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Predictive factors for respiratory complications in pediatric anesthesia

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Abstract

We conducted a prospective observational, descriptive, and analytical study covering all patients under 16 years of age who were admitted to the operating room for scheduled or urgent surgery between July and August 2022. The purpose of this study was to identify the epidemiological characteristics of our population, describe the means of upper airway management in our practice, and analyze postoperative respiratory complications in pediatric anesthesia and their predictive factors. A total of 200 children were included in this study, with an average age of six years and an average weight of 21 kg. Of these, 53 (26.5%) underwent sedation with propofol 3 mg/kg and ketamine 1 mg/kg or a combination of a hypnotic (propofol or ketamine) and fentanyl at the dose of 2 gamma/kg. General anesthesia was used for 93 (46.5%) patients, while the remaining 54 (27%) were operated on under locoregional anesthesia associated with sedation. Depending on the type of surgery and anesthesia, the upper airway management protocol was chosen: 85 (42.5%) patients were operated on under an oxygen mask, 12 (6%) under a face mask, 10 (5%) under a laryngeal mask and 93 (46.5%) were intubated. Postoperative respiratory complications occurred in 28 patients (14%), with desaturation being the most common complication (10.5%). In multivariate statistical analysis, the factors found to be associated with the occurrence of postoperative respiratory complications were: weight less than 10 kg (p = 0.006, OR = 4.16 [1.54-11.22]) and unipulmonary ventilation (p = 0.008, OR = 14.77 [2.09-104.02]).

Keywords: Pediatric anesthesia; Airways; Respiratory complications; Intubation; Recent infection of the airways

1. Introduction

Child management in the operating room requires specific knowledge to ensure a better outcome [1]. During general anesthesia, the management of airways is crucial. According to data from the APRICOT study, 50% of perioperative critical events are respiratory [2].

Bronchial hyperreactivity is common in pediatric otolaryngology, thus increasing the risk of respiratory complications, including laryngospasm, bronchospasm, and desaturation [3] [4]. Most of the time, these complications evolve favorably but can also be responsible for hypoxic circulatory arrest in some cases [5] [6].

2. Material and methods

2.1. Study design and setting

We conducted a prospective observational, descriptive, analytical, monocentric study of all patients from birth to 16 years old admitted to the Pediatric Central Operating room for scheduled or urgent surgery between July and August

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2022. Our objectives were to study the epidemiological characteristics of our population, describe the means of upper airway management in our practice in the pediatric population, and analyze postoperative respiratory complications in pediatric anesthesia and their predictive factors. Respiratory complications were defined by the occurrence of a desaturation episode (SpO2 < 90%), laryngospasm, bronchospasm, apnea, or inhalation.

After admission to the operating room, patients were monitored for heart rate, blood pressure, and pulse oxygen saturation. For cooperative patients, vascular access was obtained without sedation, while for non-cooperative patients, vascular access was obtained after inhalation induction. After the introduction of the vascular approach and depending on the type of surgery, the patient received either general anesthesia, sedation, or a combination of sedation and regional anesthesia.

For patients operated on under general anesthesia, the anesthetic induction was done by a hypnotic (propofol 2.5-5 mg/kg or ketamine 1-2mg/kg, depending on the age and hemodynamic state of the patient), a morphine (fentanyl 1-3 µg/kg, depending on age), and a curare (rocuronium 0.6-1.2 mg/kg, depending on the type of induction: full stomach or not). For patients operated on under sedation, anesthetic induction was done either by ketamine at the dose of 1-2 mg/kg or by propofol at the dose of 2.5-5 mg/kg and fentanyl 1-3 µg/kg, depending on the age and duration of surgery. For patients operated on under combination sedation and regional anesthesia, the anesthetic induction was done with ketamine at the dose of 1-2 mg/kg before the implementation of regional anesthesia.

The management of the airways in the general anesthesia group was done by orotracheal intubation with a probe of a diameter adapted to the age of the patient; in the sedation group, it was done either by a laryngeal mask, a face mask, or an oxygen mask; and in the sedation and regional anesthesia group, it was done either by a face mask or an oxygen mask. The anesthetic maintenance was done with sevoflurane in all three groups. We excluded from the study patients with an outstanding upper airway infection, patients who had been operated on under locoregional anesthesia without associated sedation, and those who were admitted to the operating room already intubated. The study was approved by the institutional review board (Comité d'Ethique Hospitalo-Universitaire de Fès) with a waiver of informed consent.

