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RISK FACTORS FOR RESPIRATORY ADVERSE EVENTS DURING GENERAL ANESTHESIA IN CHILDREN

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Summary. *Respiratory adverse events are not rare in pediatric anesthesia. The risk of airway complications must be considered before anesthesia. The current study was designed to determine the incidence and risk factors for adverse respiratory events in children undergoing general anesthesia.*
The study population included 682 children from neonates to 14 years who were presented for an elective or emergency surgical procedure. Data regarding the incidence and severity of perioperative respiratory complications were collected prospectively.
Airway complications occurred in 39/682 cases (5.71%). Laryngeal inspiratory stridor (15/682) and irregular breathing (breath-holding) (10/682) were predominant complications (64.1%). Complete laryngeal spasm, coughing, hiccups and apnea were observed in 3 cases each. Obstruction by the tongue and excessive secretion happened in one child separately. Characteristics associated with an increased frequency of complications included age less than 1 year and existence of a respiratory infection. Most of these complications occurred at emergence from anesthesia (19/39, 48.72%) The face mask group exhibited lower incidence of airway complications than intubated group. There is no significant difference between groups of patients extubated awake and in deep inhalation anesthesia. Respiratory complications appeared almost two times more frequently during emergency than during elective procedures.
Age less than 1 year, recent respiratory infection, intubation and emergency procedure were identified as independent factors associated with an increased risk of airway complications during the general anesthesia in children.

Key words: *Risk factors, adverse respiratory events, anesthesia, children*

Introduction

Respiratory complications remain an important factor in the perioperative course of pediatric anesthesia. Occurrence and severity of respiratory complications during general anesthesia depend on child's age, anatomical, morphologic and developmental characteristics, past and family history, history of present illness, preoperative evaluation, anesthetic management and surgical procedures (1-4).

Epidemiological data concerning anesthesia-related mortality and morbidity are few and are now largely outdated because of the many advances in the standard of anesthetic practice. Many of them gave a rough estimate of the overall risk but, since they were retrospective, did not permit the investigation of risk factors. In addition, they focused on deaths and cardiac arrests and did not include other life-threatening accidents.

The aim of the study

The aim of this study was to describe and to evaluate the frequency of perioperative airway complications in children undergoing general anesthesia and to identify those perioperative independent risk factors which are commonly associated with a high incidence of airway complications.

Patients and methods

The study population was consisted of 682 children who underwent elective and emergency general anesthesia at the Clinic for Pediatric Surgery and Orthopedics in Niš, from January 1999 to July 1999. Children were assigned according to the age, the time available for estimating anesthesia risks, the presence of respiratory disease (URI, asthma), the likelihood of difficult laryngoscopy and intubation and the time of extubation.

Assessment of anesthesiology risk was done during the preanesthetic interview (including the review of the child's present and past medical history, previous anesthetic records and laboratory results).

The choice of airway and anesthetic management was left to the discretion of the anesthesiologist.

Standard monitoring was begun before induction and included electrocardiography, pulse oximetry and noninvasive blood pressure monitoring. Respiratory

function was evaluated by frequency, rhythm and deepness of breathing, estimation of tidal and minute volume and peak inspiratory pressure.

For the purpose of this study, adverse respiratory events were defined as any episode of perioperative airway obstruction (e.g. laryngospasm), oxygen desaturation less than 90% (for ≥ 10 s), breath holding (≥ 15 s), severe coughing, and any requirement for unanticipated endotracheal intubation.

Univariate analysis was carried out using the chi-squared test and Fisher's exact test for categorical data. Relative risks were calculated for each independent variable using the standard formula.

Results

This prospective study included 682 patients. Airway complications occurred in 39/682 cases (5.71%). Laryngeal inspiratory stridor (15/682) and irregular breathing (breath-holding) (10/682) were predominant complications (64.1%). Complete laryngeal spasm, coughing, hiccups and apnea were observed in 3 cases each. Obstruction by the tongue and excessive secretion happened in one child separately (Table 1).

