PREGLED LITERATURE – REVIEW ARTICLE

Preventing the Most Common Anesthesia Related Complications in Children

Prevencija najčešćih komplikacija vezanih za izvođenje anestezije kod dece

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Summary Over the last decades change in the profile of common complications in paediatric anesthesia was noticed. The differences between children and adults are distinguished especially in three areas: the high complication rate among neonates, the importance of respiratory disorders in younger children, and the high frequency of postoperative nausea and vomiting in older children. Many pitfalls and problems can be avoided by early recognition, quick intervention and strict attention to details of management

Keywords*:* prevention; complications; anesthesia; child

Sažetak Tokom poslednjih decenija uočena je promena u zastupljenosti najčešćih komplikacija u dečijoj anesteziji. Osnovne razlike između dece i odraslih mogu se grupisati u tri pojavna oblika: najveća učestalost komplikacija prisutna je kod novorođenčadi, respiratorne komplikacije karakteristične su za decu mlađeg uzrasta a najveća frekvenca postoperativne mučnine i povraćanja uočena je kod starije dece. Brojni izazovi i problemi mogu se izbeći ranim prepoznavanjem i brzom svrsishodnom intervencijom.

Ključne reči:prevencija; komplikacije; anestezija; dete

Introduction

One of the most frequent questions parents ask of a paediatric anesthesiologist is "What are the risks of anesthesia for my child (1)?"

In most circumstances, there is no noticeable change in the paediatric patient a few days following minor surgery and anesthesia; however, experience shows us this outcome cannot be guaranteed. The wise anesthesiologist acknowledges this preoperatively, although many parents may not choose to discuss their fears and the risks of anesthesia on the day of surgery. Large, retrospective, and prospective studies document a low incidence of morbidity and even less mortality in healthy children undergoing anesthesia for elective surgery. It is commonly said that the chance of injury during anesthesia is less than that during the car ride to the hospital. But unanticipated bad things have happened.

The possible complications in paediatric anaesthesia are many and one usually distinguishes:

- mortality
- major morbidity, e.g., permanent neurological damage following hypoxaemia or hyponatraemia, subglottic stenosis following intubation, more rarely limb deformities following vascular access
- "minor morbidity": with no sequelae (e.g., postoperative nausea and vomiting) or of supposed short-term duration (e.g., behavioural changes).

Progress in pharmacology, equipment and education has lead to a dramatic decrease in mortality and major morbidity caused by anaesthesia. This has increased interest in the prevention of minor sequelae but has also raised new questions regarding the effects of anaesthesia on immunity, neuronal apoptosis etc.

Minor events, significant injuries, and deaths related to the administration of anesthesia are more common in younger, sicker paediatric patients, and notably in emergency surgeries (2, 3).

Respiratory complications

Perioperative respiratory adverse events (PRAEs) are a major risk for perioperative morbidity and cause 30% of perioperative cardiac arrests in children. Typical adverse events in children with respiratory tract infection are laryngospasm, bronchospasm, breath holding, atelectasis, arterial oxygen desaturation, bacterial pneumonia, and unplanned hospital admission. Upper respiratory tract infections (URIs) are very frequent in childhood, and the

mean annual incidence of respiratory illnesses per child is higher in younger children: infants and preschool children have 6–8 colds a year.

Children presenting with signs of a serious infection, bacterial superinfection, or impairment of the lower respiratory tract are at an increased risk for adverse events; signs of serious or systemic infection include fever above 38.5°C, dyspnea, wheezing, purulent secretion and cough, pneumonia and otitis media. The parents have important influence, as passive smoking is a predictor of adverse events as well as the parents' belief that 'their child has a cold (4).

The incidence of respiratory events during anesthesia is also higher in younger children. This effect may be due to the relatively narrow infant airway and the higher incidence of respiratory tract infections in young children. The findings of increased risk for children who are younger than 1 year of age (especially children younger than 1 month) indicate the need for greater caution when caring for children who are under 1 year of age (5). Prematurity, congenital heart disease and other congenital defects place neonates and infants at higher anaesthesia risk than older children and adults.

Viral invasion of the respiratory epithelium and mucosa during a 'cold' can lead to persistent bronchial hyperreactivity and bronchoconstriction for up to 6 weeks, which is similar to the pathophysiology of asthma bronchiale. However, there is a consensus that it is no longer mandatory to postpone surgery for a period of 6 weeks. Several authors have proposed a delay of at least 2 weeks when acute clinical signs of an infection are observed (6, 7).

