

[19RC1

Paediatric airway problems

M. Weiss

Department of Anaesthesia, University Children's Hospital, Zurich, Switzerland

Saturday, June 6, 2009 13:00 - 13:45 Room: Yellow 3

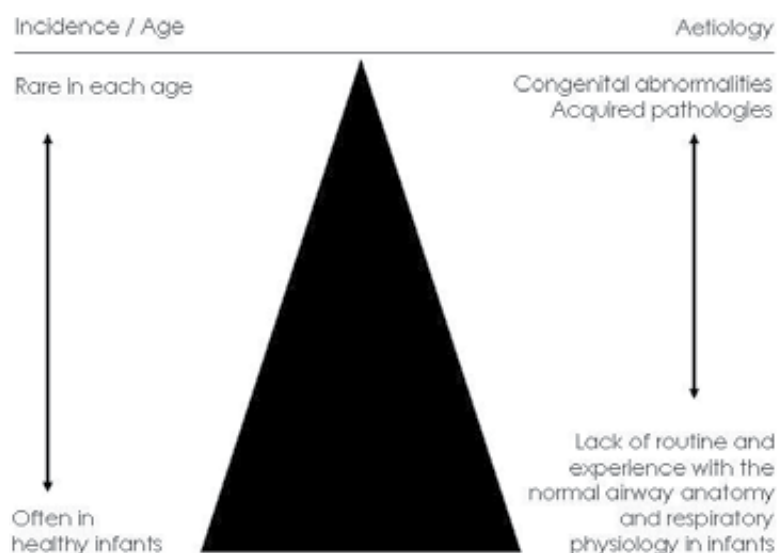
In recent years, airway management and associated problems in children have become one of the leading topics of discussion in the literature and at international meetings reflecting its importance and emphasising the inexperience, uncertainty and the lack of airway guidelines in this field of paediatric anaesthesia care. This lecture aims to cover epidemiology, morbidity and mortality, classification and issues related to problems in paediatric airway management. Proposals for training and guidelines are also discussed.

Epidemiology

Airway related problems in children constitute a major risk factor for peri-operative respiratory adverse events [1-3]. An incidence of intra-operative respiratory complications as high as 21% has been reported [2]. Laryngospasm, bronchospasm, airway obstruction, oxygen desaturation and difficult tracheal intubation are the most common problems [1, 2]. They are more frequent in infants than in older children and occur most often in children undergoing ENT surgery. The risk was increased 2.74 times in children not anaesthetised by a specialist paediatric anaesthesiologist.

Unlike adult or obstetric anaesthesia, the incidence of difficult or failed intubation in otherwise healthy children is low, except, of course, in patients with rare diseases and syndromes [4]. Intubation difficulties, particularly in younger children, are almost always a function of inexperience. Unexpected difficulties with the paediatric airway are extremely rare or even non-existent for well-trained paediatric anaesthesiologists, while 'beginners' and inexperienced anaesthetists will see them quite often [5] (Figure 1).

Figure 1



Incidence, age and aetiology of airway problems in children

Morbidity and mortality

Respiratory problems are still a major cause for peri-operative morbidity and mortality in children [6-8]. In 1985-90 respiratory events were more common among paediatric claims (43% vs 30%) and the mortality rate was greater in the paediatric claims (50% vs 35%) compared with adult claims [7]. In the 1990s, cardiovascular events (26%) joined respiratory complications (23%). The decrease in the incidence of respiratory complications, in particular those due to inadequate oxygenation and ventilation, may be attributable to the prevalent use of capnography and pulse oximetry. The widespread use of the laryngeal mask airway 'saved' patients with a difficult airway or from oesophageal intubation. However, airway complications not preventable by respiratory monitoring (such as airway obstruction, aspiration of gastric contents, premature extubation and difficulties with tracheal intubation) remain a significant concern.

Death (41%) and brain death (21%) remained the predominant injuries in paediatric anaesthesia malpractice claims in the 1990s and cardiovascular and respiratory events not preventable by respiratory monitoring remain a major source of liability. Interestingly only one third of injured patients belonged to ASA Class III-V. This confirms the earlier finding in claims of inadequate ventilation where poor medical condition or obesity remain uncommonly associated factors, unlike in adult claims (6% vs 41%). Similarly, it has been shown that cyanosis (49%) and/or bradycardia (64%) often preceded cardiac arrest resulting in death or brain damage in previously healthy children [6]. In a recent update of the Pediatric Perioperative Cardiac Arrest (POCA) Registry (1998-2004), respiratory complications account for a 27% of incidents, of which airway obstruction due to laryngospasm remains the commonest [8].