Table 1. The most common respiratory complications

Respiratory complication	n	% (n=39)	% (n=682)
1. Obstruction by the tongue	1	2.57	0.14
2. Laryngeal spasm (complete obstruction)	3	7.69	0.44
3. Laryngeal inspiratory stridor (partial obstruction)	15	38.46	2.20
4. Irregular breathing (breath holding)	10	25.64	1.47
5. Cough	3	7.69	0.44
6. Hiccup	3	7.69	0.44
7. Apnea	3	7.69	0.44
8. Excessive secretion	1	2.57	0.14
Total	39	100.00	5.71

Characteristics associated with an increased frequency of complications included age < 1 year ($p<0.05$, $\chi^2=6.082 > \chi^2=3.841$, relative risk 2.27) (Table 2) and existence of a respiratory infection ($p<0.0001$, $\chi^2=21.36 > \chi^2=15.26$, relative risk 5.28) (Table 3).

Table 2. Age of children and respiratory complications

Age	n	Complications	
		n	%
< 1 year	60	7	11.67
from 1 to 14 years	622	32	5.14
Total	682	39	5.71

Table 3. Respiratory disease and respiratory complications

Operated in general anesthesia	n	Complications	
		n	%
With respiratory disease	27	7	25.9
Without respiratory disease	655	32	4.9
Total	682	39	5.71

Most of these complications occurred at emergence from anesthesia (19/39, 48.72%) (Table 4) .

Table 4. Period of general anesthesia and complications

Period of general anesthesia	Number of respiratory complications	%
Induction	8	20.51
Maintenanace	12	30.77
Recovery	19	48.72
Total	39	100.00

The face mask group exhibited lower incidence of airway complications than intubated group ($p<0.001$, $\chi^2 = 12.76 > \chi^2=10.827$, relative risk 2.94) (Table 5).

Table 5. Respiratory complications in intubated children

Intubation	n	Complications	
		n	%
Intubated	208	22	10.6
Unintubated	474	17	3.6
Total	682	39	5.7

There is no significant difference between groups of patients extubated awake and in deep inhalation anesthesia ($\chi^2=0.013 < \chi^2=3.841$, $p>0.05$) (Table 6).

Table 6. Extubation and respiratory complications

Extubation	n	Complications	
		n	%
While anesthetized	86	6	6.97
Awake	122	8	6.55
Total	208	14	6.73

Respiratory complications appeared almost two times more frequently during emergency than during elective procedures (relative risk 1.85) (Table 7).

Table 7. Emergency operations and complications

Operation	n	Complications	
		n	%
Emergency	158	14	8.9
Elective	524	25	4.8
Total	682	39	5.71

Discussion

The overall incidence of airway complications was 5.71%. We found out that, in the majority of cases, the causes of complications were listed as irritation of the airway (laryngeal inspiratory stridor). In the most of the children laryngeal inspiratory stridor occurred at the end of anesthesia, after extubation, which is in accordance with literature data (5).

In the most of our patients (nine) irregular breathing, i.e. breath holding, happened during the anesthesia maintenance. In infants it could be explained by the fact that tidal volume occurs at the same volume as closing volume, so terminal bronchioles closes easily (6). Periodic breathing (recurrent pauses in ventilation lasting no

more than 5 to 10 seconds) commonly occurs in newborn infants, more frequently during REM sleep (7). Intercostal muscle inhibition during REM sleep or resulting from inhaled anesthetics agents compounds weakness of highly compliant chest wall, and results in paradoxical movement of the chest wall and a fall in FRC (8). In children irregular breathing occurs in light anesthesia and also in deep planes, heralding respiratory arrest (9).

