

# Common post-operative complications in children

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## ABSTRACT

The exact incidence of common post-operative complications in children is not known. Most common one is post-operative nausea and vomiting followed by respiratory complications leading to hypoxia. Cardiac complications are less in children without associated congenital cardiac anomaly. Post-operative shivering, agitation and delirium are seen more often in children anaesthetised with newer inhalational agents like sevoflurane and desflurane. Urinary retention in the post-operative period could be influenced by anaesthetic drugs and regional blocks. The purpose of this article is to review the literature and present to the postgraduate students comprehensive information about the current understanding and practice pattern on various common complications in the post-operative period. Extensive literature was searched with key words of various complications from Pubmed, Google scholar and specific journal, namely paediatric anaesthesia. The relevant articles, review article meta-analysis and editorials were the primary source of information for this article.

**Key words:** Antiemetic drugs, apnoea, complications, dexmedetomidine, emergence agitation, emergence delirium, hypoxia, laryngospasm, nausea, paediatric, shivering, vomiting

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## INTRODUCTION

The incidences of the postoperative complications in children are not known. Complications are more commonly seen in children less than three years and more so in infants.<sup>[1]</sup> The report of morbidity and mortality in literature comes primarily from sources like institutional audits, close claim studies and reporting of anaesthesia-related cardiac arrests. Because of the specific nature of these data, it may not be universally acceptable and certainly cannot be extrapolated to our country situation as our institutional infrastructures and clinical practice patterns are different. Complications in the postoperative period have reduced considerably after introduction of monitors, especially the pulse oximeter in clinical practice. Availability of newer faster acting drugs like sevoflurane, desflurane and propofol have also played a role in reducing the incidence of complications as the recovery is faster. However, complications like laryngospasm and emergence delirium (ED) are seen more often with the inhalational agents.

In this article, we will review the commonly occurring complications and try to understand the aetiology and

current management techniques. Extensive literature was searched with key words of various complications from Pubmed, Google scholar and specific journal, namely paediatric anaesthesia. The relevant articles, review article meta-analysis and editorials were the primary source of information for this article.

## POST-OPERATIVE NAUSEA AND VOMITING

Nausea is the uncomfortable sensation of an impending episode of vomiting whereas vomiting is complex and is mediated by vomiting centre, thought to reside in the brainstem. It receives inputs from the pharynx, GI tract, higher cortical centres (e.g., the visual, gustatory, olfactory and vestibular centres) and the Chemoreceptor Trigger Zone (CTZ).

It is the most common complications of anaesthesia in infants and children, incidence rate ranges from 8.9% to 42% in susceptible children.<sup>[2]</sup> The large variation might be due to difficulty in estimating the true incidence of post-operative nausea and vomiting (PONV) in children or might be due to combining all types of surgery in reports. It is now well established

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that certain procedures like adenotonsillectomy, squint surgery and orchidopexy have a high emetic risk.<sup>[3]</sup> High incidence of vomiting in adenoidectomy and tonsillectomy is believed to be due to irritation of the pharynx and stomach by blood.

Ebenhert *et al.* reported four independent predictors of PONV, namely duration of surgery more than 30 minutes, age over 3 years, a personal or family history of PONV and strabismus surgery.<sup>[4]</sup> Intraoperative use of opioids, early administration of clear fluids and early ambulation may precipitate vomiting in susceptible patients. Though rarely life threatening, it has the potential for causing aspiration, hypovolaemia and electrolyte imbalance (hyponatraemia).

### Prevention

Most scientific evidence suggests that the prophylactic treatment should only be initiated in surgeries with high emetic potential.<sup>[5]</sup> In surgeries with low emetic potential, prophylactic treatment may be unnecessary.<sup>[5]</sup> Some anaesthetists believe that a good analgesia and maintaining normocarbida reduces the incidence of PONV. It is also believed that a block or even spraying the tonsillar fossa with local anaesthetics reduces vomiting. Intravenous ondansetron<sup>[5,6]</sup> (a serotonin (5-HT<sub>3</sub>) receptor antagonist (0.1 mg/kg) for children less than 40 kg and 4 mg for children over 40 kg and dexamethasone<sup>[6,7]</sup> (0.15 mg/kg) has been found to be highly effective. The combinations of these drugs are synergistic and often preferred in surgeries with high emetic risk.<sup>[8]</sup> Ondansetron reduces the activity of the vagus nerve, which deactivates the vomiting centre and also blocks serotonin receptors in the CTZ. Though the anti-emetic properties of dexamethasone are well established, the underlying mechanism is not known. A direct inhibition of prostaglandins, serotonin or endorphin production has been postulated.<sup>[5]</sup>