2.2. Data collection

All patients were monitored for the duration of anesthesia, from anesthesia induction to discharge from the post-interventional monitoring room. Patient data were collected prospectively on a form return developed by the study team before the start of the study. The following variables were collected: demographics, history, type of surgery, type of anesthesia, type of device chosen for upper airway management, and post-operative complications.

2.3. Statistical Analysis

The information collected on the form return was entered into Microsoft Excel 2010 and processed by the SPSS software at the epidemiology laboratory of the Faculty of Medicine and Pharmacy in Fez. Descriptive statistical analysis was used to summarize patient characteristics. The quantitative data are presented as a +/- standard mean (MSB), and the qualitative data are presented as a +/- 95% confidence interval. The comparison of quantitative and qualitative variables was based on a Student's t-test and a Chi-2 test, respectively, by univariate study. The identification of the factors predicting the occurrence of postoperative respiratory complications was carried out using univariate and multivariate analyses. A logistic regression was performed to identify variables associated with the occurrence of postoperative respiratory complications as the outcome variable of interest. Several logistic regression models were adjusted. Taking into account the large number of clinical variables included in the study, we chose a step regression approach. The elimination order was based on statistical and clinical relevance. The observed differences were considered significant for alpha risk below 5% ($p < 0.05$). The results of the multivariate analysis were presented in the form of an odds ratio (OR) and 95% confidence interval (CI). Significant variables with univariate analysis were captured in the multivariate analysis.

3. Results

3.1. Study population characteristics

During the study period, we identified 200 patients. The median age was six years, and the median weight was 21 kg, with a large male predominance: 132 (66%) boys against 68 (43%) girls. There were 169 (84.5%) patients under one year of age, and 168 patients weighed less than 10 kg. Concerning the patient's clinical history, 64 (32%) had undergone surgery before, 65 (32.5%) were hospitalized previously, three had stayed in the neonatology department, and 25 (12.5%) had undergone anterior intubation. Most of the patients came from the surgical department (145 = 72.5%). The intervention was scheduled in 146 (73%) and urgent in 54 (27%) cases. The type of surgery was primarily

traumatological or orthopedic in 89 (44.5%) cases, followed by urological surgery in 52 (26%) cases, neurological surgery in 22 (11%) cases, and digestive surgery in 17 (8.5%) cases **(Table1).**

Table 1 Population characteristics

Characteristics	**N (%)**
Background	
Previous hospitalization	65 (32.5%)
Surgery	64(32%)
Anterior intubation	25 (12.5%)
Stay in neonatology	3 (1.5%)
Tumor pathology	3 (1.5%)
Chronic renal failure	2 (1%)
Tuberculosis	2 (1%)
Immunosuppression	1 (0.5%)
Spina bifida	2 (1%)
Recent infection of the airways	1 (0.5%)
Source of patients	
Surgery	145 (72.5%)
Neonatology	6 (3%)
Urgency	7 (3.5%)
Resuscitation	2 (1%)
External	40 (20%)
Type of surgery	
Trauma/Orthopedics	98 (44.5%)
Urology	52 (26%)
Neurological	22 (11%)
Digestive	17 (8.5%)
Thoracic	8 (4%)
Maxillofacial	7 (3.5%)
Otolaryngology	1 (0.5%)
Vascular	1 (0.5%)
Other	4 (2%)
Type of intervention	
Scheduled	146 (73%)
Urgent	54 (27%)

The preoperative evaluation classified 152 (76%) patients as ASA physical status classification I, 21 (10.5%) as ASA physical status classification II, and 27 as (13.5%) ASA physical status classification III. Four (2%) patients had a cold. Nutritional status was normal in 190 (95%) cases; seven (3.5%) patients were cachectic, and three (1.5%) were obese. Difficult intubation criteria found were as follows: poly malformative syndrome in four (2%) patients, retrognathism in four (2%) patients, and cleft palate in three (1.5%) patients **(Table 2).** The majority of patients were fasting (94%, or

188), while 12 (6%) were considered stomach full, of which 11 (5.5%) benefited from a nasogastric tube and aspiration of gastric contents. Cooperating patients received psychological preparation from the anesthetic team. There was ketamine premedication in 8 (4%) cases, while atropine was used in 14 (7%) cases. After inhalational induction by sevoflurane, 197 (98.5%) patients received a peripheral venous line; two (1%) required an epicranial line, while a central venous line was necessary in one (0.5%) case.

