PAEDIATRIC ANAESTHESIA

1. PREOPERATIVE EVALUATION

All children must be assessed before anaesthesia and/or surgery. For a child < 6 months, the birth history is important.
Pre-operative evaluation of the children includes:

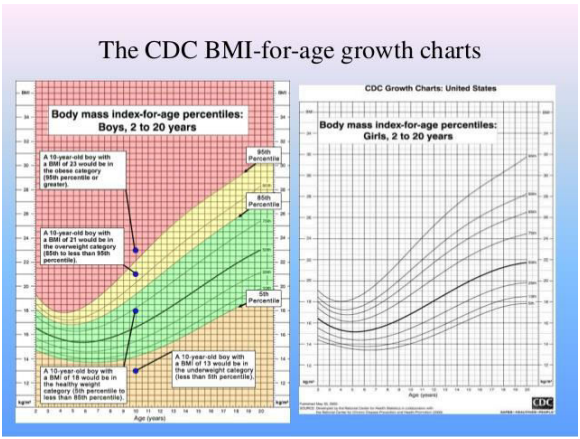
a) History

- Perinatal history/ events
- If born premature, the corrected post-gestational age (PGA) PGA = post-natal age + gestational age
- Complications related to prematurity
- Neonatal Intensive Care Unit admission and events if applicable
- History of apnoeic spells
- Developmental milestones
- Feeding
- Any associated congenital anomalies
- Family history of anaesthesia related problems,
- Medical diseases e.g. Asthma, Upper Respiratory Tract Infection (URTI)
- Previous anaesthetic history/ history of motion sickness
- Drug history
- Allergies: drugs, foods, adhesive tapes etc

b) Examination

- Height and Weight. (Weight is particularly important as drug dosages are ordered based on it. Height is important for calculating the body mass index (BMI) and body surface area. The latter is applicable in situations such as cardiopulmonary bypass). *Exception*: obese patients where it should be based on an estimate of lean body weight.

BMI and obesity in children



- Any obvious anomalies e.g. dysmorphism, cleft lip/palate, etc.
- Airway
- Dentition: presence of loose teeth/ orthodontic devices
- Examination of the heart and lungs
- State of hydration, nutrition
- The developmental/ cognitive/ neurological state of the child
- Vital signs of the child including saturations on room air
- Examination for possible venous access sites

Good rapport with both parent and child will go long way in making the anaesthetic experience a pleasant one.

c) Laboratory Investigations

Routine investigations are unnecessary for most healthy, normal children undergoing minor surgery, and are not ordered unless the history/ physical examination suggest otherwise.

For major operations, the following investigations may be required:

- FBC including platelets.
- Urea, electrolytes and glucose
- PT/PTT
- GXM or Type and screen.
- ECG / CXR
- LFT or any other relevant investigations like 2D echocardiograms

Fasting guidelines

Elective Surgery

1. Children 1 year and above:
   a. For the morning list:
      Children should be kept nil by mouth from 12 midnight.
      A clear drink can be given up to 3 hours before scheduled induction of anaesthesia
   b. For the afternoon list:
      The child can have a light breakfast by 0600 hours and clear fluids up to 3 hours before scheduled induction of anaesthesia

*Clear fluids refer to glucose, water, clear fruit juice (non- particulate, e.g. apple juice, but not orange juice with pulp).
*Light breakfast means milk with 2 pieces of biscuits or a piece of plain bread only (no butter). Please be specific: in our Asian context breakfast could mean a bowl of noodles or fried rice!
***always** consult the anaesthetist in charge of the list as the order of cases may change.
* Fasting guidelines may need to be more stringent in cases where there is gastro-esophageal reflux or other factors increasing the risk of pulmonary aspiration.

2. Infants under 4 months of age :
   - breast milk : completed 3 hours before anaesthesia
   - infant formula :completed 4 hours before anaesthesia

3. Infants above 4 months but under 1 year :
   - formula milk/ :completed 6 hours
   - clear feeds (up to 10 ml /kg) : 2-3 hours prior to anaesthesia
   - If the child does not take formula milk and parents want to give breast milk: 4 hours before anaesthesia

Emergency surgery

When possible, depending on the urgency of the case, fasting guidelines should follow those for elective surgery.

1. Children 1 year and above :
   - full meal > 8hours
   - light meal or milk : 6 hours
   - clear feeds (up to 10 ml/kg) : 2-3 hours prior to anaesthesia

2. PRE-MEDICATION

Anxiolytic / Sedative premedication:

Premedication to relieve anxiety is not routinely prescribed as play therapy and parental presence are widely employed in our institution. However some children with special needs, learning disabilities, "repeat customers" or those who are particularly anxious or fretful may require and benefit from anxiolysis or sedation before induction of anaesthesia. It is worth checking previous anaesthetic charts and talking to the parent/caregiver regarding the need for premedication.