Laryngeal spasm occurred in two children during the induction in anesthesia. In one infant (2 month old) it was probably the consequence of endotracheal intubation attempt in the light anesthesia. Aggravating factor was generally poor condition of the child. Olsson and Hallen (10) found that the incidence of laryngospasm was high in the age group 0–9 years (28/1000 patients). Tiret at al (11) concluded that the anesthetic risk was closely related to the patient's preoperative condition. It increased markedly with ASA score (rate of complications >10 per 1000 for patients ASA ≥ III) and with co-existing diseases (rate of complications > 20 per 1000 with three or more co-existing diseases). Laryngospasm during inhalational anesthesia by mask could be explained by irritant effect of inhaled anesthetics (12).

Coughing occurred in three patients during recovery from anesthesia. In one child happened after the extubation while he was anesthetized. Milenković et al. (6) emphasize the possibility of postextubational croup in children in whom severe coughing happened during the recovery.

Hiccup occurred in three children. In one child it appeared during the induction, as adverse effect of intravenously given barbiturate (Nesdonal). In two children hiccup happened during the recovery.

Obstruction by the tongue and excessive secretion occurred one time each. In five month infant (bilateral palatoschisis) obstruction by the tongue was caused by the tumor (ectopio glandulae microsalivaris lingue).

Despite the premedication (atropine), excessive secretion followed i.v. ketamine anesthesia in one child.

The rate of anesthetic complications was significantly higher in infants than in children. Olsson and Hallen (10) find out that incidence of laryngospasm in the age group 1 to 3 month (27,6/1000 patients) was more than three times the incidence in other age groups (8,6/1000 patients). Olsson (13) also reported the very high incidence of bronchospasm in children between 1 and 3 month, and explained that it could depend on a hyperexcitability of the airways in this age group.

A prospective survey of Bonoli at al (14) which included 9289 pediatric patients showed that the major incidence (risk factors) of the minor complications was present in patients less than 6 months, ASA group 2-3-4, emergency surgery, patients with associated pathology, long duration of anesthesia and high risk operations.

Respiratory infections increased the risk of airway complications by 5.28 (relative risk).

Cote at al (15,16) suggest that elective surgery should be postponed at least 2 weeks after the withdrawal of the symptoms of respiratory disease, but at the same time they emphasize that this statement is arbitrary and need to be verified in practice.

According to Šešlija at al (17), elective surgery interventions should be delayed for 4-7 weeks. Difficult decision about the elective surgery in child, who is in hyperactive period of respiratory tract infection, have to make anesthesiologist, surgeon and parent all together.

Tait at al (18) conclude that anesthesiologists who have great professional experience (more than 10 years) more often decide to postpone the elective surgery.

At the time when elective surgery is scheduled the child should be well and asthma must be controlled according to individual medical protocol. If it is not the case, child should be sent to pediatrician and get the therapy. If the child has the signs of upper respiratory tract infection, elective surgery should be postponed, because many surveys (19) report the higher number of respiratory complication connected to anesthesia and asthma exacerbation. According to Black (20) it is unwise to undertake elective surgery within 4 weeks of a major exacerbation of asthma. According to Milenković at al (6) it is wise to undertake elective surgery in general anesthesia after 4 to 6 weeks after the latest asthma attack or the infection of upper or lower respiratory tract. Endotracheal anesthesia, especially if there is the evidence about the recent exacerbation of asthma, increase the possibility of respiratory complications, above all of coughing and bronchospasm (21).

The use of a facial mask (FM) is a characteristic associated with a decrease frequency of complications that is in agreement with published studies in children (22). It is well known that use of FM in a child with respiratory infection is associated with lower risk but this device is not appropriate for certain surgical procedures (full syomach, duration of surgery)(23). Our results confirm these findings.

Asai at al (24) concluded that the incidence of respiratory complications associated with tracheal extubation may be higher than that during tracheal intubation.

Tracheal extubation could be performed in awake or deeply anesthetized patients (25). Patel at al (26) compared the differences in oxygen saturation and airway-related complications and found out that there is no differences between the two groups in the number of patients requiring supplemental oxygen that is in accordance with our results. Coughing and exertion during the extubation in awake patients could increase the incidence of sore throat and postintubation croup. Valsalva maneuver and breath holding during the coughing and choking could decrease oxygen saturation. On the other side, patients with a full stomach or who have "difficult" airway should be extubated only after the complete return of airway reflexes and possibility to maintain satisfactory ventilation. In patients who have airway hyperreactivity (e.g. acute respiratory infection, bronchial

asthma) it is advocated that extubation should be performed in deep inhalation anesthesia (17).