Fifty-three (26.5%) children were operated on under sedation either by propofol 3 mg/kg and ketamine 1 mg/kg or a combination of a hypnotic (propofol or ketamine) and fentanyl at the dose of 2 gamma/kg, 93 (46.5%) were operated on under general anesthesia, and 54 (27%) were operated on under locoregional anesthesia associated with sedation. Propofol was the most commonly used drug in 129 (64.5%) cases, ketamine was used in 101 (50.5%) cases, fentanyl was used in 107 (53.5%) cases, and curare was used in 55 (27.5%) cases.

Table 2 Criteria for difficult intubation

Criteria for difficult intubation	**N (%)**
Facial dysmorphia	2 (1%)
Limited mouth opening	1 (0.5%)
Retrognathism	4 (2%)
Poly malformative syndrome	4 (2%)
Down syndrome	1 (0.5%)
Cleft palate	3 (1.5%)

The upper airway management protocol was chosen depending on the type of surgery and anesthesia: 85 (42.5%) patients were operated on under an oxygen mask, 12 (6%) under a face mask, 10 (5%) under a laryngeal mask, and 93 (46.5%) were intubated.

In the oxygen mask group, 15 (7.5%) patients had an oropharyngeal cannula; eight (4%) were put on pure oxygen; 74 (37%) on oxygen and sevoflurane; and five (2.5%) on oxygen, sevoflurane, and nitrous oxide. We were not able to complete the procedure for five patients. Two patients had a rachianesthesia failure, and we had to change the anesthetic technique. The other three patients experienced apnea related to deep sedation (two cases) and a fall of the tongue (one case). In four (2%) cases, a change of device was used: intubation in one case, insertion of a laryngeal mask in one case, and a face mask in two cases.

In the face mask group, two patients had an oropharyngeal cannula; 11 (5.5%) patients were put on oxygen and sevoflurane; and one patient was put on oxygen, sevoflurane, and nitrous oxide. There was no failure in this group. In the laryngeal mask group, all patients were put on oxygen and sevoflurane, and there were no failures here as well.

In the intubation group, 92 (46%) patients benefited from orotracheal intubation, while one patient (0.5%) received nasal intubation using Magill pliers. One patient also underwent tube intubation without a balloon and with packing. The intubation guide was used in nine (4.5%) cases. and a Sellick maneuver in 24 (12%) cases. Unipulmonary ventilation was used in five (2.5%) cases. The majority of patients (89, or 44.5%) were put on oxygen and sevoflurane, while only four (2%) received a mixture of oxygen, sevoflurane, and nitrous oxide. Extubation was performed in the operating room for 78 (39%) patients, in the neonatal department in eight (4%) cases, and in the resuscitation department in seven (3.5%) cases. The majority of patients (190, or 95%) were operated on in a dorsal position, while five (2.5%) were in a lateral position, and five (2.5%) were in a ventral position.

Postoperative respiratory complications occurred in 28 (14%) cases, and desaturation occurred in 21 (10.5%) patients. Laryngospasm occurred in six (3%) patients, of which five (2.5%) were related to superficial anesthesia, and one (0.5%) was due to early extubation. Bronchospasm occurred in two (1%) patients. Three (1.5%) patients presented with apnea, and one patient had inhalation. One patient had a cardiac arrest following anaphylactic shock related to a pulmonary hydatic cyst but had a good evolution. Two patients presented with hemorrhagic shock; the first had a good outcome, while the second developed septic shock and progressed to multi-organ failure, leading to postoperative death in the neonatology department.