Premedication is administered most commonly in oral form, but intranasal and intravenous routes have also been employed. The most commonly used anxiolytic agent is midazolam. The drug is usually given together with syrup simplex. Please refer to the chapter under 'drug dosages' for alternative agents, its dosages and formulations.

Premedication is not ordered in the ward; it is prescribed and given only at our Operating Theatre reception. Reasonable anxiolysis and/ or sedation are usually obtained in the majority of children within 15min. **Parents or care-givers should be cautioned to keep a close eye on the child in the play area to avoid accidental injury from falls. A member of the anesthesia team should stay with the premedicated child.**

Antisialogogue:

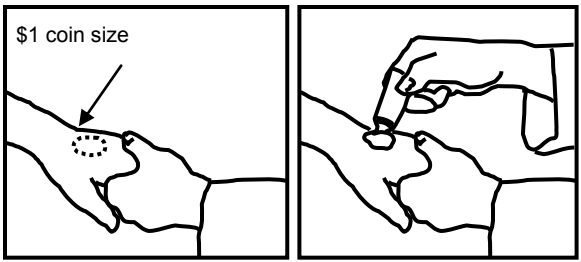
When a patient is scheduled for instrumentation of the airway eg: microlaryngobronchoscopy (MLB) or bronchoscopy, an antisialogogue agent like atropine or glycopyrrolate may be administered. Please consult your anaesthetic consultant on the need for this.

Ametop cream:

This is to be applied over visible veins 30- 45 minutes prior to venepuncture when intravenous induction is planned (write down an estimated time)

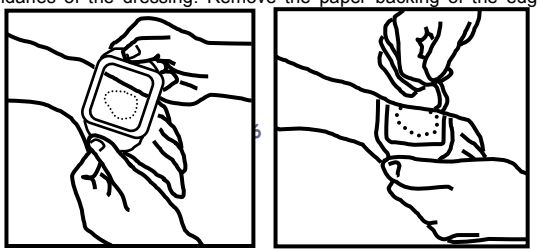
Instructions for application:

Select a suitable venepuncture site on the dorsum of the hand or foot. Mark a small circle around the vein approximately the size of a $1 coin.



Apply a generous amount of Ametop cream over the circle or vein. The layer of cream should be at least 2 mm thick. You should not be able to see the vein through the cream. Do not rub the cream into the skin.

Cover the dorsum of the hand with a transparent dressing such as Tegaderm® or Opsite®, making sure that the Ametop stays within the boundaries of the dressing. Remove the paper backing of the edge



and seal the dressing. Do *not* spread the cream out into a thin film. Leave for 45 minutes. Make sure young children do not remove dressing or eat the Ametop!

If Ametop has been applied for an insufficient period of time and intravenous cannulation is desired in a child who is cooperative, getting the child to breathe a mixture of nitrous oxide and oxygen may help facilitate the process. Alternatively, inhalational induction may be used.

Ametop gel

This is a topical anaesthetic that contains tetracaine and has been shown to be superior to am. It should be applied in a similar manner to EMLA for 30min for venepuncture and 45 min for intravenous cannulation. Its numbing effect lasts 4-6 hours after a 30-45min application. Unlike EMLA, it does not cause vasoconstriction but there may be redness, swelling or itch noted over the application site. If blistering is noted, the gel should be removed immediately. It should not be left longer than 45 min on a patient. It may be reapplied after a minimum period of 5 hours.

The gel should not be applied to broken or inflamed skin. It should not be used in full term neonates or premature babies.

PERIOPERATIVE FLUIDS

Intravenous fluids are administered perioperatively to maintain homeostasis during this period. Water and electrolytes are required to correct deficits and ensure adequate intravascular volume. Calories in the form of dextrose may be needed to prevent hypoglycaemia.

Unless fasted for a long period of time, most children undergoing minor procedures which allow them to resume feeding soon after surgery do not need intra-operative intravenous fluids.

Children undergoing major surgery, or those who have incurred fluid deficits, and/ or are required to remain nil by mouth post-operatively will require intravenous (IV) fluids. Fluids may be given for:

- Resuscitation - to correct pre-existing hypovolaemia or dehydration
- Maintenance - to provide water, electrolytes and glucose during the starvation period.

sign	5% body weight fluid loss 50ml/kg (mild)	10% body weight fluid loss 100ml/kg (moderate)	15% body weight fluid loss 150ml/kg (severe)
Pulse (rate/strength)	Normal/ normal	Increased /weak	Greatly increased/ feeble
Blood pressure	Normal	Normal to low	Reduced and orthostatic
Respiration	Normal	Deep	Deep and rapid
Mucous membrane	Moist	Dry	Very dry
Anterior fontanelle	Normal	Sunken	Markedly sunken
Eyes	Normal	Sunken	Markedly sunken
Skin turgor sunken	Normal	Decreased	Markedly decreased
Sensorium	Normal/ thirsty/ restless	Thirsty/ lethargic but arousable	obtunded
Urine output	<2ml/kg	<1ml/kg	<0.5ml/kg

- Replacement of ongoing losses

Resuscitation

This should begin pre-operatively although full resuscitation may not be possible if the child has to undergo surgery without delay. In these

unusual situations, resuscitation must continue intraoperatively. It is important to be able to assess the degree of dehydration in a child. This is summarized in the table below. Hypovolaemia (losses from the intravascular space) should be replaced initially with 20 ml/kg boluses of isotonic solutions like normal saline or colloid. Blood should be considered if the haemoglobin is low, or there is ongoing bleeding, or more than 40 ml/kg of fluid is required.

