PHILIPPINE ACADEMY OF PEDIATRIC PULMONOLOGISTS

A Subspecialty Society of the Philippine Pediatric Society

Position Statement

Updates and Review of Preoperative Evaluation of Pediatric Patients for Elective Surgery

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PHILIPPINE ACADEMY OF PEDIATRIC PULMONOLOGIST Inc. (PAPP, Inc)

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FOREWORD

The Philippine Academy of Pediatric Pulmonologists (PAPP) published the 2011 Position Statement on Preoperative Evaluation of Pediatric Patients for Elective Surgery. The statement emphasized the purpose of preoperative evaluation: Evaluate the general status, identify risk (s) and implement measures to reduce the risk of patients undergoing surgery.

A thorough history and physical examination (PE) that focuses on risk factors are of utmost importance in preoperative evaluation. Findings on history and PE will determine the need for selective laboratory test(s) to maximize the preoperative preparation of the patient.

In the process of our update for evidence-based recommendations, we were limited to systematic reviews, consensus statements, guidelines, cohorts, and case studies. The reason for this limitation is the heterogenicity of the population and surgical procedures/interventions. However, there were a few meta-analyses studies included in the recommendations for the selective pre-operative tests. There were no randomized controlled trials (RCTs) studies for this update.

What is new in this update? We divided the document into five sections as follows:
Section A: Clinical questions on preoperative evaluation
Section B: Pediatric Procedural Sedation/Anesthesia outside the operating room
Section C: Preoperative considerations on common health conditions unique in pediatrics
Section D: Risk reduction strategies on common pediatric respiratory conditions
Section E: Interim Preoperative /Preprocedural guidelines during the COVID pandemic.

The surge in ambulatory care has likewise increased the number of procedures handled on an outpatient basis. These include imaging studies, office procedures, and even dental extractions. These procedures may sometimes require the use of sedation and anesthesia. Therefore, it warrants a special section that tackles its safety, which focuses on appropriate patient selection.

We also have recommended the use of stratification tools to classify patients' risk to effectively communicate the medical condition to the patients, and suggest appropriate risk reduction strategies with other members of the medical team (anesthesiologist and surgeons).

A questionnaire for identification of risk factors in children for increase adverse anesthetic events was included.

This position statement serves as a guide and provides recommendations in performing preoperative evaluation in healthy children and children with common clinical conditions for elective surgery. Specialty consultation and multi-disciplinary planning for children with complex medical condition is not covered in this position statement.

Summary of Recommendations

1. There is no patient with zero risk for anesthesia or surgical complications.

2. Identification of individual risks, surgical and anesthesia risk is important in preoperative evaluation.

3. Complete history and thorough physical examination are the key elements in preoperative evaluation in children.

4. Routine preoperative laboratory testing is NOT recommended in low risk patients for elective surgery.

5. Selective preoperative tests may be requested based on the clinical characteristics of the patient and the planned procedure.

6. When preoperative tests are felt to be necessary, it is probably safe to use test results that were performed and were normal within the past four months as preoperative tests unless there has been an interim change in clinical status.

7. Assessment of nutritional status for malnutrition is important in pediatric patients who will require nutritional support for an elective major surgery,

8. Patient with neurologic condition like seizure disorder should be on optimal condition before an elective surgery.

9. The use of pediatric surgical risk stratification tools are recommended to classify risk of patients to effectively communicate the patients pre anesthetic clinical condition.

10. The decision to proceed or cancel an elective surgery depends on the risk, benefit and consequence of delaying the procedure. It is also determined by the clinical judgment of the surgeon and anesthesiologist after an appropriate communication with the primary care physician and/or specialist.

11. Pediatric procedural sedation or anesthesia should be planned and patient selection is important to safety of pediatric sedation.

12. Former preterms, presence of congenital heart problems, neuromuscular disorders, and neurodevelopmental disorders are special pediatric population with preanesthetic concerns.

13. The presence of URTI is not an absolute contraindication to proceed with surgery. The decision should take into account the risk to benefit ratio of the procedure.

14. Optimal control of asthma symptoms in children is recommended before an elective surgery. There are risk reduction strategies to optimize asthmatic patients before undergoing surgery.

