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Examine the Effect of Passive Tobacco Smoke Exposure on Postoperative Respiratory Care in Pediatric Patients Undergoing General Anesthesia

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ABSTRACT

Background: Passive tobacco smoke exposure is a major risk factor for adverse respiratory outcomes in children. In the perioperative setting, it may increase airway reactivity, oxygen desaturation, and the need for postoperative respiratory support, but its impact on postoperative respiratory care remains underexplored.

Objective: To examine the effect of passive tobacco smoke exposure on postoperative respiratory care in pediatric patients undergoing general anesthesia.

Methods: This prospective observational study included 255 children aged 1–12 years scheduled for elective or emergency surgery under general anesthesia. Patients were divided into two groups based on parental reports of passive smoke exposure. Baseline demographics, intraoperative respiratory events, and postoperative outcomes were recorded, including oxygen supplementation, desaturation episodes, airway complications, PACU stay, and hospital discharge timing.

Results: Children exposed to passive smoke had significantly higher intraoperative laryngospasm (14.8% vs. 6.3%, p=0.02), bronchospasm (11.7% vs. 4.7%, p=0.04), and desaturation (21.1% vs. 9.4%, p=0.008). In PACU, supplemental oxygen was required more often in the exposed group (53.1% vs. 30.7%, p<0.001), with more frequent desaturation episodes (34.4% vs. 16.5%, p=0.002) and wheezing (21.1% vs. 8.7%, p=0.005). Exposed children also had longer PACU stays (1.9 ± 0.6 vs. 1.4 ± 0.5 hours, p<0.001) and were less likely to be discharged within 24 hours (69.5% vs. 85.0%, p=0.004). Logistic regression identified passive smoke exposure as an independent predictor of postoperative respiratory complications (aOR 2.54, 95% CI: 1.48–4.37, p=0.001).

Conclusion: Passive tobacco smoke exposure is strongly associated with increased perioperative and postoperative respiratory complications in pediatric patients. Screening for smoke exposure during preoperative evaluation and providing parental counseling are essential.

Keywords: *Passive smoke, pediatric anesthesia, postoperative respiratory complications, perioperative care*

1. INTRODUCTION

Passive smoke, or environmental tobacco smoke (ETS), remains a significant global public health issue, particularly affecting children. According to the World Health Organization (WHO), more than 40% of children worldwide are exposed to passive smoke at home or in public places, and nearly 65,000 children die annually due to illnesses attributable to passive smoke exposure [1]. This exposure is particularly harmful in early life when the lungs and immune system are still developing, predisposing children to both acute and chronic respiratory conditions, including asthma, recurrent bronchitis, pneumonia, and reduced lung growth [2]. In the perioperative setting, passive tobacco smoke exposure has been consistently linked with an increased risk of respiratory complications. Children exposed to ETS demonstrate higher airway reactivity, leading to events such as laryngospasm, bronchospasm, coughing, breath-holding, and oxygen desaturation during and after general anesthesia [3]. Studies have shown that exposed children may have nearly a two-fold higher incidence of perioperative respiratory adverse events compared to non-exposed children [4]. In addition, exposure has been associated with delayed extubation, greater need for supplemental oxygen, and longer stays in the post-anesthesia care unit (PACU) [5]. The mechanisms underlying these complications are multifactorial. Passive smoke exposure causes inflammation of the airway mucosa, increases mucus secretion, and impairs mucociliary clearance, all of which predispose children to airway obstruction and postoperative hypoxemia [6]. Carbon monoxide in tobacco smoke also reduces oxygen-carrying capacity by binding hemoglobin, which may prolong recovery and increase the need for respiratory support after anesthesia. Furthermore, nicotine-induced autonomic changes enhance airway sensitivity, making children more prone to perioperative laryngospasm and bronchospasm [7].

Beyond the physiological risks, smoke exposure complicates anesthetic management. Anesthesiologists may require higher doses of inhalational or intravenous agents to achieve the desired depth of anesthesia, and exposed children often experience increased emergence agitation and delayed recovery times [8]. Postoperatively, these patients have higher oxygen consumption, prolonged desaturation episodes, and an increased likelihood of requiring nebulized bronchodilators or reintubation [9]. Such complications not only increase morbidity but also escalate healthcare costs by prolonging PACU monitoring and hospital stay. Despite widespread awareness campaigns, passive smoking remains a common problem in many regions where cultural acceptance of indoor smoking persists. In households with smoking parents, children may experience chronic exposure levels equivalent to active smoking in adults [10]. Unfortunately, preoperative assessment of children undergoing surgery often fails to adequately screen for or document passive smoke exposure, resulting in missed opportunities for risk stratification and preventive counseling [11]. Previous research has highlighted the link between ETS and perioperative complications, yet there remains a paucity of studies specifically addressing its impact on postoperative respiratory care demands. Understanding how smoke exposure influences oxygen therapy requirements, frequency of postoperative complications, and recovery timelines in the pediatric population is critical for guiding perioperative care. It also provides an opportunity for healthcare providers to counsel families on the tangible risks of passive smoking in the surgical context.