Maintenance

Several formulas are available; the simplest and most commonly used is the one devised by Holliday and Segar (and modified by Oh). Do note though that infants, particularly neonates, have increased maintenance requirements and this is discussed under the chapter Pediatric Medicine Clinical Guidelines For Intravenous Fluids In Children.

Body weight	Holliday and Segar	Oh
1-10kg	4ml/kg/hour	4ml/kg/hour
10-20kg	40ml/hour + 2ml/kg/hour above 10 kg	20 + (2 x weight in kg) ml/kg/h
>20kg	60ml/hour + 1ml/kg/hour above 20 kg	40 + weight in kg ml/kg/h

Intraoperatively, the amount of insensible loss will vary depending on the extent of surgical exposure and trauma. The additional fluid requirements for minimal tissue trauma may range from 0-2ml/kg/hr, moderate surgery 2-4ml/kg/hr and up to 10ml/kg/hr for severe tissue trauma/ major surgery. All this should factor in determining the maintenance fluid rate.

Children given hypotonic fluid may become hyponatraemic. Surgery and anaesthesia cause antidiuretic hormone (ADH) levels to rise, resulting in conservation of water and predisposing patients to hyponatremia. A rapid or profound drop in sodium results in water moving into cells causing swelling and oedema. This can manifest as raised intracranial pressure, brain stem herniation, coning and death. Prepubertal children in particular are susceptible to brain damage associated with postoperative hyponatraemic encephalopathy. As such, the use of hypotonic solutions is avoided during surgery except in patients with hypernatremia.

Ongoing losses:
An estimate of the blood loss can be made by weighing swabs (approximately 10ml per average swab), monitoring suction losses and “eyeballing” drapes. There may also be other sources of fluid losses such as the gastrointestinal tract fluid or cerebral spinal fluid or urine. The type of ongoing loss should determine the type of fluid used to replace the loss.

Monitoring urine output and central venous filling pressures are useful adjuncts in determining the volume status of the child. If surgery is prolonged and there are extensive fluid shifts / blood loss, regular blood gas, haematocrit, electrolyte and serum glucose monitoring should be carried out to optimize fluid management.

Fluids in the Operating theatre

In the OT, the default fluid used for patients will be Hartmann's Solution except for the following categories:
Neonates: Dextrose 5% or Dextrose 10% as maintenance drip, and use Normal Saline or Albumin 5%/ blood /blood products for volume resuscitation / replacement as appropriate to the clinical situation.
Neurosurgical cases: Normal Saline

It should be remembered that complications may arise from excessive administration of crystalloids or colloids. Excessive administration of normal saline for example is associated with acidosis. More recently, balanced salt solutions such as plasmalyte A have become available. These isotonic solutions have an electrolyte composition similar to human plasma and are hence less likely to result in electrolyte disturbances.

The composition of some commonly used crystalloids and colloids are given below.

fluid	osmolarity	Na	Osmolality	Tonicity	others
0.9% saline	308	154	isosmolar	isotonic	
D5%/ 0.9% saline	586	150	hyperosmolar	isotonic	
4.5% albumin	275	100-160	isosmolar	isotonic	
Hartmann's solution	278	131	Slightly hyposmolar	Slight hypotonic	K/Ca/ lactate
0.45% saline	154	77	hyposmolar	hypotonic	
D5%/0.45% saline	432	75	hyposmolar	hypotonic	
D5%	278	0	isosmolar	hypotonic	
D10%	555	0	hyperosmolar	hypotonic	
Sterofundin	309	145	isosmolar	isotonic	K/ Ca/ Mg/ acetate / malate
Plasmalyte A	294	140	isosmolar	isotonic	Na/ K/Ca/Mg/acetate/ gluconate

For more information on Fluid Orders in the General Paediatric Wards, see chapter on Paediatric Medicine Clinical Guidelines - Intravenous Fluids in Children.

KK PAN CONSENSUS GUIDELINES FOR PREVENTION OF PONV

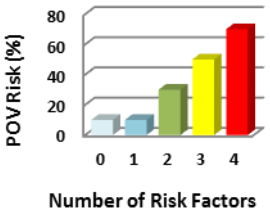
Postoperative nausea and vomiting (PONV) is is one of the leading postoperative complaints from parents and the leading cause of readmission to the hospital. Severe vomiting can be associated with dehydration, postoperative bleeding, pulmonary aspiration, and wound dehiscence.[1]

POV occurs twice as frequently in children than in adults, increasing from 3 yrs of age until puberty, then decreasing to adult rates. Gender differences are not seen before puberty. The two most common emetogenic surgical procedures evaluated in children are strabismus repair and adenotonsillectomy.