It has been shown that any manipulation of the upper airway of the child results in a significant increase of the risk of PRAE. Such manipulation can include the instrumental manipulation of the airway itself, for example, with bronchoscopy, or invasive airway management, for example, endotracheal intubation. Surgery near the airway, such as ENT surgery or eye surgery, and surgery with impairment of respiratory function, such as upper abdominal surgery or cardiac surgery, are also associated with increased risk (4).

Salbutamol pretreatment should be considered in all children presenting with a URI or a moist cough. Hamilton et al. (8) investigated more than 1000 children for elective general anesthesia with endotracheal intubation and found a significantly higher rate of desaturation in children treated with topical lidocaine compared with the placebo group. In this study, no difference in the incidence of laryngospasm was found. There is still a lack of evidence for the preventive effects of intravenous lidocaine on the incidence of PRAEs. Sanikop and Bhat (9) showed that 1.5 mg/kg lidocaine given 2 min before extubation resulted in a decrease in postextubational laryngospasm and coughing with statistical significance and clinical relevance.

Intravenous induction with propofol itself can be described as a safety margin because the intravenous line is already established and thus not necessary to implement during the critical interval of anesthesia induction; if complications occur, they can be treated without any loss of time. Furthermore, propofol was shown to have bronchodilating effects similar to those of volatile anesthetics. In a study comparing propofol and sevoflurane for procedural sedation for MRI, apnea with laryngospasm occurred more often during anesthesia with sevoflurane compared with propofol. However, the incidence of coughing and breath-holding was higher in the propofol group (10). von Ungern-Sternberg et al. (11) suggest that 'intravenous anesthesia with propofol might be associated with lower incidence of PRAE with a better preventive effect when used as a maintenance drug compared to sevoflurane', and Lerman (12) comments on the findings that 'one should anticipate a reduced frequency of PRAEs after intravenous induction of anesthesia than after inhalational induction, even when a minimally noxious agent such as sevoflurane is used'. Desflurane should be strictly avoided because of its bronchoconstrictory characteristics. The use of nitrous oxide in patients with pulmonary infections should be avoided, as it can lead to diffusion hypoxia and atelectasis. Atracurium may also cause bronchospasm and laryngospasm.

There is controversy in the literature regarding the use of the airway device and associated risk of laryngospasm. The endotracheal tube (ETT) was shown to be associated with increased incidence of laryngospasm. The use of facemask in URI was suggested to be associated with low incidence of laryngospasm. However, in three recent prospective studies, there was no statistical difference of the incidence of laryngospasm among facemask, LMA and ETT. This may have been attributed to beta error, too small a sample size for a rare occurrence. On the contrary, in two retrospective studies, LMA was shown to increase the incidence of laryngospasm. However, data collection accuracy and LMA's appropriate use in these studies have been questioned. It is suggested that the use of cuffed tracheal tubes in younger than 4-year-old children may predispose to laryngotracheal injury and laryngospasm (13). Recruitment maneuver for extubation of the trachea should be used, and trachea should be extubated either in deep anesthesia or after complete emergence.

When laryngospasm occurs, it is treatable with airway-opening maneuvers, deepening of sedation, application of continuous positive airway pressure and muscle relaxation. Laryngospasm is more frequent in children with an URI who had their anesthesia supervised by a less experienced anesthesiologist.

Bronchospasm during anesthesia is characterized by an expiratory wheezing, prolonged expiration, and/or increased pressure during intermittent positive pressure ventilation (IPPV) or decreased tidal volumes during pressure controlled ventilation (PCV). It is usually triggered by airway irritation, especially in patients with a pre-existing airway disease. To prevent serious desaturation during the bronchospasm, a rapid recognition and treatment of the problem is important and includes ceasing the stimulation,

deepening the anesthesia, and administering bronchodilators, adrenaline or salbutamol.

The relationship between preoperative fasting and risk of pulmonary aspiration of gastric contents is an area of constant interest. In assessing the risk of pulmonary aspiration, gastric volume is used as a surrogate to guide perioperative fasting. The practice of anesthesia has changed dramatically in recommendations for preoperative fasting.Based on the evidence from the meta-analysis and the agreement of the consultants and ASA members, clear liquids are appropriate up to 2h before elective procedures requiring general anesthesia, regional anesthesia, or monitored anesthesia care. The literature is insufficient but the consultants agree that fasting from breast milk should be maintained for 4 h. Fasting from formula, nonhuman milk, and light meal should be for 6 h, and fasting from fatty meal should be at least 8h. Guidelines from the European Society of Anaesthesiologists also have the same recommendations. This evidence applies only to children who are considered to be at normal risk of aspiration/regurgitation during anesthesia (14). The study results of Schmitz et al. stress the need for smooth induction even in patients who followed the recommended guidelines (15).