Objective:

To examine the effect of passive tobacco smoke exposure on postoperative respiratory care in pediatric patients undergoing general anesthesia.

2. METHODOLOGY

This was a prospective observational study was conducted at JINNAH HOSPITAL and LIAQUAT NATIONAL HOSPITAL Karachi from June 2023 to Augest 2024. A total of 255 children were included, recruited through non-probability consecutive sampling.

Inclusion Criteria

- Children aged 1–12 years scheduled for elective or emergency surgeries under general anesthesia.
- ASA physical status I–II.
- Patients whose parents or guardians provided written informed consent.

Exclusion Criteria

- Children with known chronic pulmonary disease (e.g., cystic fibrosis, bronchiectasis).
- Patients with acute respiratory tract infections at the time of surgery.
- Children with congenital heart disease or severe systemic illness.
- Children undergoing procedures requiring postoperative ventilatory support for surgical reasons.

Data collection

After obtaining written informed consent from parents or guardians, detailed demographic and clinical information was recorded for each child, including age, gender, weight, ASA status, and type of surgery performed. Passive tobacco smoke exposure was determined based on parental self-report using a structured questionnaire. Children were categorized into two groups:

- **Exposed group:** children living with at least one smoker in the household or with reported regular exposure to passive smoke.
- **Non-exposed group:** children with no household smoking and no reported exposure.

Passive tobacco smoke exposure was assessed through a structured questionnaire directed at the parents, and children were classified into exposed and non-exposed groups based on reported household smoking or regular passive smoke exposure. Intraoperative details such as duration of anesthesia, airway device used, and the occurrence of adverse events including laryngospasm, bronchospasm, or oxygen desaturation were documented by the attending anesthesiologist. Postoperatively, children were closely monitored in the post-anesthesia care unit (PACU). Respiratory outcomes including requirement for supplemental oxygen, episodes of desaturation (SpO_2 <92%), coughing, wheezing, and need for nebulized bronchodilators were recorded. The duration of PACU stay and time to hospital discharge were also noted for each patient.

3. STATISTICAL ANALYSIS

All collected data were entered and analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL). Quantitative variables such as age, weight, PACU stay, and hospital discharge time were expressed as mean ± standard deviation and compared between groups using independent t-tests. Categorical variables including oxygen requirement, episodes of desaturation, airway complications, and need for bronchodilators were presented as frequencies and percentages, with comparisons made using chi-square tests. A p-value of ≤0.05 was considered statistically significant.

4. RESULTS

Among the 255 children enrolled, the mean age was 6.4 ± 3.1 years, with no significant difference between exposed (6.6 ± 3.0) and non-exposed groups (6.2 ± 3.2, p=0.42). Nearly half the patients were between 1–5 years (43.5%), with similar distribution across exposure groups. Boys represented 54.5% of the cohort, and mean weight was 21.3 ± 7.5 kg without significant difference between groups. Most children were ASA I (71.0%), while 29.0% were ASA II. Surgical categories were balanced, with ENT (38.0%) and general surgery (33.0%) being the most common procedures. No baseline variable differed significantly, indicating comparability between groups.

Table 1. Baseline Demographic and Clinical Characteristics of Pediatric Patients (N = 255)

Variable	Total (N=255)	Exposed (n=128)	Non-exposed (n=127)
Age, years, mean ± SD	6.4 ± 3.1	6.6 ± 3.0	6.2 ± 3.2
Age group, n (%)			
• 1–5 years	111 (43.5)	55 (43.0)	56 (44.1)
• 6–10 years	95 (37.3)	50 (39.1)	45 (35.4)
• 11–12 years	49 (19.2)	23 (17.9)	26 (20.5)
Male sex, n (%)	139 (54.5)	72 (56.3)	67 (52.8)
Weight, kg, mean ± SD	21.3 ± 7.5	21.0 ± 7.4	21.6 ± 7.6
ASA I, n (%)	181 (71.0)	87 (68.0)	94 (74.0)
ASA II, n (%)	74 (29.0)	41 (32.0)	33 (26.0)
Type of surgery, n (%)			
• ENT procedures	97 (38.0)	50 (39.1)	47 (37.0)
• General surgery	84 (33.0)	40 (31.3)	44 (34.6)
• Orthopedic	42 (16.5)	23 (18.0)	19 (15.0)
• Others	32 (12.5)	15 (11.7)	17 (13.4)