3.2. Univariate and multivariate analysis of risk factors for respiratory complications in pediatric anesthesia

Univariate statistical analysis allowed us to identify the predictive factors for the occurrence of postoperative respiratory complications in pediatric anesthesia: age < 1 (p = 0.000, OR = 4.91 [2.01-11.97]), weight < 10kg (p = 0.000, OR = 5.7 [2.36-13.76]), neonatal patients (p = 0.010, OR = 6.76 [1.29-35.35]), thoracic surgery (p = 0.003, OR = 7 [1.64-29.85]), digestive surgery (p = 0.008, OR = 3.99 [1.34-11.87]), ASA III patients (p = 0.000, OR = 5.06 [2.01-12.72]), full stomach patients (p = 0.000, OR = 7.54 [2.23-25.45]), premedication (p = 0.011, OR = 3.48 [1.27-9.54]), SNF (p = 0.000, OR = 9.10 [2.56-32.35]), gastric aspiration (p = 0.000, OR = 9.13 [2.28-38.47]), GA (p = 0.004, OR = 3.39 [1.41-8.12]), intubation (p = 0.004, OR = 3.39 [1.41-8.12]), unipulmonary ventilation (p = 0.003, OR = 10.20 [1.62-64.08]), Sellick maneuver (p = 0.000, OR = 4.95 [1.91-12.86]), lateral position (p = 0.003, OR = 10.20 [1.62-64.08]), and table extubation (p = 0.001, OR = 4 [1.75-9.12]).

The following factors were found to be protective: trauma surgery (p = 0.000, OR = 0.12 [0.03-0.41]), antecedents of surgery (p = 0.030, OR = 0.31 [0.10-0.93]), LRA + sedation (p = 0.036, OR = 0.28 [0.08-0.98]), oxygen mask (p = 0.003, OR = 0.23 [0.08-0.65]), and back position surgery (p = 0.000, OR = 0.13 [0.03-0.44]) **(Table 3).**

Table 3 Predictive factors for postoperative respiratory complications in univariate analysis

Factors	**Univariate analysis**			
	Respiratory complications (N = 28)	**No respiratory complications (N = 172)**	**P value**	**OR (95% CI)**
Female sex	9 (13.2%)	59 (86.8%)	0.823	0.9 [0.38-2.13]
Age < 1 year	11 (35.5%)	20 (64.5%)	0.000	4.91 [2.01-11.97]
Weight < 10kg	12 (37.5%)	20 (64.5%)	0.000	5.7 [2.36-13.76]
Provenance				
Neonatology	3 (50%)	3 (50%)	0.010	6.76 [1.29-35.35]
Surgery	20 (13.8%)	125 (86.2%)	0.891	0.94 [0.38-2.68]
Urgency	0 (0%)	7 (100%)	0.277	0.85 [0.80-0.90]
External	5 (12.5%)	35 (87.5%)	0.760	0.85 [0.30-2.39]
Urgent intervention	11 (20.4%)	43 (79.6%)	0.114	1.94 [0.84-4.46]
Type of surgery				
Neurological	6 (27.3%)	16 (72.7%)	0.057	2.65 [0.94-7.51]
Maxilofacial	1 (14.3%)	6 (85.7%)	0.982	1.02 [0.11-8.84]
Thoracic	4 (50%)	4 (50%)	0.003	7 [1.64-29.85]
Digestive	6 (35.3%)	11 (64.7%)	0.008	3.99 [1.34-11.87]
Urological	8 (15.4%)	44 (84.6%)	0.730	1.16 [0.47-2.83]
Traumatology	3 (3.4%)	86 (96.6%)	0.000	0.12 [0.03-0.41]
Anterior intubation	2 (8%)	23 (92%)	0.350	0.49 [0.11-2.24]
ATCD surgery	4 (6.2%)	60 (93.8%)	0.030	0.31 [0.10-0.93]
ASA III	10 (37%)	17 (63%)	0.000	5.06 [2.01-12.72]
Full stomach	6 (50%)	6 (50%)	0.000	7.54 [2.23-25.45]
Premedication	7 (31.8%)	15 (68.2%)	0.011	3.48 [1.27-9.54]
Nasogastric tube	6 (54.5%)	5 (45.5%)	0.000	9.10 [2.56-32.35]
Gastric aspiration	5 (55.6%)	4 (44.4%)	0.000	9.13 [2.28-38.47]
Sedation	5 (9.4%)	48 (90.5%)	0.240	0.54 [0.19-1.51]