Classification and management

Problems with the paediatric airway are not necessarily related to anatomical abnormalities leading to failed tracheal intubation or inability to ventilate the patient by face mask. The aetiology of paediatric airway problems is multilayered and can be classified as followed:

The normal (difficult) airway

Problems associated with the management of the normal paediatric airway are related to their differences from the adult airway in several ways:

Anatomical differences

Coned shaped larynx; cricoid region the smallest part in children up to the age of 8 years; u-shaped and floppy epiglottis; higher and more anterior positioned larynx; short neck; large occipital head; large tongue; smaller oral cavity, susceptibility of the small airway to damage resulting in swelling and airway obstruction; changing variables with increasing age and weight.

Physiological differences

Reduced apnoea tolerance due to higher oxygen consumption, reduced functional residual capacity and increased alveolar collapse; rapid development of hypercarbia due to higher carbon dioxide production; cardiovascular responses to hypoxaemia; life-threatening respiratory reflexes such as laryngospasm and bronchospasm.

Pharmacological differences

Higher MAC values for volatile anaesthetics; higher induction dose requirements for intravenous hypnotics; thoracic wall rigidity due to systemic opioids; differing doses of and response to muscle relaxants.

Differences in equipment used

Changing sizes of mask, oropharyngeal airways, laryngoscope blades, tracheal tubes, supraglottic airway devices, and other accessories for securing the paediatric airway with increasing weight and age; problems with uncuffed tracheal tubes such as air leakage with inefficient ventilation and oxygenation, absent end-tidal carbon dioxide; damage of the larynx due to oversized tracheal tubes.

Psychological differences

Problems with pre-oxygenation and co-operation during assessment of the airway and prior to induction of anaesthesia.

Difficulties in paediatric airway management arising from differences from adult patients can be prevented by education and supervision of young anaesthesiologists in paediatric airway management and by regular training. Extensive training in facemask ventilation, direct laryngoscopy and tracheal intubation is important, particularly for anaesthesia trainees during short rotations to paediatric anaesthesia.

Although infrequent, respiratory compromise due to unexpected difficult airway can be salvaged by fiberoptic intubation through a laryngeal mask airway and techniques such as insertion of a supraglottic airway for the management of ventilation or oxygenation difficulties have become a 'gold standard' in paediatric anaesthesia practice [9, 10].

The difficult (normal) airway

Several circumstances can impair direct laryngoscopy in the child with normal intubation anatomy such as infectious diseases of the airway (epiglottitis (supraglottitis), pseudo-croup (infraglottitis), peritonsillar abscess, abscesses in the oral cavity, lingual tonsillitis), trauma (injury by sharp objects, burns, scalds, chemical injuries) or a foreign body in the upper airway. These patients' airways are best managed by an anaesthesiologist experienced with inhalational induction techniques, face mask ventilation, direct laryngoscopy and tracheal intubation in children. Supraglottic airway devices are not appropriate in the management of these patients.

The real difficult airway

Patients with some syndromes, congenital abnormalities of the airway and metabolic diseases may represent a real difficult airway [4]. Most common among these are the craniofacial dysmorphologies such as the Goldenhar's syndrome, Robin and Treacher-Collin's syndrome as well as Hurler and Hunter mucopolysaccharidoses. Patient with a real difficult airway should be managed by experienced paediatric anaesthesiologists. Standard techniques used are inhalational induction and fiberoptic oro- or nasotracheal intubation with or without the use of an endoscopy facemask or the laryngeal mask airway [10-14]. Other special techniques include the retro-molar approach, blind oral or nasal intubation, and digitally guided intubation using endoscopic rigid laryngoscopes and stylets. They are all used rarely and remain reserved for suitably trained anaesthesiologists familiar with them [4]. Amongst these the laryngeal mask airway has become an important tool in patients with difficult facemask ventilation and tracheal intubation, particularly in patients with a mucopolysaccharidosis [13].

Patients with large head and neck tumours as well as mediastinal mass syndrome constitute high risk airway situations which are should be managed in specialised paediatric centres only [15, 16].

Future implications

To reduce problems in paediatric airway management as well as related morbidity and mortality, defining competency and teaching skills and the establishment of proper guidelines for the management of the normal and the difficult paediatric airway are required.

Regulations

Because of their limited respiratory reserve and differences from the adult airway, children below the age of 2-3 years must be anaesthetised by (or under supervision of) a paediatric anaesthesiologist. A minimum of regular training and experience is required to maintain skills [17, 18].

Training

Paediatric airway management must receive the highest priority during resident training. In particular, the following practical skills must be taught:

- Inhalational induction of anaesthesia
- Manual ventilation by facemask (the most important skill of a paediatric anaesthesiologist!)
- Insertion of, and ventilation by, a laryngeal mask
- Direct laryngoscopy and conventional tracheal intubation
- Fiberoptic intubation through a laryngeal mask airway and related tube exchange techniques
- Nasal CPAP ventilation

Training in naso- or oro-tracheal fiberoptic intubation should be limited to paediatric anaesthesiologists.

