



# An update on the perioperative management of children with upper respiratory tract infections

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## Purpose of review

This review summarizes the current evidence for the management of children with recent upper respiratory tract infections (URTIs). Furthermore, the review includes management guidelines for children with URTIs.

## Recent findings

Good history and clinical examination is sufficient in most children presenting with URTI. Testing for immune markers or preoperative nitric oxide measurement does not add any additional value. Preoperative bronchodilator administration, intravenous induction with propofol, and noninvasive airway management all reduce the occurrence of respiratory adverse events.

## Summary

Most children can be safely anaesthetized even in the presence of an URTIs if the perioperative anaesthesia management is optimized. In this review article, we have included a management algorithm for children with URTI presenting for elective surgery.

## Keywords

anaesthesia management, paediatric anaesthesia, respiratory adverse events, upper respiratory tract infections

## INTRODUCTION

The common cold or upper respiratory tract infections (URTI) are frequently present in children. Although URTI is commonly mild and self-limiting in nature, it does place a burden on society because of the increased use of healthcare resources and absences from work or school [1].

Performing anaesthesia in children with URTI increases the risk of perioperative respiratory adverse events (PRAE, e.g., laryngospasm, bronchospasm, desaturations, breath holding) [2–7].

The purpose of this review is to summarize current evidence regarding perioperative anaesthetic management of children with an URTI.

## PREVALENCE/INCIDENCE OF UPPER RESPIRATORY TRACT INFECTION

Most studies define URTI as two of the following symptoms: rhinorrhoea, sore or scratchy throat, sneezing, nasal congestion, malaise, cough, or fever more than 38° [6,7].

Although children under the age of 4 have on average up to 8 URTI per year [1], the incidence of URTI decreases with age with adults having two colds per year on average [1]. The occurrence of URTI is seasonal with increased incidence during

the colder months in the temperate and during the rainy season in the tropical regions [1]. Between 25 and 45% of children presenting for elective surgery will have a history of a recent URTI [7,8]; therefore, unsurprisingly, URTI is the most common cause of surgery cancellation in children [9]. Most children with URTI have symptoms for around 1 week but these can persist for up to 3 weeks [1].

Although URTIs in children are most commonly caused by a viral infection [1], bacterial superinfections are regularly found [1]. Rhinovirus is by far

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## KEY POINTS

- Children with current and recent (up to 2 weeks) URTI have an increased risk of a PRAE (e.g., laryngospasm, bronchospasm, desaturation, breath holding).
- In such children, the following risk factors further increase the risk for PRAE: age less than 2 years, prematurity, passive smoking, respiratory comorbidities, airway surgery, and use of an ETT.
- In children with severe URTI (green runny nose, moist cough, wheezing, fever, lethargy), we recommend to postpone surgery if possible for at least 2 weeks.
- To reduce the risk of PRAE in children with current or recent URTI, anaesthetic management can be optimized as follows: experienced staff performing airway management, use of preoperative inhaled salbutamol, i.v. induction with propofol, avoidance of desflurane, use of TIVA or sevoflurane with a propofol, or lignocaine bolus prior to any airway manipulations.

(up to 80%) the most frequent virus causing URTI in children [10]. Other viruses include: parainfluenza, respiratory syncytial, influenza, enterovirus, and adenovirus, metapneumovirus, and human Bocavirus [10]. Testing for the infective agent is not routinely performed in children with URTI as such results do not change anaesthetic management. However, many experts acknowledge an respiratory syncytial virus (RSV) infection as a more severe respiratory infection, which requires particular attention and a careful risk benefit analysis before proceeding with anaesthesia and surgery especially in infants [11].

The risk of a PRAE is significantly increased in children with URTI [2–7,12]. Children with a current and/or recent URTI experience between 24 and 30% PRAE as opposed to children without URTI (8–17% PRAE) [5,7]. This is even more pronounced in infants and those born prematurely [7].