15. Children with OSA identified to be at risk for post operative respiratory complication should be admitted and monitored closely.

Section A: Clinical Question on Preoperative Evaluation

Clinical Question 1: What are the risk factors associated with increased perioperative adverse events?

KEY POINTS / RECOMMENDATIONS:

The following risk factors have been identified to be associated with increased perioperative adverse events (both pulmonary and cardiac adverse events):

Patient Risks:

- **Age: infants**
- **History of prematurity**
- **American Society of Anesthesiologists (ASA) physical class III or higher**
- **Presence of co-morbidities:**
  - **Acute respiratory tract infection**
  - **History of bronchial asthma**
  - **Cardiovascular disease**
  - **Obesity**
  - **Obstructive sleep apnea**

Surgical Risks:

- **Elective vs Emergency**
- **Intrinsic surgical risk – type of surgery**

Anesthesia Risk:

- **History of malignant hyperthermia**

Summary of Evidence:

<u>Patient Risks:</u>

Age

Adverse intraoperative events occurred more frequently in infants younger than 1 year than in older children. Increased frequency of respiratory complications has been associated with age < 1 y/o be due to early closure of terminal bronchioles, periodic breathing in infants and a highly compliant chest wall. [1,2,3,4] Pulmonary complications noted include irritation of the airway (laryngeal stridor/spasm), irregular breathing patterns, apnea, airway obstruction, coughing, snoring, bronchospasm, and oxygen desaturation.[5,6,7]

Increased incidence of perioperative cardiac arrest in infants has been reported in several studies. [2,8,9,10,11] A multi-centered prospective descriptive study in children also showed that incidence of anesthesia-related cardiac arrest was significantly higher in

infants than in older children.[2] Severe underlying disease such as prematurity, congenital heart disease, and other congenital defects place the infant at higher anesthetic risk than older children. Age as an independent factor of underlying disease was not predictive of mortality following cardiac arrest.

History of prematurity:

There are two common concerns with former preterm infants: the presence of bronchopulmonary dysplasia and possibility of postoperative apnea.[2] Preterms and former preterm children had a higher frequency of adverse events compared with term children (14.7% vs 8.5%) and were at a higher risk to develop any adverse event regardless of age at the time of the procedure. Neurologic dysfunction in preterm and former preterm infants may also play a role in the development of adverse events, including apnea and airway obstruction.[7]

Please refer to Section on Preoperative considerations on common health conditions unique in pediatrics for former preterm infants

American Society of Anesthesiologists (ASA) physical class III or higher

Patients who are in ASA classes I and II are frequently considered appropriate candidates for minimal, moderate, or deep sedation. Children in ASA classes III and IV, children with special needs, and those with anatomic airway abnormalities or extreme tonsillar hypertrophy present issues that require additional and individual consideration, particularly for moderate and deep sedation. An ASA status $\geq$ 3 significantly increases the risk of perioperative complications in children by 4 to 14 times.[12] The THAI study identified ASA physical status $\geq$ 3 as a major risk factor for increased incidence of perioperative complications, such as desaturation, reintubation, difficult intubation, coma/convulsion, cardiac arrest, and death.[2]

Table 1: ASA-PS Classification System

ASA PS classification	Definition
ASA I	A normal healthy patient
ASA II	A patient with mild systemic disease
ASA III	A patient with severe systemic disease
ASA IV	A patient with severe systemic disease that is a constant threat to life
ASA V	A moribund patient who is not expected to survive without the operation
ASA VI	A declared brain- dead patient whose organs are being removed for donor purposes

***The addition of "E" denotes Emergency surgery: (An emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part)*

Presence of co-morbidities:

Upper Respiratory Tract Infection (URTI)

URTI are the most common preoperative comorbidity being confronted in children.[13] There is a significant increase in the risk of perioperative respiratory adverse events in children with acute or recent (<2 weeks) upper respiratory tract infection.[14,15] The increased airway inflammation and hyperreactivity associated with URTI persists for several weeks, and may result in laryngospasm, bronchospasm, and oxygen desaturation. Despite the greater risk in perioperative complications in children with URTI, none of these complications resulted to any long term sequelae.[13,14,16]

Please refer to Section on Preoperative Risk reduction strategies for URTI.