According to POVOC[2] scores, where the POV risks are 9%, 10%, 30%, 55% and 70% for patients with 0, 1, 2, 3 or 4 risk factors respectively. (risk factors include age≥3 yrs, duration of surgery ≥30 mins, strabismus surgery, previous hx of PONV)

Eberhart et al[3] to predict the risk for POV in children.When 0, 1, 2, 3, or 4 of the depicted independent predictors are present, the corresponding risk for PONV is approximately 10%,10%, 30%, 50%, or 70%, respectively.

Risk Factors	Points
Surgery ≥ 30 min.	1
Age ≥ 3 years	1
Strabismus surgery	1
History of POV or PONV in relatives	1
Sum =	0 . . . 4



The management of PONV in children involves proper preoperative preparation, risk stratification, rational selection of antiemetic prophylaxis, choice of anesthesia technique, and a plan for postoperative antiemetic therapy. Children at moderate-to-high risk for PONV should receive prophylactic antiemetic therapy which can be single or double.

We reviewed various PONV consensus guidelines and management algorithms of other paediatric units. Whilst considering local prescribing guidelines, we recommend the following:

INTRA-OPT PROPHYLAXIS

Single drug

- IV ondansetron 0.15mg/kg (max 8 mg, only in children>1 mth old, to be used with caution in cardiac patients with arrhythmias) for the following groups:
  - ≥ 3yrs + use of intra-opt opioids
  - ≥ 3yrs + middle ear surgery
  - ≥ 3yrs + surgeries ≥30 mins duration

Double prophylaxis

- **IV ondansetron 0.15 mg/kg (max 8 mg)** AND **IV dexamethasone 0.15 mg/kg (max 5mg)** for any of the following risk factors:
  - Strabismus surgery
  - Tonsillectomy ± Adenoidectomy
  - Middle ear surgery + opioid use
  - Previous history of PONV

POST-OPT PRESCRIPTION

- **IV ondansetron 0.15 mg/kg 8 hrly/prn** for:
  - ALL SDA and inpatients (√ the □ on the doctor's postoperative orders on the PC in OT)
  - ALL patients put on Acute Pain Service for PCA/NCA opioids and epidurals (Order in the CLMM along with APS orders)

TREATMENT for established vomiting (defined as vomiting ≥ 2X post-opt)

- **IV ondansetron 0.2mg/kg (max 8 mg)**
  - If ondansetron has not been given

- **IV dexamethasone 0.15 mg/kg (max 8 mg)**
  - If only ondansetron has been given, and dexa not given yet
  - Ensure no contra-indications eg. Hyperglyceamia/ sepsis

- **Call the consultant anaesthetist** if vomiting persists in spite of the above, may consider the following with discretion:
  - IV Metoclopramide 0.5 mg/kg (slow bolus over 10 min) (max 20 mg)
  - IV Dimenhydrinate 0.5 mg/kg (max 12.5 mg)
  - IV Promethazine 0.5 mg/kg (max 25 mg)- only in children>6 mths old
  - IV Droperidol 10-15 mcg/kg (max 1.25 mg)- not as first-line, only in children>2yrs with wt>10kg, see FDA black box warning.
  - IV Dolasetron 350mcg/kg (max 12.5 mg)
  - IV Granisetron 40 mcg/kg (max 0.6 mg)
  - IV Tropisetron 0.1 mg/kg (max 2 mg)
  - IV Propofol subhypnotic dose infusion (as rescue in PACU only, ordered by consultant anaesthetist)

General peri-operative measures to reduce POV baseline risks.

- Ensure adequate hydration
  - Allow clear feeds up to 2 hrs before induction
  - Intra-opt IV fluids
- Avoid/minimize the use of
  - nitrous oxide for maintenance, especially prolonged surgeries
  - Volatiles
  - Peri-operative opioids
- By Multi-modal analgesia, using opioid-sparing agents and techniques
  - eg. IV paracetamol, NSAIDs, ketamine, Regional blocks
- TIVA techniques if indicated eg, prev hx of severe POV
- Other non-pharmocological techniques eg. acupuncture

References:

1. Management of postoperative nausea and vomiting in children. Paediatr Drugs. 2007;9(1):47-69.
2. Guidelines on the Prevention of Postoperative Vomiting in Children. APA guidelines 2009.
3. The development and validation of a risk score to predict the probability of postoperative vomiting inpediatric patients. Anesth Analg 2004;99:1630–7
4. A prospective evaluation of the POVOC score for prediction of post operative vomiting in children Anesth Analg 2007; 105:1592-7
5. Consensus guidelines for the management of postoperative nausea and vomiting. Anesth Analg. 2014 Jan;118 (1):85-113.