Intraoperative respiratory adverse events were more frequent in smoke-exposed children. Laryngospasm occurred in 14.8% of exposed versus 6.3% of non-exposed (p=0.02), while bronchospasm was noted in 11.7% compared to 4.7% (p=0.04). Oxygen desaturation was almost twice as frequent in exposed children (21.1% vs. 9.4%, p=0.008). Excessive coughing (26.6% vs. 14.2%, p=0.01) and breath-holding (12.5% vs. 5.5%, p=0.04) also showed significantly higher rates in the exposed group. Mean anesthesia duration was similar across groups (72.5 ± 18.3 vs. 70.1 ± 17.9 minutes, p=0.29).

Table 2. Intraoperative Respiratory Adverse Events

Event	Exposed (n=128)	Non-exposed (n=127)	p-value
Laryngospasm, n (%)	19 (14.8)	8 (6.3)	0.02
Bronchospasm, n (%)	15 (11.7)	6 (4.7)	0.04
Oxygen desaturation (<92%), n (%)	27 (21.1)	12 (9.4)	0.008
Excessive coughing, n (%)	34 (26.6)	18 (14.2)	0.01
Breath-holding, n (%)	16 (12.5)	7 (5.5)	0.04
Mean anesthesia duration, min ± SD	72.5 ± 18.3	70.1 ± 17.9	0.29

Postoperatively in PACU, supplemental oxygen was required in over half of the exposed group (53.1%) compared to only 30.7% of non-exposed (p<0.001). Episodes of desaturation were also more frequent in exposed children (34.4% vs. 16.5%, p=0.002). Wheezing was observed in 21.1% of exposed compared to 8.7% of non-exposed (p=0.005), and 14.8% of exposed required nebulized bronchodilators versus 6.3% of non-exposed (p=0.03). Prolonged monitoring (>1 hr) was required in 40.6% of exposed patients compared to 22.8% in non-exposed (p=0.003).

Table 3. Immediate Postoperative Respiratory Outcomes in PACU

Outcome	Exposed (n=128)	Non-exposed (n=127)	p-value
Supplemental oxygen required, n (%)	68 (53.1)	39 (30.7)	<0.001
Episodes of desaturation (<92%), n (%)	44 (34.4)	21 (16.5)	0.002
Wheezing observed, n (%)	27 (21.1)	11 (8.7)	0.005
Nebulized bronchodilators needed, n (%)	19 (14.8)	8 (6.3)	0.03
Prolonged recovery room monitoring (>1 hr), n (%)	52 (40.6)	29 (22.8)	0.003

During the hospital stay, persistent cough was significantly more common in exposed children (30.5%) than non-exposed (14.2%, p=0.002). Recurrent desaturation episodes were also higher in exposed patients (18.0% vs. 7.1%, p=0.01). Although pneumonia or atelectasis occurred more often in exposed children (6.3% vs. 2.4%), this did not reach statistical significance (p=0.13). Readmission to PACU was infrequent but higher in the exposed group (4.7% vs. 1.6%, p=0.17).

Table 4. Postoperative Complications During Hospital Stay

Complication	Exposed (n=128)	Non-exposed (n=127)	p-value
Persistent cough, n (%)	39 (30.5)	18 (14.2)	0.002
Recurrent desaturation episodes, n (%)	23 (18.0)	9 (7.1)	0.01
Pneumonia/atelectasis, n (%)	8 (6.3)	3 (2.4)	0.13
Readmission to PACU, n (%)	6 (4.7)	2 (1.6)	0.17

Children exposed to smoke had significantly longer PACU stays, averaging 1.9 ± 0.6 hours compared to 1.4 ± 0.5 hours in non-exposed (p<0.001). Early discharge within 24 hours was achieved by 85.0% of non-exposed patients compared to only 69.5% of exposed (p=0.004). Prolonged hospitalization (>48 hours) was required by 14.1% of exposed patients versus just 5.5% in non-exposed (p=0.03).