History of Bronchial Asthma:

Poorly controlled asthma is the most important risk factor for perioperative respiratory adverse events, increasing the incidence of bronchospasm by 2.2-5.7%. [16,17,18,19] The following conditions suggest poor control: history of a recent asthma exacerbation warranting the use of oral corticosteroids, an increased use of inhaled short-acting β2-agonists, a recent exacerbation of asthma symptoms, and emergency visits to the hospital during the last months because of asthma.[18,23] Treatment should be optimized and all asthma medications should be continued up to the day of surgery.[12] Elective surgery should be scheduled at least 4 weeks after an exacerbation. [3,9,20,21,22]

For patients who require emergency surgery, the risk of proceeding without an optimized asthma control should be weighed against the need for immediate surgery. Patients who are taking long-term high dose ICS or who have received OCS for more than 2 weeks within the previous 6 months should receive hydrocortisone perioperatively because of the risk of adrenal crisis during surgery.[16,17]

Please see Section on Preoperative Risk reduction strategies for Bronchial Asthma

Cardiovascular disease

Congenital heart disease (CHD) has been shown to increase the cardiovascular (11.5%) and respiratory (4.7%) perioperative complications in children.[12] CHD increases mortality in noncardiac surgery by a factor of 2. The following are the major risk factors for increased mortality: cyanosis, younger age, more complex cardiac defects, poor general health, and current treatment for cardiac failure.[14] The more severe the CHD, the higher the risks of reintubation and mortality[12]. Hence, the best approach is to identify patients at high risk so that appropriate testing and therapeutic measures can be done to reduce perioperative risks.[24]

All infants younger than 1 year who have a murmur, even if asymptomatic, should undergo formal evaluation by a cardiologist before surgery because a significant cardiac lesion may have not yet become clinically apparent. On the other hand, most older children who have an “innocent murmur” without symptoms and signs of cardiovascular disease can safely undergo surgery.

A preoperative cardiology evaluation is recommended for those who have other types of murmur or who have symptoms or signs of cardiovascular disease. Asymptomatic patients with a family history of sudden death should make one consider hypertrophic obstructive cardiomyopathy.

Please see Section on Preoperative considerations on common health conditions unique in pediatrics for cardiac disease: congenital heart disease.

Obesity

Childhood obesity has been associated with several co-morbidities, which includes hypertension, hyperlipidemia, respiratory diseases, and adult heart disease.[25,26.] Respiratory comorbidity is the most common and includes bronchial hyperreactivity/asthma, increased risk for obstructive sleep apnea (OSA), obesity-hypoventilation syndrome, and impaired lung function. Moreover, the upper airway in obese children can be narrowed by subcutaneous fat deposition on the palatal and pharyngeal soft tissues, chubby cheeks and a large tongue. Obese children are also vulnerable to airway infections and gastroesophageal reflux.[27]

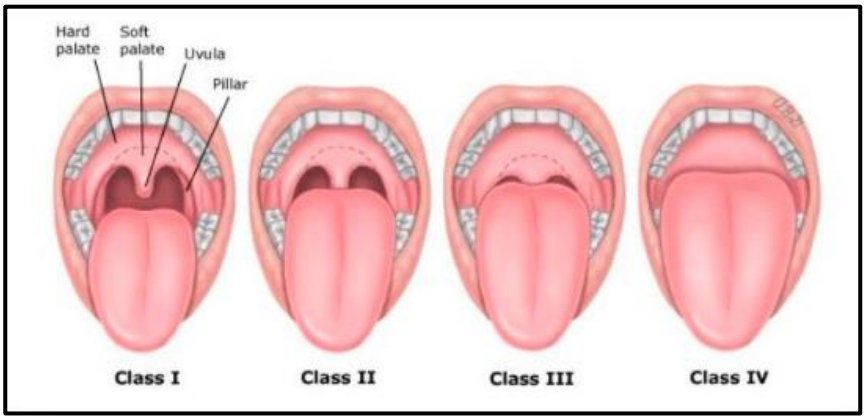
Several studies in children have shown that overweight and obesity are risk factors for perioperative adverse events, including difficult mask ventilation, airway obstruction, intraoperative oxygen desaturation,[25,26,28] difficult laryngoscopy, unexpected hospitalization,[28] and overall critical respiratory events. Although all adverse respiratory events related to obesity were easily managed and there were no serious sequelae, identification of risk factors will be important as a means to anticipate, identify, and treat complications that may occur in obese children, and thus optimize their anesthetic care.[25]