3. COMMON MEDICAL CONDITIONS IN CHILDREN

a. The child with runny nose
b. The wheezy child
c. The child with a murmur
d. The difficult child
e. The Autistic child
f. The Child with cerebral palsy / brain impaired
g. The Child with Down Syndrome

a) The Child with Runny Nose

The questions we have to consider are:

- What is the cause; vasomotor/allergic rhinitis or infective
- What are the risks in proceeding – risk vs benefit
- What complications might happen
- How to proceed

What is the cause?

Signs and symptoms of infection include fever, malaise, poor feeding and purulent nasal discharge. On the other hand, a history of atopy and wheezing in the absence of the above symptoms may suggest an allergic cause.

What complications may happen in the presence of a respiratory tract infection?

There is increased risk of laryngospasm, bronchospasm and hypoxaemia perioperatively. Increased secretions and mucus plugging of the airways can occur. A rare but serious complication is myocarditis and arrhythmias. The increased sensitivity of airways may persist for up to 6-8 weeks post upper respiratory tract infection.

Risks are increased with:

- Infants and toddlers
- Presence of URTI
- Airway surgery or if the child has a difficult airway
- Less experienced anaesthetists
- Asthmatics
- Passive smoking

Risk vs. Benefit: Discuss the case with the Senior Anaesthetist in charge and the surgeon. There may be the need to proceed with emergency surgery even in the face of a URTI whilst taking measures to prevent and treat complications that arise. Parents should be counseled on the risks. Elective surgery may proceed if the cause of runny nose is non infective and the child optimized as much as possible (this does not necessarily equate symptom free). This is especially so if the surgery may improve symptoms of airway obstruction. Again, the anaesthetist, surgeon and parents need to be aware of possible complications and hospital admission in event of serious complications arising, if the case was planned as day surgery.

How to proceed: All children with signs and symptoms of URTI should be postponed if the surgery is not urgent. Symptoms of URTI include rhinorrhoea, nasal congestion, productive cough and systemic features of viral toxemia such as malaise, fever, myalgia, headache, irritable behaviour, problems with eating or sleeping. Surgery should be postponed for at least 2 weeks after the child recovers.
If the child has only a runny nose with clear discharge or nasal congestion, we may proceed if the child looks well, and the surgery is minor and will not require tracheal intubation. Laryngeal mask airway (LMA) may be used if the surgery requires a clear field in the head & neck, but the depth of anaesthesia must be adequate prior to placement to avoid possibility of laryngospasm.

If emergency surgery must proceed in a child with URTI, precautions must be taken. The maintenance of adequate anaesthetic depth in

accordance with the degree of surgical stimulation is imperative! The risk was lower with:

- the use of intravenous induction
- maintenance of anaesthesia with inhalational agents except desflurane
- airway management by a paediatric anaesthesia specialist
- Facemask/ LMA instead of tracheal intubation
- Salbutamol premedication for kids with URTI

In the postoperative period, the child may require humidified oxygen and physiotherapy

RISK ASSESSMENT OF ADVERSE RESPIRATORY EVENTS IN PAEDIATRIC ANAESTHESIA

Children having a general anaesthetic can have various respiratory adverse events such as airway obstruction, breath holding, atelectasis, desaturation, coughing, stridor, laryngospasm and bronchospasm. These events can lead to severe hypoxia and cardiac arrest on occasions where they are not or cannot be adequately managed.

Hence it is important to identify children with risk factors that can predispose to respiratory adverse events during general anaesthesia with the aim of

- Informing the patients/parents about the risks of general anaesthesia
- Discussing the benefits and risks of general anaesthesia with the surgeons
- Discuss benefits and risks of rescheduling general anaesthesia
- Preoperative preparation of the patient and operating theatre to minimize the risks and manage adverse events effectively.

Factors predisposing to higher risk of peri-operative respiratory adverse events in children having a general anaesthetic

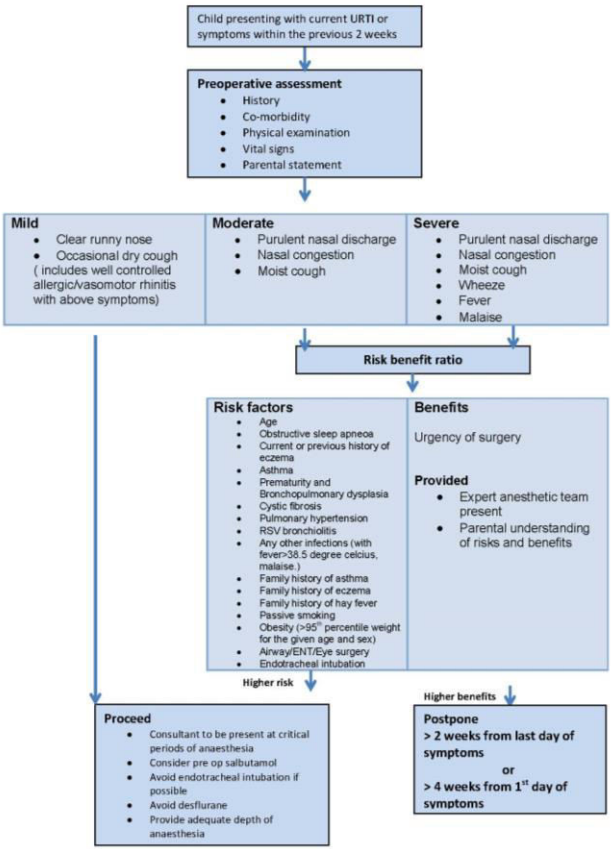
- Patient factors:
  - Upper respiratory tract infection – ongoing or within 2 weeks of general anaesthesia