Obtained results correlates with ones of Tiret at al (23) who concluded that complications appeared three times more frequently during emergency than during elective procedures. However, data from literature remind us that possibility of respiratory complication occurrence during the elective surgery shouldn't be underestimated. Kluger and Short study (27), which represent a review of 133 cases of aspiration, shows that this difficult complication occurs twice as often in elective compared with emergency surgery, with 56% of incidents taking place during induction of anesthesia. Antiaspiration prophylaxis was prescribed in 14% of patients who subsequently aspirated.

Conclusion

The respiratory adverse events are not rare in pediatric anesthesia. They are often of minor clinical importance but in some cases, despite the introduction of modern monitoring and treatment, still represent an important cause of morbidity and mortality. The risk of airway complications must be considered before anesthesia. Their incidence is increased when anesthesia is given to children with recent respiratory infections, when children are aged less than 1 year, when endotracheal tube is used and during the emergency procedures.

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FAKTORI RIZIKA ZA NASTANAK RESPIRATORNIH KOMPLIKACIJA U TOKU IZVOĐENJA OPŠTE ANESTEZIJE KOD DECE

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Kratak sadržaj: *Respiratorne komplikacije se često javljaju u pedijatrijskoj anesteziji. Faktori rizika za nastanak komplikacija vezanih za disajni put moraju se imati u vidu pre izvođenja svake anestezije. Ova studija imala je za cilj da utvrdi koji su najčešći faktori rizika koji dovode do respiratornih komplikacija tokom izvođenja opšte anestezije u dečjem uzrastu.*

Studijom je bilo obuhvaćeno 682 deteta uzrasta do 14 godina, koja su bila podvrgnuta opštoj anesteziji prilikom izvođenja planiranih ili hitnih hirurških intervencija. Podaci o pojavi i ozbiljnosti perioperativnih respiratornih komplikacija prikupljni su prospektivno.

Respiratorne komplikacije bile su manifestovane kod trideset devetoro dece, odnosno kod 5,71% (39/682). Laringealni inspiratorni stridor (15/682) i nepravilno disanje (zadržavanje disanja) (10/682) bile su najčešće komplikacije. Na navedene dve komplikacije otpada više od polovine svih komplikacija (64,1%). Na trećem mestu u rangu slede, sa istim procentom zastupljenosti 7,69% (3/682), kompletni laringealni spazam, kašalj, štucanje i apneja. Opstrukcija jezikom i ekscesivna sekrecija dogodile su se kod po jednog deteta. Posebno se zapaža povećana incidenca javljanja respiratornih komplikacija kod dece mlađe od 1 godine i u slučaju postojanja respiratorne infekcije. Do većine respiratornih komplikacija dolazi pri buđenju iz anestezije (19/39, 48,72%). Rizik intubirane dece da će imati respiratorne komplikcije pri anesteziji je, na osnovu naših podataka, veći u odnosu na rizik kod neintubirane dece. Zastupljenost respiratornih komplikacija u odnosu na vreme ekstubiranja (u dubokoj anesteziji ili posle buđenja i uspostavljanja refleksa) ne pokazuje značajnu razliku. Naši podaci ukazuju da se respiratorne komplikacije skoro dva puta češće javljaju pri izvođenju hitnih operacija.

Uzrast manji od 1 godine, skorašnja respiratorna infekcija, intubacija i hitnost procedure su identifikovani kao faktori koji su pojedinačno ili u kombinacijama udruženi sa povećanim rizikom za nastanak respiratornih komplikacija u toku izvođenja opšte anestezije kod dece.

Ključne reči: *Faktori rizika, respiratorne komplikacije, anestezija, deca*