Obstructive Sleep Apnea (OSA)

Obstructive sleep apnea (OSA) is undiagnosed in 80% of affected patients, making these patients at risk during the perioperative period. OSA has been associated with a higher incidence of perioperative (difficult intubation, hypoxemia, and tachycardia) and postoperative complications (hypoxemia), increased intensive care unit admissions, and greater duration of hospital stay.[29] It is thus important to identify patients with OSA preoperatively to recognize complications that may arise peri- and post-operatively.[30]

To evaluate sleep apnea, a thorough history and physical examination preoperatively should be done. The following should be asked in the history: snoring, excessive daytime sleepiness, witnessed apneas, frequent awakenings at night, and morning headaches. A focused physical examination should be conducted to evaluate neck circumference, body mass index, modified Mallampati score, tongue volume, tonsillar size, and nasopharyngeal characteristics.[29]

Figure 1: Modified Mallampati Classification



Modified Mallampati classification is a simple scoring system that relates the amount of mouth opening to the size of the tongue and provides an estimate of space available for oral intubation by direct laryngoscopy.
Class I- soft palate, uvula and pillars are visible; *Class II*- soft palate and base of the uvula are visible; *Class III*- only the soft palate is visible; and *Class IV*- only the hard palate is visible
(adapted from Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia 1987; 42:487)[31]

Polysomnography remains to be the gold standard in the evaluation of patients with OSA. However, it is not routinely recommended prior to performing surgery due to several reasons: it is expensive, it may delay the surgery, and it may not be readily available in some institutions. Hence the use of STBUR questionnaire can be utilized to identify children at high risk for OSA. It is a simple, 5-item questionnaire that was developed from the Sleep-Related Breathing Disorder (SRBD) questionnaire, and has been validated in children with sleep disordered breathing[12]. It is useful as a clinical tool in identifying children at increased risk for perioperative respiratory adverse events. The likelihood of a perioperative respiratory adverse event is increased three-fold in the presence of any 3 STBUR symptoms, and increased ten-fold in the presence of 5 STBUR symptoms.[12,32,33] Nocturnal pulse oximetry has also been used for the screening of OSA.[29]

Table 2: The STBUR Questionnaire

STBUR Questionnaire
Does your child **1. snore more than half of the time?** **2. snore loudly** **3. have any trouble breathing or struggle to breathe?** **4. stop breathing during the night?** **5. feel unrefreshed in the morning after a night of sleep?**
When 3 of the 5 symptoms are present , the child is 3 times more susceptible to PRAEs. When all 5 symptoms are present , the child is 10x more susceptible to PRAEs.
PRAEs: airway collapse or obstruction, breath holding, oxygen desaturation, hypercarbia, paroxysmal respirations, bronchospasm, or laryngospasm
STBUR = Snoring , Trouble Breathing, Un-Refreshed PRAE = perioperative respiratory adverse event

Retrieved from Bauer, E. E., Lee, R., & Campbell, Y. N. (2016). Preoperative Screening for Sleep-Disordered Breathing in Children: A Systematic Literature Review. AORN Journal, 104(6), 541–553. doi:10.1016/j.aorn.2016.10.003 [32]

Surgical Risks:

Elective vs Emergency Surgery

There is an increase in the risk of perioperative respiratory complications in emergency procedures being documented in both adult and pediatric patients. To date, the extent of increased risk has not been evaluated in children but studies in adult patients show a two- to six-fold increase in the risk of perioperative respiratory complications compared to elective procedures.[12]

Type of Surgery: Intrinsic surgical risk

The likelihood of perioperative respiratory complications is also affected by the intrinsic risk of surgical procedures, which is being related to a 30-day mortality[34]. There have been reports of an increased risk of developing perioperative respiratory complications after ENT surgery in children as compared to non-ENT surgical procedures[12].

A list of pediatric surgical procedures categorized based on Current Procedural Terminology codes from the American College of Surgeons National Surgical Quality Improvement Program Pediatric Database is shown in Table 3 below.

