persistent coughing in 11 (11.0%), laryngospasm in eight (8.0%), bronchospasm in seven (7.0%), breath-holding in six (6.0%), and upper-airway obstruction in five (5.0%) (Table 2). Based on the timing of the first event, nine events occurred during induction, nine during maintenance, six during emergence, and four in the post-anaesthesia care unit.

Table 2. Pattern of perioperative respiratory adverse events

Respiratory adverse event	Number (%)
Any perioperative respiratory adverse event	28 (28.0%)
Oxygen desaturation	16 (16.0%)
Persistent coughing	11 (11.0%)
Laryngospasm	8 (8.0%)
Bronchospasm	7 (7.0%)
Breath-holding	6 (6.0%)
Upper-airway obstruction	5 (5.0%)
Multiple respiratory events	10 (10.0%)

Individual events were not mutually exclusive.

Management and immediate outcomes

Most events were transient and responded to simple airway interventions. Supplemental oxygen was administered to 16 children, airway repositioning or jaw thrust was required in 12, and oropharyngeal suctioning was performed in nine. Seven children required continuous positive airway pressure or brief manual positive-pressure ventilation, and five received an inhaled bronchodilator. Two children with persistent laryngospasm required intravenous succinylcholine, and one child required endotracheal reintubation. Eight children had a prolonged post-anaesthesia care stay and three were admitted for unplanned overnight observation. No child required postoperative mechanical ventilation or paediatric intensive-care admission, and there were no perioperative deaths.

Factors associated with perioperative respiratory adverse events

Children who developed PRAEs were more frequently younger than 3 years than those without an event (53.6% versus 27.8%; p=0.015). Recent upper respiratory tract infection was present in 39.3% of children with an event compared with 15.3% of those without an event (p=0.009). Higher ASA physical status, recurrent wheezing or asthma, parental smoking, and multiple airway-instrumentation attempts were also significantly associated with PRAEs. Endotracheal intubation, ENT or airway surgery, and anaesthesia lasting longer than 90 minutes showed higher event proportions without reaching statistical significance (Table 3).

Table 3. Comparison of children with and without perioperative respiratory adverse events

Characteristic	Respiratory event (n=28)	No respiratory event (n=72)	p-value
Age <3 years	15 (53.6%)	20 (27.8%)	0.015
Male sex	18 (64.3%)	40 (55.6%)	0.428
ASA physical status II or III	15 (53.6%)	23 (31.9%)	0.045
Recent upper respiratory tract infection	11 (39.3%)	11 (15.3%)	0.009
Recurrent wheezing/bronchial asthma	7 (25.0%)	7 (9.7%)	0.048
Exposure to parental smoking	13 (46.4%)	18 (25.0%)	0.037
ENT or airway surgery	8 (28.6%)	10 (13.9%)	0.086
Endotracheal intubation	24 (85.7%)	48 (66.7%)	0.057
Multiple airway-instrumentation attempts	7 (25.0%)	4 (5.6%)	0.005
Anaesthesia duration >90 minutes	10 (35.7%)	14 (19.4%)	0.087

Values are presented as number (percentage). Pearson chi-square test was used. ASA: American Society of Anesthesiologists; ENT: ear, nose, and throat.

Multivariable analysis of predictors

After adjustment for potential confounding factors, age younger than 3 years, recent upper respiratory tract infection, parental smoking, and multiple airway-instrumentation attempts remained independently associated with PRAEs. Repeated airway instrumentation demonstrated the strongest association, with an adjusted odds ratio of 4.79 (95% confidence interval: 1.23-18.64; p=0.024) (Table 4). The model showed acceptable calibration on the Hosmer-Lemeshow test (p=0.710), and the Nagelkerke R^2 was 0.34.