### Treatment

Children should be nursed in lateral and head low position to prevent aspiration. A single dose of i.v. ondansetron has been very effective. It is not indicated in neonates. In patients who have received prophylactic dose, administration of a second intravenous dose of ondansetron postoperatively does not provide additional control of nausea and vomiting. Other serotonergic antagonists which have also been found to be effective are granisetron (10-80 mcg/kg) and tropisetron (0.1-0.2 mg/kg). Metoclopramide (0.25 mg/kg) is also an effective agent.<sup>[6]</sup> There is insufficient

evidence in the literature about the efficacy of droperidol, acupuncture and gastric aspiration.<sup>[8]</sup>

## OXYGEN DESATURATION (HYPOXIA)

In children, oxygen saturation less than 93% in the postoperative period should be a cause of concern. Oxygen therapy with a face mask should be initiated. The oximeter probe position should be checked to countercheck the correctness of the SpO<sub>2</sub> reading. Often in our recovery setup, the proper size of probe may not be available. A spring loaded probe when applied to an infant might show lower SpO<sub>2</sub> as it compresses the arterioles, so change of site will provide the correct reading. A wrap around oximeter probe should be used in infants. The common cause of hypoxia in the immediate post-operative period could be due to residual effect of anaesthetics, inadequate reversal, respiratory depression, airway obstruction and laryngospasm.

### Airway obstruction

Airway obstruction may occur after the stimulation of extubation is over. It can be diagnosed by paradoxical see-saw breathing pattern, intercostal indrawing, subcostal, sternal recession and tracheal tug. Some anaesthetists prefer to extubate at a deeper plane to prevent laryngospasm. This practice increases the incidence of *tongue fall back* which is the most common cause of airway obstruction in the immediate postoperative period. Neck extension, mouth opening and jaw-thrust alone or together might be sufficient to correct obstruction. It can be prevented by nursing the child in lateral position with neck extended.

Following surgery of the oral cavity, adenotonsillectomy, tongue surgery, dental procedures, proper count of the throat pack may prevent post-operative obstruction due to throat pack. Throat inspection and pharyngeal suction under direct vision with a laryngoscope may prevent obstruction.

In case of persistent obstruction, neuromuscular blockade should be reassessed. Adequate reversal of neuromuscular blocking agents can be diagnosed clinically by thoraco-abdominal respiration with adequate upward movement of upper chest on inspiration, sustained eye opening, adequate muscle tone as seen in neck and abdominal muscles. Some children might need reintubation and ventilation till such time adequate reversal is achieved.

*Laryngospasm* is the other common cause of airway

obstruction.<sup>[9,10]</sup> Despite advances in monitoring and the standard of care in the practice of anaesthesia, it remains one of the main causes of respiratory complications seen, especially in children. Laryngospasm is more often seen in the post-operative period with newer anaesthetic agents like Sevoflurane and Desflurane.<sup>[10,11]</sup> There is controversy as to whether extubation should be carried out at a deep or light plane of anaesthesia in the attempt to minimise laryngospasm. Some studies suggest a reduction in the incidence of laryngospasm if the patient is extubated at a deeper plane of anaesthesia.<sup>[11]</sup> Others like Tsui *et al.* have reported no cases of laryngospasm in patients who, after undergoing tonsillectomy and adenoidectomy, were extubated awake.<sup>[12]</sup> Several studies have shown no difference in the incidence of laryngospasm between the two techniques of extubation.<sup>[11,13]</sup> Producing an artificial cough by applying positive pressure just before extubation to expel subglottic secretions has been shown to decrease the incidence of laryngospasm possibly, because it decreases the adductor response of the laryngeal muscles.<sup>[14]</sup>