## PATHOPHYSIOLOGY

Symptoms depend on the anatomical location of the infected mucus membranes. For example, the rhinovirus most often inoculates the nasal mucosa and will cause a runny nose but can then spread to the throat and trachea, whereas the influenza virus has a predilection to the tracheobronchial epithelia [1]. Viral infection of the mucus membranes causes airway inflammation. Similar to asthma, airway inflammation can lead to increased secretions, airway susceptibility, and bronchial hyperreactivity with increased risk of PRAE predominantly laryngospasm and bronchospasm [13,14]. In addition, some viruses can produce neuraminidase that

inhibits muscarinic type 2 receptors thereby increasing the release of acetylcholine [13]. Furthermore, viral-induced liberation of tachykinin and neuropeptides have been described [13]. Both pathways increase the likelihood of bronchospasm.

## PREOPERATIVE ASSESSMENT

### Does the child have an upper respiratory tract infection?

The hallmark of a cold is nasal discharge, sneezing, sore throat, and cough [1]. The most frequent symptoms are rhinorrhoea (66%), followed by nasal congestion (37%), sneezing (29%), productive cough (26%), sore throat (8%), and fever (8%) [5]. Bronchitis and tracheitis can cause dry cough and wheeze. Hoarse voice indicates laryngitis. Nonspecific symptoms including irritability, loss of appetite, fatigue, muscle pain, headache. Fever is not uncommon in children [1].

Several risk factors for the occurrence of PRAE in children with URTI have been identified [13]. These can be divided into patient factors, surgical factors, and anaesthetic management, see Table 1.

In children with URTI history of fever (relative risk 2.9), 'green' instead of 'clear runny nose' (relative risk 3.2 and 1.4, respectively) or 'moist' instead of 'dry cough' (relative risk 3.2 and 1.8, respectively) are associated with increased risk of bronchospasm and laryngospasm [7].

Lee *et al.* [15] have proposed a 'COLDS' score to assess the risk of PRAE in children with URTI presenting for elective surgery. The following parameters: current symptoms, onset of symptoms, additional lung disease, planned airway type, and planned surgery score 1, 2, or 5 points. Although this 'COLDS' score has not been validated the use of such a score might have some merit. The lowest overall score will be 5 emphasizing that no anaesthesia in children with current or recent URTI is without any risk. It is suggested that any category scoring the 5 should be regarded as a red flag alerting the perioperative team of the increased risk of PRAE and allowing to team to modify the risk of the child where possible.

### Preoperative management

There is much debate but no consensus regarding the optimal timing of elective surgery in children with recent URTI. The duration of airway susceptibility and bronchial hyper reactivity in children following a URTI remains unclear but is known to persist well beyond resolution of symptoms. Given the high frequency of URTI in children, it can be difficult to find a time in which the child is truly

**Table 1.** Risk factors for the occurrence of perioperative respiratory adverse event in children with upper respiratory tract infection

Patient	Copious secretions/presence of sputum nasal congestion Paternal smoking/passive smoking History of reactive airway disease, younger age Prematurity (<37 weeks) Parental belief, 'the child has is sick/a cold'
Surgery	Surgery of the airways Ear nose throat surgery Eye surgery Upper abdominal surgery Cardiac surgery
Anaesthetic management	Invasive airway (endotracheal intubation)  Anaesthetic agents (desflurane) Experience and competence of the anaesthesiologist in paediatric anaesthesia