There are 4 risk quartiles categorized depending on the 30-day mortality rates. The 30-day mortality rate for risk quartile 1 is 0%; greater than 0% to less than 0.14% for risk quartile 2; greater than or equal to 0.14% to less than 1.15% for risk quartile 3; and greater than or equal to 1.15% for risk quartile 4. Surgical procedures classified under quartiles 1 and 2 are low-risk procedures while those under quartiles 3 and 4 are high-risk procedures[34].

Table 3: Risk Quartile Category of Pediatric Surgical Procedure

Risk Quartile 1	
1. Anterior neck procedures (thyroid/thyroglossal duct) 2. Arthroscopy 3. Arthrotomy (knee) 4. Arteriovenous malformation supratentorial 5. Branchial cleft 6. Bullae resection 7. Open cholecystectomy 8. Clitoroplasty 9. Colotomy/duodenotomy/foreign body 10. Craniosynostosis 11. Craniotomy: bone flap/cyst 12. Cystoscopy and ureteroscopy 13. Digit reconstruction 14. Dislocation of hip and femur 15. Drainage of neck abscess 16. Ear procedures (tympanoplasty, mastoidectomy, others) 17. Epiphyseal arrest 18. External fixation (bone) 19. Excision of parotid tumor/gland 20. Facial bone reconstruction	43. Neuroendoscopic replacement of ventricular catheter 44. Oophorectomy 45. Orchidopexy 46. Osteoplasty 47. Osteotomy (limb) excluding hip osteotomy 48. Ovarian cyst drainage/resection 49. Palatoplasty, secondary repair of cleft palate/lip 50. Partial excision of bone tumor 51. Partial splenectomy 52. Partial colectomy 53. Percutaneous nephrostolithotomy 54. Pharyngoplasty 55. Procedure on tendons and/or muscles 56. Procedures related to the bile duct 57. Replacement of cranial nerve stimulator 58. Reconstruction pectus excavatum 59. Rectal procedure 60. Renal biopsy 61. Renal procedures 62. Repair of syndactyly 63. Retropharyngeal/peritonsillar abscess

21. Foot division of joint capsule, ligament, or cartilage 22. Forehead reconstruction 23. Fracture/dislocation of humerus/tibia/foot 24. Hypospadias 25. Incision and drainage of submandibular/submental gland 26. Implantation/revision/repositioning of tunneled intrathecal or epidural 27. Joint procedure 28. Laminectomy (with or without neoplasm) 29. Laparoscopic colectomy 30. Laparoscopic ileostomy 31. Laparoscopic jejunostomy 32. Laparoscopic hernia 33. Laparoscopic cyst aspiration 34. Laparoscopic enterolysis 35. Laparoscopic nephrectomy 36. Laryngoplasty/laryngoplasty cricoid 37. Lithotripsy 38. Lower gastrointestinal procedures/fistula/anoplasty 39. Lymphadenectomy (except deep cervical) 40. Mastectomy 41. Mediastinal tumor resection 42. Nephrectomy	64. Revision colostomy/ileostomy 65. Rhinoplasty with/without revision to nasal tip 66. Salpingectomy 67. Simple diaphragm repair 68. Sinus endoscopy (partial ethmoidectomy) 69. Sinus endoscopy: sphenoidotomy 70. Skin graft 71. Skin lesion excision 72. Sympathectomy 73. Sleeve gastrectomy 74. Enterocystoplasty 75. Spine fusion reinsertion or removal, exploration 76. Subarachnoid/subdural shunt 77. Subdural implantation of electrodes 78. Thoracoscopic thymus resection 79. Tracheoplasty 80. Urinary tract procedures 81. Upper gastrointestinal procedure 82. Ureteral catheterization 83. Urethral procedures 84. Vaginoplasty 85. Varicocele excision or ligation 86. Varicose 87. Ventral hernia (omphalocele)
Risk Quartile 2	
1. Appendectomy 2. Craniotomy: bone tumor resection 3. Gastrostomy closure 4. Hemiepiphyseal arrest 5. Laminectomy with release of spinal cord 6. Lap splenectomy 7. Laparoscopic cholecystectomy 8. Lymphadenectomy (deep cervical)	9. Neuro: Implantation of cranial nerve neurostimulator 10. Orchidopexy (abdominal approach) 11. Osteotomy (hip) 12. Primary plastic cleft lip/palate 13. Pyloromyotomy 14. Sinus surgery: ethmoidectomy 15. Sinus surgery: maxillary antrostomy
Risk Quartile 3	
1. Arthrodesis 2. Arthrotomy (hip infection) 3. Brain tumor resection/open or endoscopy 4. Bronchoscopy (foreign body removal) 5. Colectomy for congenital megacolon 6. Craniectomy with cervical laminectomy 7. Craniotomy: electrode placement for seizure monitoring 8. Cystoscopy and ureteroscopy with stent placement 9. Cystostomy with drainage 10. Diagnostic thoracoscopy (mediastinum) 11. Diverticulum 12. Enterostomy closure 13. Enterotomy/foreign body 14. Enterolysis 15. Excision of submandibular gland 16. Exploratory retroperitoneal 17. Fracture of femoral shaft 18. Gastrostomy/foreign body 19. Implantation or replacement of drug infusion device 20. Intussusception 21. Laparoscopic colostomy or cecostomy	26. Laparoscopic proctectomy with pull-through 27. Laparoscopic proctectomy and colectomy 28. Large omphalocele/final reduction 29. Laryngoscopy with operative procedure 30. Mammaplasty 31. Myelomeningocele 32. Nephrectomy with rib resection, ureterectomy 33. Osteotomy (hip) with fixation 34. Placement of enterostomy/rev of complicated enterostomy 35. Pleurodesis (thoracoscopy) 36. Pulmonary decortication 37. Pulmonary wedge resection 38. Repair of low imperforate anus 39. Replacement or revision ventriculoperitoneal shunt/ ventriculocisternostomy 40. Rhinoplasty including any of the following septal repair/choanal/polyp removal/sinus endoscopy 41. Salpingo-oophorectomy 42. Small intestine resection (no tapering) 43. Small omphalocele with primary closure