Table 4. Multivariable logistic regression analysis of predictors of perioperative respiratory adverse events

Predictor	Adjusted odds ratio	95% confidence interval	p-value
Age <3 years	2.68	1.05-6.84	0.039
Recent upper respiratory tract infection	3.42	1.25-9.36	0.017
Exposure to parental smoking	2.47	1.01-6.05	0.048
Multiple airway-instrumentation attempts	4.79	1.23-18.64	0.024

DISCUSSION

The present study found that 28.0% of children experienced at least one PRAE during general anaesthesia. Oxygen desaturation was the commonest event, followed by persistent coughing, laryngospasm, and bronchospasm. This incidence is consistent with the broad range reported in prospective paediatric cohorts, although direct comparisons require caution because event definitions and monitoring periods differ. Mamie et al. documented substantial intraoperative and recovery-room respiratory morbidity, while Wudineh et al. also reported frequent PRAEs in a prospective hospital cohort.4,12 The higher incidence than the severe respiratory-event rate in APRICOT reflects the inclusion of transient but clinically relevant events such as coughing, breath-holding, and short desaturation episodes.1

Age below 3 years independently increased the odds of a respiratory event. This finding agrees with large cohort evidence showing a progressive reduction in respiratory risk with increasing age.3,4 Younger children possess narrower airways, lower functional residual capacity, higher oxygen consumption, and less tolerance of apnoea. Small changes in airway calibre from secretions, instrumentation, or mucosal oedema therefore produce a proportionally greater increase in resistance and faster oxygen desaturation.

Recent upper respiratory tract infection was another independent predictor. Airway epithelial inflammation, enhanced secretions, and persistent reflex hyperresponsiveness provide a biologically plausible explanation. Tait et al. identified desaturation, breath-holding, reactive airway disease, airway surgery, and smoke exposure as relevant risks among children with respiratory infections.5 Contemporary guidance likewise recommends integrating symptom severity, timing, comorbid lung disease, airway device, and surgical urgency rather than cancelling all children through a fixed rule.7,13 Parental smoking approximately doubled the adjusted odds of PRAEs. Passive smoke exposure promotes airway inflammation and increases reactivity to tracheal stimulation. The prospective study by Jarraya et al. similarly identified passive smoking as a major predictor among children with upper respiratory symptoms.8 This finding supports explicit preoperative questioning and family counselling, not merely documentation of a general respiratory history.

Multiple airway-instrumentation attempts showed the strongest association. Repeated laryngoscopy or device insertion increases mechanical stimulation, secretions, oedema, and interruption of oxygenation. Early allocation of an experienced anaesthesiologist and a clear backup airway plan are therefore important for children with anticipated difficulty. Although tracheal intubation and airway surgery showed higher event proportions, their associations did not reach statistical significance, probably because of limited power. Evidence regarding airway devices remains mixed, while propofol induction can reduce PRAEs in selected high-risk children compared with inhalational induction.9-11 Most events in this cohort responded to basic airway manoeuvres, oxygen, or brief positive-pressure support, but reintubation and unplanned observation demonstrate that apparently minor events still carry operational and clinical consequences.

LIMITATIONS

This study has several limitations. Its single-centre design and modest sample restrict external validity. The number of respiratory events limited the precision of multivariable estimates, as reflected by wide confidence intervals. Anaesthetic techniques were not standardized because care followed routine practice, creating residual confounding. Recent respiratory infection and tobacco-smoke exposure were parent-reported. Follow-up ended after post-anaesthesia care or immediate admission, so delayed respiratory events were not captured.

CONCLUSION

Perioperative respiratory adverse events occurred in more than one-quarter of children undergoing general anaesthesia, although most were transient and responded to prompt airway support. Oxygen desaturation was the commonest event. Children younger than 3 years, those with a recent upper respiratory tract infection, those exposed to parental smoking, and those requiring repeated airway instrumentation had independently increased odds of an event. These findings support systematic preoperative respiratory screening, counselling on smoke exposure, careful airway planning, and allocation of experienced personnel for anticipated difficulty. Larger multicentre studies using standardized definitions and longer postoperative surveillance are needed to refine locally applicable risk-stratification tools and evaluate targeted preventive strategies in paediatric anaesthesia practice.

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