- Dry nocturnal cough
- Obstructive sleep apneoa
- Current or previous history of eczema
- Asthma
    - Bronchial reactivity on exercise
    - Wheezing in the past 12 months
    - Past history of asthma (if no wheeze in the past 12 months)
- Prematurity and bronchopulmonary dysplasia
- Cystic fibrosis
- Pulmonary hypertension
- RSV bronchiolitis
- Any other infections (with fever>38.5 degree centigrade, malaise.)
- Family history of asthma
- Family history of eczema
- Family history of hay fever
- Passive smoking
- Obesity (>95th percentile weight for the given age and sex)
- Younger age (< 6 years, particularly < 1 year, decreasing age by each year increases the risk by 11%)

- Surgical factors:
    - Urgent/emergent procedures
    - Airway, ear nose throat, eye surgeries
- Anaesthetic factors:
    - Inexperience
    - Anaesthetic agents (desflurane> sevoflurane> propofol)
    - Airway management (Endotracheal tube > LMA > Facemask)

If the child you assess has any of the above risk factors, it is prudent to discuss your case with your consultant prior to proceeding with the general anaesthetic.

Child with a runny nose: Algorithm for management of a child with current or past upper respiratory tract infection



b) The Wheezy Child

All children coming for elective surgery must be free from signs and symptoms of acute asthma. Ex-premies with Chronic Lung Disease may have hyperactive airways and may be still on home oxygen therapy. Ascertain the frequency of attacks, severity of disease and current medical management. The majority of cases are mild. Severe asthmatics should be reviewed and may need to be admitted for optimization of their condition by the Respiratory Physician before coming to the operating theatre. Respiratory function tests may be difficult to administer in younger children. The child may benefit from pre-operative bronchodilator (MDI or nebuliser as appropriate) administration. Depending on the severity of the disease, they may require monitoring and/or care in a High Dependency Unit postoperatively.

c) Cardiac murmur

An incidental murmur may be picked up during the pre-operative visit. There is the need to differentiate between an innocent and pathological murmur.

Innocent murmurs are common can be detected in children who are thriving well, active with no evidence of cyanosis, breathlessness at rest or on exertion. They are not associated with anatomical or physiological abnormalities. It is *usually* soft, grade 1-3, early systolic and disappears with body positioning. It can also be continuous as in a venous hum. Criteria usually associated with pathological murmurs are: diastolic, pansystolic, late systolic, very loud murmurs, associated signs of cardiac disease or continuous murmurs (except venous hums) that persist regardless of body position. Clinically it may be difficult to unequivocally differentiate between the two and referral to a cardiologist should be made preoperatively for elective surgery. Under emergency conditions, because it is often difficult *clinically* to rule out small structural lesions, all children with murmurs should receive antibiotic prophylaxis prior to surgery that is likely to cause significant

bacteraemia (dental, genitourinary, oral or gastrointestinal) unless cardiac review has determined otherwise.

Children less than 1 year old with murmur should be evaluated by cardiologist before operation.

Features of Cardiac Murmurs in Children	
Innocent	Pathological
Asymptomatic	Symptomatic
Soft, Gr 1-3	Loud
*Early Systolic	Pan / Late Systolic, Diastolic
No Thrill	Thrill
Disappears with body positioning	Remains constant body positioning

* With the exception of venous hums which are continuous murmurs

d) The Difficult Child

These children may be uncooperative and aggressive for various reasons (bad past anaesthesia experience, behavioural issues, mental retardation). It is useful to review the medical/ anaesthetic history of the child. Discuss with the parents / caregiver what factors affect behavior and what methods have worked in past anaesthetics (if any). If the child is very anxious due to multiple surgeries and anaesthetics, premedication given under direct supervision of the attending anaesthetist in the Children's OT waiting area may be useful. Please refer to section under "premedication".

e) The Autistic Child

They usually react badly to any change in routine and may have very special likes and dislikes. Certain stimuli (sounds / sights) may also trigger severe distress. Discuss with parents / caregiver about the factors that affect behaviour and about the methods that have worked in past anaesthetics. Special considerations e.g. wearing their own clothes, having 2 parents at induction (especially for the older, larger child), early removal of IV cannulae, recovery with parental presence in a quiet side area should be considered.