The incidence of laryngospasm is three times higher in infants than older children.<sup>[15]</sup> Children anaesthetised by occasional paediatric anaesthetist have been reported to have an increased incidence by 1.7 times.<sup>[16]</sup> A recent history of upper respiratory tract infection (URTI) or asthma is associated with 2- to 7-fold increase in incidence of laryngospasm.<sup>[17]</sup> Although there is no established optimal prescribed time period, current literature and our clinical practice suggest a decrease in incidence of respiratory complications two weeks after recovery from symptoms of URTI.<sup>[14,17]</sup> Noxious stimuli at lighter plane of anaesthesia are most important anaesthesia-related factor. When the child is coming out of the effect of anaesthetics in the immediate post-operative period, simply insertion of an airway or nasogastric tube, laryngoscope blade or even suction catheter may induce laryngospasm.

It is diagnosed clinically and correct diagnosis depends on the experience of the anaesthetist. It can lead to hypoxia, bradycardia and cardiac arrest if effective treatment is not provided promptly. Removal of the irritant stimulus, jaw thrust and administration of 100% oxygen are the first steps in management. Oxygen therapy should be started with a 'T' piece so that continuous positive airway pressure (CPAP) might be initiated which often breaks the spasm.<sup>[18]</sup> Increasing the depth of sedation can be achieved by intravenous agents only. Sub hypnotic dose of propofol

(0.8 mg/kg) has been used successfully.<sup>[19]</sup> Propofol is believed to suppress the laryngeal reflex. However, suxamethonium is the gold standard for treatment of laryngospasm. The threshold for using suxamethonium should not be high as the complication of prolonged hypoxia could lead to severe morbidity or mortality. A dose of 1 mg/kg with atropine 0.02 mg/kg when associated with bradycardia is used. If intravenous route is not available, intramuscular dose of 4 mg/kg may be administered.<sup>[20]</sup>

## POST-INTUBATION STRIDOR

Post-extubation stridor is usually seen after use of a tight-fitting endotracheal tube (either a cuffed one or a large size uncuffed one), repeated intubation and trauma, coughing and straining on the tube. Because subglottic region is the narrowest part of the paediatric airway, even a tube which passes the vocal cords smoothly might cause mucosal trauma and oedema and significant airway obstruction. Humidified cold mist after extubation, mild sedation might be helpful in mild croup. Racemic adrenaline administered by nebuliser for 5 to 10 minutes helps in producing vasoconstriction and minimising tissue oedema. Dexamethasone is not effective in immediate post-operative period but a dose of 0.5 mg/kg has been used 6 hourly for 4 to 6 doses by some anaesthetists. Rarely, a child might require reintubation with a smaller size tube.

## PULMONARY OEDEMA

In the immediate post-operative period, post-obstructive pulmonary oedema is seen after relief of laryngospasm<sup>[21]</sup> or airway obstruction due to any other cause.<sup>[22]</sup> This is attributed to high negative intrathoracic pressure generated by forced inspiration against closed glottis or blocked airway which leads to increased interstitial negative pressure and increased capillary permeability.<sup>[23]</sup> Early recognition and treatment are essential to prevent serious complications. Once airway obstruction is relieved, child should continue to be administered CPAP (5-10 cm H<sub>2</sub>O) with high concentration of oxygen. Diuretics and fluid restriction is helpful. If hypoxia persists, endotracheal intubation and positive pressure ventilation with positive end expiratory pressure should be initiated. Usually, it is self limiting and resolve by 24 to 48 hours.

## RESPIRATORY INSUFFICIENCY

Respiratory insufficiency could be because of opioid

over dose, apnoea in an ex-prematurity baby or post-operative apnoea in a child with obstructive sleep apnoea.

*Opioid over dose*, especially with longer acting drugs like morphine, is the common cause of depression of respiration. A conscious patient whose rate of breathing is low and breathing improves on stimulation are two cardinal features of opioid over dosage. Usually, the respiratory rate is less than ten and there is an increase in the depth of breathing. Management depends on severity of respiratory depression. It could be reversed by Naloxone or might need intubation and ventilation. A dose of 0.01 mg/kg repeated after every 2-3 minutes is recommended. Its half life is shorter and may need to be repeated or an infusion set up. One should make provisions for alternative pain relief as naloxone reverses analgesia as well.