Cardiovascular complications

Intravascular fluid loss and current volume status are often underestimated in paediatric patients, especially in newborns and infants. Due to their smaller blood volume, paediatric patients are more sensitive to excessive as well as inadequate hydration. In children, heart rate may be a more sensitive guide to intravascular fluid status than blood pressure. By the time hypotension becomes apparent, severe hypovolemia is often already present, and cardiovascular collapse may soon ensue without appropriate volume resuscitation. Securing adequate intravascular access prior to surgery is a must for surgeries in which significant blood loss is expected. Failure to do so and failure to keep up with intraoperative blood loss are the most common reasons why cardiac arrests from hypovolemia are deemed to be anaesthesia- related (16).

Difficulty of intravenous cannulation is sometimes encountered especially in the preterm neonates, overweight babies and when most peripheral veins had been ruined from withdrawal of blood sample for laboratory investigations and intravenous therapy.

Large-volume or exchange transfusions in neonates and small children can result in life-threatening hyperkalemia and cardiac arrest. This is potentially preventable. Serum potassium levels can rise quickly during blood transfusions in children with a small blood volume. Blood components with the highest levels of potassium include whole blood, irradiated blood and units approaching their expiration date. To reduce the risk of transfusion-related hyperkalemia in neonates and infants, washed or fresh (i.e. less than 7 days old) packed red blood cells should be used. Packed red cells have a lower potassium load than whole blood because of the reduced amount of plasma. Life-threatening hyperkalemia can still occur with packed red blood cells if large volumes are rapidly transfused.

The most common equipment problems are complications of anaesthesiologist-placed central lines, either from induction of an arrhythmia or from creation of tamponade, hemothorax or pneumothorax (16).

Poor ASA physical status (≥III) and emergency surgery have been reported as risk factors for paediatric perioperative mortality and are the only predictive factors of mortality after cardiac arrest. Morita et al. (17) found that most incidents of perioperative cardiac arrest and death in neonates can be attributed to underlying comorbidities rather than causes related to the anesthesia. Children with heart disease exhibit higher rates of perioperative cardiac arrest and mortality when undergoing cardiac or noncardiac surgery.

Nausea and vomiting

Postoperative nausea and vomiting (PONV) is considered as one of the “big little problems” after general anesthesia. The incidence of this distressing problem can be reduced by using a total IV anesthetic (TIVA) technique instead of inhaled anesthetics and by administering antiemetics prophylactically. However, routine efforts to prevent PONV are not indicated because of the potential for adverse effects, the perception that there are increased costs, and the lack of evidence that patient satisfaction is affected.

There is good evidence from clinical trials that toddlers are less susceptible to emetic stimuli than school children and adolescents. As nausea is difficult to identify in infants and small children, studies of PONV in this patient population are usually limited to the onset of postoperative vomiting (POV). Around the age of three years, the risk to develop PV increases dramatically.

Most surgery does not have an influence on PV, even though this might have been expected by theoretical pathophysiological considerations (e.g., middle ear surgery is often considered to be a risk surgery). However, strabismus surgery is an independent risk factor for PV.

The longer an emetic stimulus (e.g., administration of volatile anesthetics and opioids) is present, the more likely it is that this trigger leads to nausea and vomiting. The positive history of PONV is an unequivocally accepted risk factor for further PONV symptoms at future anesthesia. Thus, it was not surprising to notice that this was also the case in children. More interesting is that children with parents or siblings who have experienced PV or PONV after a previous anesthesia are at increased risk. The question is whether this family association with PV/PONV is genetically or behaviorally determined. There is some evidence in the literature that genetic aspects might be involved (18).

The mechanism for the potential antiemetic effect of performing locoregional anesthesia in children remains speculative. When performed intraoperatively, a locoregional block reduced the need for opioids and also for

large doses of volatile anesthetics that were shown to be a main cause for PV during the early stage of recovery.
It is not surprising that the administration of postoperative opioids had a tendency to increase PV, because opioids are known to cause PONV.

Murat et al. study(19) gave very interesting finding that the incidence of adverse events during anaesthesia was similar in patients operated as an emergency compared with nonemergency surgery, but vomiting was less frequently reported in patients operated as an emergency compared with nonemergency surgery.
High-risk patients must be given multimodal prophylaxis, involving both the avoidance of known risk factors and the application of multiple validated and effective antiemetic interventions (20).

Conclusion

Despite an overall improvement in mortality and morbidity rates for anaesthetized children over the past 50 years, the long-recognized fact that anaesthesia related complications occur more frequently in the paediatric population still holds true. Infants are at greatest risk of complications and they suffer predominantly respiratory complications.

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