e) The Child with Cerebral Palsy / Brain damaged Child

Children with CP may or may not have mental handicap. Assess the level of the child's intelligence. In both categories, venous access and patient positioning may be problematic due to disuse of limbs and contractures. Difficulty in swallowing, repeated episodes of pulmonary aspiration and possible kyphoscoliosis require careful assessment of the child's respiratory status. Special measures to prevent pressure sores should be taken. Children with seizures should have their anti-epileptic medications continued in the perioperative period as far as possible.

f) The Child with Down's Syndrome

Children with Down's Syndrome or Trisomy 21 present with multiple problems. Although some with this condition may be difficult at induction (see The Difficult Child) and a combination of parental/care-giver presence, persuasion, coercion and or premedication may be required, it is important to realize that these children have varying degrees of cognitive function and some are capable of holding intelligent conversations. The anaesthetic plan therefore needs to be tailored to the individual. Trisomy 21 children are often "floppy" (hypotonic) as infants and more prone to delayed recovery and airway obstruction. Other problems are listed in table below:

Pathophysiology & Clinical Manifestation	Anaesthetic Implications
microcephaly, macroglossia hypotonia	potential difficult airway exaggerated response to NMBDs
obstructive sleep apnoea atlantoaxial instability	loss of airway in post-op period C spine XR; caution with neck manipulation
congenital subglottic stenosis	downsize ETT by one size
recurrent pulmonary infection CHD: VSD, TOF, PDA	frequent cancellation of surgery preop cardiac evaluation prophylactic antibiotics
duodenal atresia	"E" neonatal surgery, full stomach

4. PAEDIATRIC ANAESTHESIA EQUIPMENT

A. UNCUFFED Endotracheal tube (UC ETT)

Age	Wt (kg)	ID* (mm)	Oral length (cm)	Nasal length (cm)
Neonate	< 1	2.5	5.5	7
Neonate	1-3	3.0	6-9	7.5-11
Neonate	> 3.5	3.5	9	11
3/12	6	3.5	10	12
1 yr.	10	4.0-4.5	11	14
2 yr.	12	4.5-5.0	12	15
3 yr.	14	4.5-5.0	13	16
4 yr.	16	5.0-5.5	14	17
6 yr.	20	5.5-6.0	15	18
8 yr.	24	6.0-6.5	16	20
10 yr.	30	6.5	17	21
12 yr.	38	7.0	18	22

Although there are many guidelines available, it is the usual practice to prepare, in addition, ETTs that are half a size larger and smaller than the estimated size. The tube should not fit tightly, a small leak is advisable. Always test for leak by holding a sustained pressure of about 15 cm H_2O. After intubation, always listen in both axillae and epigastric areas.

* ID internal diameter

In general, the following formulae can be used:

ETT size (ID) : age(yrs)/4 + 4.5 for patients >2 years

Insertion Depth
For children over 1 year of age:
Insertion depth (cm) for orotracheal intubation= age/2+13
Insertion depth (cm) for nasotracheal intubation= age/2+15

For children under 1 year of age:
Insertion depth for orotracheal intubation= weight/2+8
Insertion depth for nasotracheal intucation=weight/2+9

Alternatively, ETT insertion depth can be guided by the depth marker on the ETT. The ETT depth marker is located at the distal end of the ETT.
The ETT should be inserted until the depth marker (dense black line) is at the level of the vocal cords. The length of the ETT at the upper incisor or nostril is then noted as the depth of insertion.

Cuffed Paediatric Endotracheal Tubes
Cuffed ETT are recommended for children >8yrs.
Under special circumstances, we may choose to use cuffed endotracheal tubes in infants and small children. These patients often require the presence of a cuffed tube to allow adequate ventilation in the face of high airway resistance and peak ventilating pressures. It is recommended to measure cuff pressure regularly (20-30cm H_2O)We currently have cuffed ETTs from size 3-0mm ID.
Microcuff ETT is a specially designed paediatric tube with a high volume low pressure cuff. They afford lower risk of airway trauma and mucosal tissue injury.

B) Laryngeal Mask Airway (LMA)

Recommended sizes are:

Size	Weight (kg)	Max cuff inflation vol (ml)
1	5	up to 4
1.5	5 - 10	up to 7
2	10 - 20	up to 10
2.5	20 - 30	up to 14
3	30 - 50	up to 20
4	50 - 70	up to 30
5	70 - 100	up to 40

Cuff recommended to be inflated up to maximum of 60 cm H_2O

ProSeal LMA

ProSeal LMA is available for use in well fasted patients with no risk of regurgitation or aspiration. Choose size as for regular LMAs.

Intubation via LMA

Patients can be intubated via LMAs.

The largest ETT & FOB that can be used with each LMA is given in the table below.