*Apnoea of prematurity* is seen in premature babies up to post-conceptual age (PCA) of 48 weeks but the risk remains till the PCA of 56 weeks.<sup>[24]</sup> In our country, the small size babies are small for date due to maternal malnutrition but are physiologically mature. In these babies, apnoea is not often seen. Caffeine (10 mg/kg) has been found to be effective in treating apnoea of prematurity and now-a-days is often administered in NICU to these babies.<sup>[25]</sup> Regional blocks like ilioinguinal, caudal and subarachnoid block have been reported to decrease the incidence of apnoea.<sup>[26]</sup> Limitation of subarachnoid block is that, the duration of action is reduced in neonates as their volume of CSF is more and has a higher turnover causing earlier elimination of the local anaesthetic. These children after surgery should be monitored and observed for at least 24 hours in a high dependency area or ICU.

Now-a-days, the common indication of tonsillectomy is obstructive sleep apnoea (OSA). This group of children are at risk of developing apnoea in the post-operative period.<sup>[27]</sup> Children with OSA are more sensitive to opioids. In mild cases of OSA, many anaesthetists do use fentanyl and even morphine without much adverse effect. However, in moderate to severe cases, opioids should be avoided and analgesia provided by paracetamol, NSAIDs or ketamine.<sup>[28]</sup> These children should be monitored for SpO<sub>2</sub> at least for 24 hours. All children with severe OSAs might be taken care of in the ICU in the post-operative period. Some of them might need assisted ventilation like Pressure Support or Synchronised Intermittent Mandatory Ventilation (SIMV).

## CARDIO VASCULAR SYSTEM INSTABILITY

Fluctuations in blood pressure and arrhythmias are not commonly seen in children. *Bradycardia* is usually due to hypoxia or a response to medication like fentanyl or neuromuscular block reversing agent. It is treated by removing the cause. Active management is necessary only when associated with hypotension. *Tachycardia* could be due to pain and anxiety or fluid deficit.

*Hypotension* could be because of inadequate fluid administration or ongoing blood loss. Inappropriate blood pressure cuff may provide a false reading. Fluid status should be reassessed and adequate fluid infused.

One of the common cause of hypotension in the immediate post-operative period is *post-tonsillectomy bleeding*.<sup>[29]</sup> It is called primary when bleed occurs within 6 hours of surgery and is due to slip of ligature. It can also be seen after few days up to 7 days which is called secondary bleeding and is due to bleeding from slough on the tonsillar fossa. It is difficult to assess the loss as children swallow the blood. It is also difficult to find a venous access in a hypotensive child, if intravenous line is lost. Alternatively, intraosseous approach might be initiated for initial resuscitation. A full stomach with swallowed blood adds to the risk of aspiration. The management is optimisation of volume status, blood transfusion and surgical ligation of the bleeding vessel at the tonsillar fossa. Without proper optimisation, these patients might develop profound hypotension after induction of anaesthesia. Presence of a trained person at induction to apply cricoids pressure is a great help. Because of active bleeding, it might be difficult to visualise the structures of the oral cavity, pharynx and larynx. Two functioning suction machine, two sets of laryngoscopes and different size of tubes should be prepared prior to induction of anaesthesia. Usually, ketamine (2 mg/kg) is used for induction. In properly resuscitated cases, propofol or thiopentone might be used with caution since they might cause myocardial depression and hypotension. One has to be extra cautious while deciding to use propofol as it does not allow the reflex rise in heart rate following hypotension causing further hypotension. Rapid sequence intubation with suxamethonium (2 mg/kg) is the preferred technique of securing the airway.

## POST-OPERATIVE SHIVERING AND AGITATION

Post-operative agitation could be simple shivering, agitation or delirium. There is plenty of overlap



between these terms in our understanding and management. It could be distressing and harmful to the child as well as care giver and treatment should be initiated at the earliest.