General anesthesia	20 (21.5%)	73 (78.5%)	0.004	3.39 [1.41-8.12]
LRA + sedation	3 (5.6%)	51 (94.4%)	0.036	0.28 [0.08-0.98]
Curarisation	8 (14.5%)	47 (85.5%)	0.891	1.06 [0.43-2.58]
O_2 mask	5 (5.8%)	80 (94.1%)	0.003	0.23 [0.08-0.65]
Face mask	3 (25%)	9 (75%)	0.257	2.17 [0.55-8.57]
Laryngeal mask	0 (0%)	10 (100%)	0.197	0.85 [0.80-0.90]
Intubation	20 (21.5%)	73 (78.5%)	0.004	3.39 [1.41-8.12]
Unipulmonary ventilation	3 (60%)	2 (40%)	0.003	10.20 [1.62-64.08]
Guide	3 (33.3%)	6 (66.7%)	0.087	3.32 [0.78-14.12]
Sellick	9 (37.5%)	15 (62.5%)	0.000	4.95 [1.91-12.86]
Position				
Dorsal	24 (12.6%)	166 (87.3%)	0.000	0.13 [0.03-0.44]
Ventral	2 (40%)	3 (60%)	0.090	4.33 [0.69-27.18]
Lateral	3 (60%)	2 (40%)	0.003	10.20 [1.62-64.08]
Table extubation	25 (32%)	53 (67.9%)	0.001	4 [1.75-9.12]

In multivariate analysis, the only factors that emerged associated with the onset of postoperative respiratory complications were weight < 10kg (p = 0.006, OR = 4.16 [1.54-11.22]) and unipulmonary ventilation (p = 0.008, OR = 14.77 [2.09-104.02]) **(Table 4).**

Table 4 Predictive factors for postoperative respiratory complications in multivariate analysis

Factors	**Multivariate analysis**	
	P value	**OR (95% CI)**
Weight < 10kg	0.006	4.16 [1.54-11.22]
Unipulmonary ventilation	0.008	14.77 [2.09-104.02]

4. Discussion

Pediatric anesthesia remains marked by the high frequency of respiratory events, as seen in our study with an incidence rate of 14%, and also in the literature where the frequency varies from 3% to more than 20% [7][8][4]. Due to their anatomical and physiological peculiarities, children have more respiratory adverse events than adult patients, and they account for 60% of all anaesthetic complications [9]. In the meta-analysis by Ghassemi *et al.*, acute, severe complications of pediatric anesthesia were dominated by those related to upper airway management [10]. Laryngospasm was the leading cause of desaturation in our series, constituting 3% of all cases. In addition, according to the North American registry of perioperative cardiac arrest (NARCA), which collected data from 68 healthcare institutions between 1998 and 2004, laryngospasm was found to be the most common cause of airway obstruction leading to cardiac arrest [11]. In the Thai anesthesia incidents (THAI study) conducted between March 1, 2003 and February 28, 2004 in 20 hospitals across Thailand, respiratory cardiac arrest was the most common cause of anesthesia-related cardiac arrest [12]. The same result was observed in a survey conducted in a Brazilian higher education hospital over a 9-year period [13].

The univariate and multivariate statistical analyses in our study allowed us to identify two main factors predicting the occurrence of respiratory complications following pediatric anesthesia: a weight of less than 10 kg and unipulmonary ventilation. In the literature, infants with low weight are a well-known factor as a provider of respiratory complications [1] [2]. Neonates and infants under 12 months of age had the highest rate of adverse events in both intraoperative and post-anesthesia recovery [14]. Moreover, children with urgent procedures and severe comorbidities were at an increased risk of potential complications [15]. In pediatric thoracic surgery, a pulmonary exclusion for optimization of

surgical conditions through unipulmonary ventilation is associated with unavoidable hypoxemia, even though its exact incidence remains unknown [16] [17].