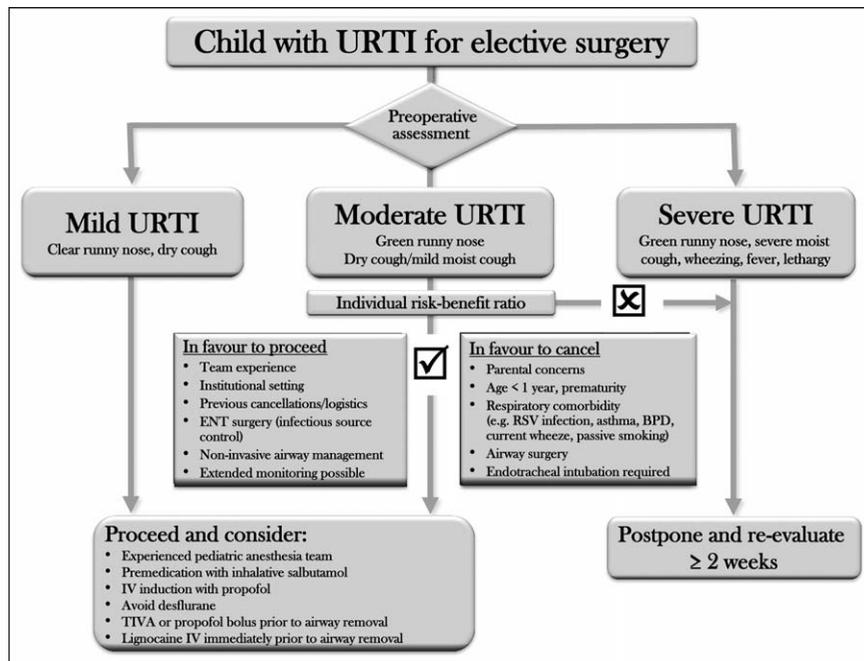
Adapted with permission [4–8,12].

well. There are no randomized controlled trials regarding best timing of general anaesthesia in children with URTI [16]. Observational trials have the inherent selection bias with the sickest children having their surgery postponed. Most studies show that a current/recent URTI bare similar risk of PRAE [5,7,17]. There are only few studies examining the effect of different time points after URTI on the

occurrence of PRAE. One observational trial found that children with an URTI less than 2 weeks and 2–4 weeks had an increased risk of PRAE [odds ratio (OR) 5.2 and 3.8, respectively] as opposed to children with an URTI 4–6 weeks prior surgery (OR 0.2) [17]. However, the sample size was small and inhomogeneous. In the largest observational study to date, von Ungern-Sternberg *et al.* [7] found in 9297 children presenting for elective surgery that children with current and recent URTI (<2 weeks) had more PRAE (25 and 29%, respectively) than did children without URTI or with URTI between 2 and 4 weeks (12 and 8%, respectively).

Some authors suggest that children with a mild URTI can be safely anesthetized as the problems encountered are generally easily treated without long-term sequelae [9]. Whether a surgery should be cancelled should be a decision balancing risk and benefit for each individual child including: patient and surgical risk factors of developing PRAE, waste of public healthcare resources, previous surgery cancellation, operation wait time, distance to travel for parents, and difficulties for parents to organise time off work. An algorithm to guide preoperative management in children with URTI scheduled for elective surgery is described in Fig. 1 [9,13].

In general, cancellation of children with URTI is only rarely necessary. Although some suggest more caution and to reschedule children with URTI, delaying surgery by 4–6 weeks following each of the 6–8 URTI per year, severely restricts the ideal surgical time frame and may lead to recurrent cancellations



**FIGURE 1.** Algorithm to guide perioperative management in children with URTI scheduled for elective surgery. Based on [13]. URTI, upper respiratory tract infection; i.v., intravenous.

which again impact negatively on the patient, his/her family as well as the healthcare system. Furthermore, even when the URTI may be gone and airway hyperreactivity reduced, the risk of PRAE is still present because of inherent conditions such as wheezing or exposure to smoking. Therefore, it is not surprising that the majority of paediatric anaesthetists will still proceed with anaesthesia even in the presence of URTI [13,18,19]. The right balance needs to be found between clinical judgement of fitness for surgery and risk of PRAE linked to the presence of other risk factors. When proceeding with anaesthesia and surgery, it is critical to optimize the perioperative management to reduce the risk of PRAE.

Good history and clinical examination is sufficient in most children presenting with URTI. Testing for immune markers or preoperative nitric oxide measurement does not add additional value [20,21]. We do not routinely recommend any additional investigations in children presenting with URTI for surgery.

If suspicion arises of the presence of undiagnosed asthma or a bacterial infection (e.g., group A streptococcus tonsillitis) referral should be made to a specialist to initiate appropriate investigations and treatment (e.g. antibiotics, bronchodilators,

steroids) [22]. In children less than 1 year of age, who are suspicious for RSV infection, a rapid test may be considered [11].

## Perioperative management

The perioperative management of children with URTI is summarized in Table 2.