LMA , FOB and ETT Size (mm)

LMA Size	Maximum FOB Size	Maximum ETT size
1	2.8~~7~~mm	3.5mm Uncuffed
1.5	3.0mm	4.0mm Uncuffed
2	3.5mm	4.5mm Uncuffed
2.5	4.0mm	5.0mm Uncuffed
3	5.0mm	6.0mm Cuffed
4	5.0mm	6.0mm Cuffed
5	5.5mm	7.0mm Cuffed

*FOB : FiberOptic Bronchoscope

Our dept has FOB in the following sizes:

1. 2.2mm
2. 2.8mm
3. 3.6mm

The table below indicates the smallest ETT & LMA that can be used with each FOB.

FOB	Diameter(mm)	Smallest ETT	Smallest LMA
paed	2.8	3.5*	1.0
neonatal	2.2	2.5*	1.0

* snug fit- must remove ETT blue connector before railroading over FOB. FOB must be well lubricated with silicon spray.

One Lung Ventilation in Children (Anesth analg 1999;89;1426-9)

Age(yr)	ETT(mm)	Forgarty(F)	Ardnt(F)	DLT(F)
0.5-1	3.5-4	3		
1-2	4-4.5	3		
2-4	4.5-5	3	5	
4-6	5-5.5	4-5		
6-8	5.5-6	4-5		
8-10	6 cuff	4-5	7	26
10-12	6.5 cuff	4-5		26-28
12-14	6.5-7 cuff	5-6		32
14-16	7 cuff	5-6		35
16-18	7-8 cuff	7	9	35

Fogarty Catheter

Size(F)	3	4	5
Inflation vol(ml)	0.25	0.5	0.75
Diameter(mm)	8	9	10

Glidescope

Stat 0	<1.5kg
Stat 1	1.5-3.6kg
Stat2	1.8-10kg
Stat 2.5	10-28kg

C) Breathing Systems

Ayre's T- piece (Jackson Rees modification, Mapleson F)
Advantage: low resistance (no valves), minimal dead space and lightweight.
A pressure gauge should be used to measure ventilating pressures when ventilating on a T piece circuit.

Fresh gas flow (IPPV) :
1000 ml + 100 ml/kg BW/min for $PaCO_2$ of 4.8-5.3 kPa
or
1000 ml + 200 ml/kg BW/min

Circle system
Advantage: conserve moisture and heat, lower gas flows may be used. More economical when using expensive inhalational agents e.g. Sevoflurane. The new disposable circle system tubing and connectors are light weight.
Can be used for spontaneous respiration or IPPV. Small diameter tubing can be used for IPPV down to neonatal patients.

D) Laryngoscopes
Straight blade (Miller and Seward): use for neonates and those younger than 3 months old.
Small curved blade (Magill) can be used for those older than 3 months old.

E) Invasive Monitoring Lines
Disposable transducer sets are used – please let the Anaesthesia nurses know if you require a double or triple transducer set.
The following are general recommendations based on an average sized child. If the patient is smaller or larger than expected, up or downsize as appropriate.

RADIAL Arterial lines :

Up to 3/12 or weight<5kg	:24G terumo venula
> 3/12 or weight >5kg	:22G terumo venula
> 10yr	:20G terumo venula

FEMORAL Arterial lines:

Leaderflex catheters are available in 22G 4cm for children < 20kg
Leadercath catheters are available in 20G & 18G 8 cm for children >20kg

***Check lower limb perfusion after cannulation of femoral vessels*

Central Lines

a. Single lumen (leadercath)

Preterm neonate	<2kg	22G 4 cm
Term neonate	2-4kg	20G 8 cm
Child		20G, 18G, 8 cm

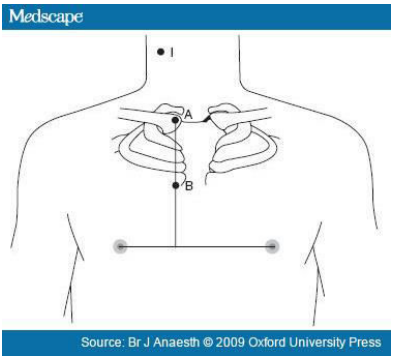
b. Double lumen

0-6 months	< 10 kg	4Fr, 5cm

c. Triple lumen

0-6 months	<10kg	4.5Fr,6cm
6 months - 12yrs	20-40kg	5.5Fr, 5cm, 8cm, 13cm
>12yrs	>40kg	7Fr, 16cm

Method for determining insertion depth of CVS



CVL tip should be positioned at junction of SVC & RA; level of carina on CXR

Two points are marked on the patient's skin during the IJV catheterization. Point A is marked at the sternal head of the right clavicle, most prominent point. Point B is marked at the midpoint of the perpendicular line from Point A to the line connecting both nipples. Point I is the insertion point of the needle. Distance from Point I to Point A and from Point A to Point B is measured. The depth of CVC is determined by adding the two measurements and subtracting 0.5 cm from this.

Practical Anatomic Landmarks for Determining the Insertion Depth of Central Venous Catheter in Paediatric Patients
H. S. Na et al
Br J Anaesth. 2009;102(6):820-823.

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