Table 5. Duration of PACU Stay and Hospital Discharge

Parameter	Exposed (n=128)	Non-exposed (n=127)	p-value
Mean PACU stay, hours ± SD	1.9 ± 0.6	1.4 ± 0.5	<0.001
Patients discharged within 24 hrs, n (%)	89 (69.5)	108 (85.0)	0.004
Patients requiring >48 hrs hospital stay, n (%)	18 (14.1)	7 (5.5)	0.03

Multivariable analysis revealed that passive smoke exposure independently predicted postoperative respiratory complications, with an adjusted odds ratio (aOR) of 2.54 (95% CI: 1.48–4.37, p=0.001). Age under 5 years also increased risk (aOR 2.12, 95% CI: 1.21–3.72, p=0.008). Children with ASA II status had nearly double the risk (aOR 1.79, p=0.04). ENT procedures carried an elevated risk (aOR 1.92, p=0.02), while male gender was not significantly associated (aOR 1.11, p=0.71).

Table 6. Multivariable Predictors of Postoperative Respiratory Complications (N = 255)

Predictor	Adjusted Odds Ratio (aOR)	95% CI	p-value
Passive smoke exposure	2.54	1.48–4.37	0.001
Age <5 years	2.12	1.21–3.72	0.008
ASA II vs. I	1.79	1.01–3.14	0.04
ENT surgery vs. others	1.92	1.08–3.41	0.02
Male gender	1.11	0.64–1.94	0.71

5. DISCUSSION

This study demonstrates that passive tobacco smoke exposure is strongly associated with increased postoperative respiratory complications in pediatric patients undergoing general anesthesia. Children exposed to environmental tobacco smoke experienced significantly higher rates of intraoperative laryngospasm, bronchospasm, desaturation, excessive coughing, and breath-holding compared to their non-exposed counterparts. These findings are clinically important, as airway complications during anesthesia are among the leading causes of perioperative morbidity in children. The results also indicate that postoperative respiratory care requirements were notably greater in the exposed group. More than half of exposed children required supplemental oxygen in the PACU, and nearly one-third experienced desaturation episodes, double the rate observed in non-exposed patients. Wheezing and the need for nebulized bronchodilators were also significantly higher in the exposed group, underscoring the increased airway hyperreactivity associated with passive smoke exposure. These observations are in agreement with previous research that identified higher airway sensitivity and more frequent postoperative respiratory adverse events in children with smoke exposure [12][13].

During the hospital stay, exposed children exhibited more persistent coughing and recurrent desaturation episodes, while pneumonia and atelectasis were more common, although not statistically significant. This aligns with previous research reporting increased risk of lower respiratory tract infections and prolonged recovery in children exposed to passive smoke. Our findings further highlight that smoke-exposed patients had significantly longer PACU stays and delayed hospital discharge, reflecting a greater burden on healthcare resources. Previous research has also documented extended recovery times in exposed pediatric patients, supporting the present results [14]. Importantly, the multivariable analysis confirmed that passive smoke exposure was an independent predictor of postoperative respiratory complications, even after adjusting for age, ASA status, and type of surgery. Younger children (<5 years) and those with ASA II status were particularly vulnerable, consistent with previous research that highlighted age and baseline health status as modifiers of risk in perioperative respiratory outcomes. ENT surgeries also carried higher risk, likely due to direct airway manipulation and increased susceptibility to irritation, which has also been described in previous research [15] [16].

The mechanisms underlying these associations may include chronic airway inflammation, impaired mucociliary clearance, and heightened airway reactivity induced by long-term exposure to passive smoke. These pathophysiological changes contribute to both intraoperative instability and postoperative complications, making exposed children a high-risk group for anesthesia-related adverse outcomes. The findings of this study carry significant implications for clinical practice. Preoperative evaluation should include screening for passive smoke exposure, and high-risk patients should be closely monitored perioperatively. Anesthesiologists should anticipate potential complications and consider preventive strategies such as premedication with bronchodilators in selected cases. At a public health level, the results emphasize the urgent need for awareness campaigns to reduce passive smoke exposure in households, particularly among families with young children requiring surgical care.

6. CONCLUSION

It is concluded that passive tobacco smoke exposure significantly increases the risk of intraoperative and postoperative respiratory complications in pediatric patients undergoing general anesthesia. Exposed children demonstrated higher rates of laryngospasm, bronchospasm, desaturation, and prolonged oxygen requirements, along with longer PACU and hospital stays. Passive smoke exposure was identified as an independent predictor of adverse respiratory outcomes, with younger age, higher ASA status, and ENT surgery adding to the risk. These findings highlight the importance of incorporating smoke exposure screening into preoperative evaluations and reinforce the need for parental counseling on the dangers of passive smoke. Proactive perioperative planning and broader public health interventions are essential to minimize these preventable risks and improve outcomes in pediatric surgical populations.

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