*Shivering* is relatively commonly seen in the postoperative period probably due to fall in core temperature. Akin *et al.* reported an incidence of 3.5% and suggested risk factors as age older than 6 years, prolonged duration of surgery and use of an intravenous induction agent.<sup>[30]</sup> It is also commonly seen after halothane anaesthesia. Intravenous pethidine (0.35 - 0.5 mg/kg) and clonidine (1.5 mcg/kg) has been widely studied in adults.<sup>[30]</sup> Therefore, it has become most recommended treatment options in children. A single intravenous dose of dexmedetomidine (0.5 mcg/kg) has been found to be as effective as pethidine in controlling shivering.<sup>[31]</sup> Oxygen therapy and forced air warming of the child are other aspects of management.

*Agitation* is a restless child who is coherent and is usually due to pain. In ED, children appears to be in a dissociate state of consciousness characterised by thrashing, agitation, incoherence and inconsolability. Irrelevant language, activity and vocalisation have been observed as associated behaviours.<sup>[32]</sup> Increased incidence of ED is often attributed to introduction of newer inhalational agents, sevoflurane and desflurane.<sup>[33]</sup> Theoretical explanations offered are rapid awakening and inadequate pain treatment. Although both sevoflurane and propofol allow for rapid emergence from general anaesthesia, only sevoflurane is associated with a high incidence of emergence agitation in infants and young children.<sup>[34]</sup> Rapid emergence does not fully explain this phenomenon.<sup>[34]</sup> There is an increased incidence of emergence agitation with sevoflurane anaesthesia compared to halothane independent of any painful stimulus.<sup>[35]</sup> The exact psychological mechanism is yet to be understood. Sevoflurane is known to increase the electrical activity of brain and ED could be due to neuro stimulation during emergence from anaesthetics.

ED seen after ketamine anaesthesia might be associated with hallucination. Prophylactic administration of midazolam or diazepam, recovery in a quiet place and non-disturbance of the child after ketamine anaesthesia prevents ED.

Children pose a danger to themselves unless agitation is promptly controlled. They might get injured or might pull out intravenous cannulae, surgical drain nasogastric tube, etc. The prophylactic administration

of ketamine (0.25 mg/kg iv or oral 6 mg/kg), clonidine (2 mcg/kg), dexmedetomidine (0.15 mcg/kg) and fentanyl (2.5 mcg/kg) has been shown to decrease the incidence.<sup>[36,37]</sup> Managing ED might be difficult as no clear guideline for therapy exists. Propofol, clonidine and midazolam have been used to control the delirium.<sup>[36]</sup>

## TEMPERATURE INSTABILITY

*Hypothermia* is seen in our setup as common heat preserving equipments, like warming mattress, blanket and fluid warmer, heated in circuit humidifier that are not freely available in our operation theatres. It is more seen in infants and smaller age group children after prolonged major surgery. Simple measures like warming the operation theatre up to 26°C, using a radiant heater at induction and recovery, covering the babies with cotton pads, infusion of warm fluids and advising the surgeon to use warm irrigation fluids may prevent the occurrence of this complication. Usually, warming the patient with warmed blankets and radiant heaters are sufficient but forced air warming might be needed which is more efficient.

*Hyperthermia* could be due to environment hyperthermia or the effect of an infective process and should be observed closely. Life-threatening condition like malignant hyperthermia is rarely seen in our country due to some unknown reason.

## URINARY RETENTION

The incidence of post-operative urinary retention in children is not known. Most of the information available is from adult studies. General anaesthetic agents cause bladder atony by interfering with the autonomic nervous system. Propofol, isoflurane, methoxyflurane and halothane have been shown to suppress detrusor contractions.<sup>[38]</sup> Halothane also increases bladder capacity. Prolonged surgery causes urinary retention because of prolonged exposure to anaesthetics. Intrathecal and epidural local anaesthetics act on the sacral and lumbar nerve fibers, blocking the transmission of afferent and efferent nervous impulses from and to the bladder.<sup>[38]</sup> The onset and the duration of the block would depend on the pharmacokinetic properties of the local anaesthetic used. Use of opioids intravenous or neuraxial increases the incidence. It is characterised by pain, agitation and lower abdominal distension. Catheterisation is the treatment. How long the catheter should be kept is not known.

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