### PREMEDICATION

We do not recommend the use of benzodiazepine for premedication in children with URTI as first-line agents as this may be associated with increased PRAE [7,17].  $\alpha$ 2 antagonists, for example, clonidine, dexmedetomidine may be better suited if premedication is required [22].

### LIGNOCAINE

We do not recommend the use of topical lignocaine to reduce the occurrence of laryngospasm in children with URTI. An observational trial found topical lignocaine to increase desaturation without reducing laryngospasms in children with URTI [24].

In contrast, lignocaine gel placed on laryngeal mask airway (LMA) reduced mainly postoperative

**Table 2.** Evidence based perioperative management of children with upper respiratory tract infection

#### Premedication

Avoid use of benzodiazepine for premedication [7,17]

Use of clonidine if premedication is required [22]

#### Lignocaine

Consider i.v. lignocaine to suppress laryngospasm in high-risk patient/high-risk procedure [23<sup>\*</sup>]

Avoid topical lignocaine to vocal cords [24]

Lignocaine gel on LMA may be beneficial to reduce postoperative coughing [25]

#### Bronchodilators

We recommend preoperative salbutamol (inhaled 10–30 min prior induction, 2.5 mg if weight <20 kg, 5 mg if weight >20 kg) in children with current and recent (<2 weeks) URTI [18]

#### Airway management

We recommend the least invasive airway device (face mask over LMA over ETT) [3,5,7,8,12,26–29]

When using ETT we recommend where possible the use of uncuffed over cuffed ETT tubes [7]

Deep removal of LMA and ETT might reduce laryngospasm and PRAE but is associated with increased airway obstructions [7,28–30]

We recommend airway control to be done by an experienced anaesthetist in children with URTI at increased risk of PRAE [7]

#### Anaesthetic agents

Propofol has good airway reflex (laryngospasm and bronchospasm) blunting properties but only mild bronchodilator effect [22,31]

Volatile anaesthetic agents have good bronchodilator properties but limited effects in suppressing airway reflexes [22]

We recommend the use of volatile anaesthetic agents to treat severe intraoperative bronchospasm

We do not recommend the use of volatile anaesthetic agents to treat severe laryngospasm

When using volatile anaesthetic agents sevoflurane is to be preferred over other volatile anaesthetic agents [5,7,22]

Desflurane should be avoided [7,22,32]

#### i.v. vs inhalational induction

In high-risk children we recommend i.v. induction with propofol over inhalational induction [8,31,33,34]

ETT, endotracheal tube; i.v., intravenous; LMA, laryngeal mask airway; PRAE, perioperative respiratory adverse event; URTI, upper respiratory tract infection.

coughing in a small RCT of children with URTI [25]. Although only short lived, intravenous (i.v.) lignocaine has been shown to suppress the laryngospasm reflex in healthy children and, therefore, may be useful in children with URTI [23].

## BRONCHODILATORS

We recommend preoperative salbutamol in children with current and recent (<2 weeks) URTI. A large prospective observational trial ( $n=600$ ) showed salbutamol inhaled 10 to 30 min prior induction (2.5 mg if weight <20 kg, 5 mg if weight >20 kg) to reduce overall PRAE mainly bronchospasm (6 vs. 11%,  $P=0.03$ ) and severe coughing (6 vs. 12%,  $P=0.03$ ) [18]. In contrast, i.v. glycopyrrolate after induction of anaesthesia does not reduce PRAE in children with URTI [26].

## AIRWAY MANAGEMENT

In children with URTI and an increased risk of PRAE, we recommend the airway management to be performed by an experienced paediatric anaesthetist as multiple attempts and insertion by less experienced staff has been shown to affect the incidence of PRAE [7].

The majority of observational studies and RCT show that endotracheal tubes (ETT) are associated with the highest risk of PRAE compared with less invasive airways (e.g., LMA or face mask). The face mask is associated with the smallest risk of PRAE in children with URTI [3,5,7,8,26,27]. We therefore, recommend the use of face mask or LMA over ETT where possible.