The risk of respiratory complications increases further in the presence of upper airway infection [18] [6], which is one of the main risk factors [9]. Other risk factors for respiratory complications are well-documented and include young age, current or recent upper respiratory tract infection, passive/active smoking, and obesity. Some risk factors are related to surgery, such as airway surgery or anesthesia related to invasive airway management [19]. Thus, managing the upper airway as non-invasively as possible helps prevent major respiratory complications [9]. While the laryngeal mask showed superiority over orotracheal intubation in the study by Drake-Brockman *et al.* [20], other authors found no difference [21] [6]. The face mask remained the device of choice in this indication if the type and duration of surgery allowed it [22] [23] [6] [24] [25]. In our practice, we adopt a preventive strategy to further reduce the incidence of respiratory complications. In case of an infection of the airways, surgery is postponed for at least two weeks unless it is an emergency. Regional anesthesia is always discussed and performed as soon as possible, with or without sedation, depending on the age of the child. For short-term procedures, sedation with an oxygen mask or facial mask is preferred over the use of a laryngeal mask.

5. Conclusion

Postoperative respiratory complications from pediatric anesthesia are common in our practice. Risk factors are related to the field, anesthesia, and surgery. To address field-related risks, a thorough evaluation of preoperative patients to identify current or recent upper airway infections is required, with special attention to the youngest patients under 10 kg in weight. To mitigate the risks associated with anesthesia, it is necessary to favor regional anesthesia if the type of surgery allows it and select the device for the management of the upper airways based on the technique of anesthesia used. Less invasive devices should be preferred to minimize the risk of respiratory complications. Concerning the risks associated with surgery, especially for thoracic procedures, unipulmonary ventilation can provide favorable conditions for the surgeon but at the cost of respiratory complications during and after the operation. To address this, armed surveillance of the patient in order to detect complications early and intervene quickly is the only means to prevent an adverse evolution.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors not have a conflict of interest.

Statement of ethical approval

Our study is purely descriptive, non-interventional, and it has been oppressed by the ethics committee of our institute.

Statement of informed consent

Informed consent was obtained from all parents of the study participants prior to admission to the operating room.

References

[1] E. Taillardat, s. Dahmani, and g. Orliaguet. Infant and child anesthesia, emc - anesthesia. Resuscit., vol. 16, no. 3, pp. 1–29, 2019, art. No. 36-640-a-20.

[2] W. Habre et al., Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe, Lancet Respir. Med., vol. 5, pp. 412–425, 2017.

[3] C. Mamie, W. Habre, C. Delhumeau, C. B. Argiroffo, and A. Morabia. Incidence and risk factors of perioperative respiratory adverse events in children undergoing elective surgery, Paediatr. Anaesth., vol. 14, pp. 218–224, 2004.

[4] B. S. von Ungern-Sternberg et al., Risk assessment for respiratory complications in paediatric anaesthesia: a prospective cohort study, Lancet, vol. 376, pp. 773–783, 2010.

[5] G. Orliaguet and N. Bourdaud, Anesthesia of a Child with Sleep Apnea Syndrome in Pediatric Risk Anaesthesia, B. Dalens, F. Veyckemans, Eds., Paris, France: Sauramps Med., 2012, pp.237–256.A. R. Tait, S. Malviya, T. Voepel-Lewis, H. M. Munro, M. Seiwert, and U. A. Pandit, Risk factors for perioperative adverse respiratory events in children with upper respiratory tract infections, Anesthesiology, vol. 95, pp. 299–306. 2001.

[6] C. L. Tay, G. M. Tan, and S. B. Ng, Critical incidents in paediatric anaesthesia: an audit of 10 000 anaesthetics in Singapore, Paediatr. Anaesth. vol. 11, pp. 711–718, 2001.

[7] I. Murat, I. Constant, and H. Maud'huy H, Perioperative anaesthetic morbidity in children: a database of 24,165 anaesthetics over a 30-month period, Paediatr. Anaesth, vol. 14, pp. 158–166, 2004.