Guidelines

Comprehensive guidelines for the management of the normal and difficult paediatric airway are rarely available from most of the national paediatric anaesthesia working groups or societies. Unfortunately they are also absent in many units. Ideally, the following guidelines should be available:

- Pre-operative evaluation and preparation of patients
- Monitoring
- Management of the anticipated difficult airway
- Management of the unanticipated difficult airway
- Rapid sequence induction
- Prevention and management of laryngospasm and bronchospasm
- Prevention and management of peri-operative aspiration
- Equipment required for management of the normal and the difficult paediatric airway

Key learning points

- Paediatric airway problems and related adverse outcome are more common in smaller children, during ENT surgery and during anaesthesia performed by non-specialist paediatric anaesthetists.
- Despite improved respiratory monitoring, airway problems are still a major cause of paediatric anaesthesia litigation.
- A common cause of paediatric airway problems is a lack of experience and familiarity with the paediatric airway.
- Education and regular training in basic paediatric airway techniques, as well as rescue techniques for the unexpected difficult airway, are mandatory to reduce airway related problems
- Recommendations for anaesthesia service provision and guidelines for the management of normal and difficult paediatric airway are mandatory.

References

1. Murat I, Constant I, Maud'huy H. Perioperative anaesthetic morbidity in children: a database of 24,165 anaesthetics over a 30-month period. *Pediatric Anesthesia* 2004; 14: 158-66.
2. Mamie C, Habre W, Delhumeau C, Argiroffo CB, Morabia A. Incidence and risk factors of perioperative respiratory adverse events in children undergoing elective surgery. *Pediatric Anesthesia* 2004; 14: 218-24.
3. Bunchungmongkol N, Somboonviboon W, Suraseranivongse S, et al. Pediatric anesthesia adverse events: the Thai Anesthesia Incidents Study (THAI Study) database of 25,098 cases. *Journal of Medical Association of Thailand* 2007; 90: 2072-9.
4. Frei FJ, Ummenhofer W. Difficult intubation in paediatrics. *Pediatric Anesthesia* 1996; 6: 251-63.
5. Airway problems and difficulties with tracheal intubation in paediatric anaesthesia [German]. Dangel PH. In: *Die schwierige Intubation*, eds Biro P, Pasch Th. Verlag Hans Huber; Bern, 1995.
6. Jimenez N, Posner KL, Cheney FW, et al. An update on pediatric anesthesia liability: a closed claims analysis. *Anesthesia & Analgesia* 2007; 104: 147-53.
7. Murray JP, Geiduschek JM, Caplan RA, et al. A comparison of pediatric and adult anesthesia closed malpractice claims. *Anesthesiology* 1993; 78: 461-7.
8. Bhananker SM, Ramamoorthy C, Geiduschek JM, et al. Anesthesia-related cardiac arrest in children: update from the Pediatric Perioperative Cardiac Arrest Registry. *Anesthesia & Analgesia* 2007; 105: 344-50.

9. Henderson JJ, Popat MT, Latto IP, Pearce AC. Difficult Airway Society guidelines for management of the unanticipated difficult intubation. *Anaesthesia* 2004; 59: 675-94.
10. Jöhr M, Berger TM. Fiberoptic intubation through the laryngeal mask airway (LMA) as a standardized procedure. *Pediatric Anesthesia* 2004; 14: 614.
11. Frei FJ, Wengen DF, Rutishauser M, Ummenhofer W. The airway endoscopy mask: useful device for fibreoptic evaluation and intubation of the paediatric airway. *Pediatric Anesthesia* 1995; 5: 319-24.
12. Stocks RM, Egerman R, Thompson JW, Peery M. Airway management of the severely retrognathic child: use of the laryngeal mask airway. *Ear Nose Throat Journal* 2002; 81: 223-6.
13. Allen DL, Rothera MR. A fibreoptic intubation technique for children with mucopolysaccharidoses using the laryngeal mask airway. *Pediatric Anesthesia* 1997; 7: 421-6.
14. Hasan MA, Black AE. A new technique for fibreoptic intubation in children. *Anaesthesia* 1994; 49: 1031-3.
15. Vas L, Naregal F, Naik V. Anaesthetic management of an infant with anterior mediastinal mass. *Pediatric Anesthesia* 1999; 9: 439-43.
16. Hammer GB. Anesthetic management for the child with a mediastinal mass. *Pediatric Anesthesia* 2004; 14: 95-7.
17. Lunn JN. Implications of the National Enquiry into perioperative deaths for paediatric anaesthesia. *Pediatric Anesthesia* 1992; 2: 69-72.
18. Auroy Y, Ecoffey C, Messiah A, Rouvier B. Relationship between complications of pediatric anesthesia and volume of pediatric anesthetics. *Anesthesia & Analgesia* 1997; 84: 234-5.