Small children in general and particularly those with URTI are prone to experience PRAE [5,7,8,28]. A recent randomized controlled trial shows that infants less than 1 year especially benefit most from LMA over ETT in terms of occurrence of PRAE [29<sup>\*\*\*</sup>]. The rate of major PRAE (laryngospasm and bronchospasm) is five-fold increased with ETT compared with LMA (relative risk 5.30, 95% confidence interval 1.62–17.35,  $P=0.002$ ) when used for children undergoing minor elective procedures [29<sup>\*\*\*</sup>]. However, it has to be emphasized that using LMA in infants and children with current or recent URTI reduces but does not abolish the occurrence of PRAE [12]. When using ETT in children with URTI, we recommend the use of cuffed over uncuffed ETT to improve ventilation and minimise leakage around the tube [7].

In general, the risk of PRAE is higher on removal than on insertion of airway devices [7,26]. Observational data suggests that deep removal of LMA or ETT reduces the occurrence of PRAE [7]. However, recent RCT reveal somewhat conflicting results. Von

Ungern-Sternberg *et al.* [30] compared the effect of deep vs. awake extubation of ETT in 100 children undergoing adenotonsillectomy. The overall incidence of PRAE was similar between the two groups. Awake extubation was associated with increased coughing (60 vs. 35%,  $P=0.03$ ), whereas airway obstructions (relieved by simple airway manoeuvres) were increased following deep extubation (26 vs. 8%,  $P=0.03$ ). In contrast, Baijal *et al.* [28] did not find a difference in PRAE comparing deep vs awake extubation of ETT in 905 children undergoing adenotonsillectomy. Unpublished data suggests that in children with URTI LMA deep removal may be more beneficial than awake as deep removal as it is associated with reduced desaturations and coughing.

## ANAESTHETIC AGENTS

Propofol has good airway reflex (laryngospasm and bronchospasm) blunting properties and is, therefore, the ideal agent to be used during the induction in children with increased risk of PRAE [22,31]. Propofol does have some bronchodilator effects but these are small in comparison with volatile anaesthetic agents.

Observational data in children with URTI as well as a large randomized controlled trial in children at particular risk for PRAE (including those with URTI) suggest that an i.v. propofol induction is associated with a significant reduction of PRAE when compared with an inhalational induction with sevoflurane [8,33].

Volatile anaesthetic agents have good bronchodilator properties but limited effects in suppressing airway reflexes [22]. Volatile anaesthetic agents can be used to treat severe bronchospasm or severe asthma.

When using volatile anaesthetic agents for either induction or for maintenance we recommend the use of sevoflurane [5,7,22]. Sevoflurane has the best bronchodilatory effect of all currently available volatile anaesthetic agents. On the contrary, desflurane is associated with a significantly increased risk for PRAE because of its property to increase airway resistance and irritability and should not be used in children particularly not in those with URTI [7,22,32]. The literature on the use of neuromuscular blocking agents in children with URTI is scarce.

## INTRAVENOUS VS. INHALATIONAL INDUCTION

Although a recent randomized control trial comparing i.v. to inhalational induction [33] demonstrated a significant reduction in PRAE in children at a particularly high risk for PRAE receiving an i.v. propofol induction, this included children with a

variety of risk factors including (but not exclusively) children with current or recent URTIs. Although propofol is associated with a reduced occurrence of laryngospasm compared with sevoflurane, cough, and breath holding is increased [31].

Additionally, a recent study examining the effect of two concentrations of sevoflurane for maintenance of anaesthesia [2.5%, minimal alveolar concentration (MAC) 1 vs. 4.7%, MAC effective dose (ED) 95 Intubation] found that higher concentrations of sevoflurane did not protect against the occurrence of laryngospasm [34<sup>■</sup>]. Laryngeal reflexes could still be found at a bispectral index of 0 [34<sup>■</sup>]. Overall we recommend an i.v. induction and maintenance with propofol over inhalational induction for children with URTI to reduce the incidence of PRAE.

## CONCLUSION

Most children can be safely anaesthetised even in the presence of an URTI if the perioperative anaesthesia management is optimized. The detailed algorithm can be used as an aide to guide clinicians in their everyday decision-making.

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## Conflicts of interest

*There are no conflicts of interest.*

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- of outstanding interest

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