[8] K. Röher and F. Fideler, Perioperative complications in pediatric anesthesia, Anasth. Intensivmed. Notfallmed. Schmerzther, vol. 57, no. 9, pp. 563–576, Sep. 2022, doi: 10.1055/a-1690-5664.

[9] A. M. Ghassemi et al., A systematic review and meta-analysis of acute severe complications of pediatric anesthesia, Paediatr. Anaesth, vol. 25, no. 11, pp. 1093–1102. Nov. 2015, doi: 10.1111/pan.12751.

[10] S. M. Bhananker et al., Anesthesia-related cardiac arrest in children: update from the Pediatric Perioperative Cardiac Arrest Registry, Anesth. Analg., vol. 105, pp. 344–350, 2007.

[11] N. Bunchungmongkol et al., Anesthesia-related cardiac arrest in children: the Thai Anesthesia Incidents Study (THAI Study), J. Med. Assoc. Thai., vol. 92, no. 4, pp. 523–530, Apr. 2009.

[12] L. G. Braz, J. R. C. Braz, N. S. M. Módolo, P. do Nascimento, B. A. M. Brushi, and L. R. de Carvalho, Perioperative cardiac arrest and its mortality in children. a 9-year survey in a Brazilian tertiary teaching hospital, Paediatr. Anaesth, vol. 16, no. 8, pp. 860–866. Aug. 2006, doi: 10.1111/j.1460-9592.2006.01876.x.

[13] N. P. Edomwonyi, I. T. Ekwere, R. Egbekun, and B. Eluwa, Anesthesia-related complications in children, Middle East J. Anaesthesiol., vol. 18, no. 5, pp. 915–927, Jun. 2006.

[14] K. Becke, Complications in pediatric anesthesia, Anaesthesist, vol. 63, no. 7, pp. 548–554, Jul. 2014, doi: 10.1007/s00101-014-2357-0.

[15] D. K. Choudhry, Single-lung ventilation in pediatric anesthesia, Anesthesiology. Clin. N. Am., vol. 23, pp. 693–708, 2005.

[16] T. W. Templeton, F. Piccioni, and D. Chatterjee, An update on one-lung ventilation in children, Anesth. analg., vol. 132, no. 5, pp. 1389–1399, May 2021. doi: 10.1213/ANE.0000000000005077.

[17] G. L. Ølsson and B. Hallen, Laryngospasm during anaesthesia. À computer-aided incidence study in 136,929 patients, Acta. Anaesthesiol. Scand., vol. 28, pp. 567–575, 1984.

[18] B. S. von Ungern-Sternberg, Respiratory complications in the pediatric postanesthesia care unit, Anesthesiol Clin., vol. 32, no. 1, pp. 45–61, Mar. 2014, doi: 10.1016/j.anclin.2013.10.004.

[19] T. F. E. Drake-Brockman, A. Ramgolam, G. Zhang, G. L. Hall, and B. S. von Ungern-Sternberg, The effect of endotracheal tubes versus laryngeal mask

[20] Airways on perioperative respiratory adverse events in infants: a randomised controlled trial, Lancet, vol. 389, pp. 701–708, 2017.

[21] A. R. Tait, U. A. Pandit, T. Voepel-Lewis, H. M. Munro, and S. Malviya, Use of the laryngeal mask airway in children with upper respiratory tract infections: a comparison with endotracheal intubation, Anesth. Analg., vol. 86, pp. 706–711, 1998.

[22] F. Bordet, et al., Risk factors for airway complications during general anaesthesia in paediatric patients, Paediatr. Anaesth., vol. 12, pp. 762–769, 2002.

[23] J. R. Homer, T. Elwood, D. Peterson, and S. Rampersad, Risk factors for adverse events in children with colds emerging from anesthesia: a logistic regression, Paediatr. Anaesth., vol. 17, pp. 154–161, 2007.

[24] S. J. Parnis, D. S. Barker, and J. H. Van Der Walt. Clinical predictors of anaesthetic complications in children with respiratory tract infections, Paediatr. Anaesth., vol. 11, pp. 29–40, 2001.

[25] R. P. Flick et al., Risk factors for laryngospasm in children during general anesthesia, Paediatr. Anaesth., vol. 18, no. 4, pp. 289–296, 2008.