22. Laparoscopic esophageal procedure 23. Laparoscopic gastrostomy 24. Laparoscopic small intestine resection 25. Laparoscopy/neoplasm related	44. Thoracotomy for lobectomy/pneumonectomy/segmentectomy/wedge resection 45. Transplantation of ureter to skin 46. Vesicostomy
Risk Quartile 4	
1. Burr holes for implanting ventricular catheter, cerebral electrodes 2. Colectomy 3. Complicated nephrectomy from prior surgery 4. Creation of ventriculoperitoneal, atrial, jugular, or others shunt 5. Diagnostic thoracoscopy (mediastinal/pericardial) 6. Exploratory laparotomy (neoplasm) 7. Gastric bypass Roux-en-Y 8. Hartmann procedure colectomy 9. Hepatectomy/hepatic lobectomy 10. Ileostomy 11. Imbrication of diaphragm for eventration 12. Intraperitoneal catheter for dialysis 13. Laparoscopy/intraperitoneal catheter 14. Large omphalocele 15. Liver wedge biopsy 16. Malrotation correction and/or reduction of midgut volvulus 17. Mediastinotomy/foreign body removal	18. Open colostomy or cecostomy/gastrostomy 19. Pancreatectomy 20. Paraesophageal/diaphragmatic hernia 21. Parietal pleurectomy (thoracoscopic) 22. Peritoneal abscess drainage 23. Sinus surgery: sphenoidectomy 24. Small intestine resection (with tapering) 25. Suture for perforated ulcer/wound/injury to the gastrointestinal tract 26. Thoracic approach for esophageal surgery 27. Thoracoscopic with foreign body removal (intrapleural) 28. Thoracoscopy/thoracotomy for lung biopsy nodule/ mass/infiltrate/cyst removal 29. Thyroidectomy 30. Total splenectomy 31. Tracheal stenosis resection 32. Tracheoscopy and laryngoscopy with biopsy/ newborn 33. Tracheostomy

Adapted from Nasr, V. G., Staffa, S. J., Zurakowski, D., DiNardo, J. A., & Faraoni, D. (2019). *Pediatric Risk Stratification Is Improved by Integrating Both Patient Comorbidities and Intrinsic Surgical Risk. Anesthesiology, 130(6), 971–980.*

Anesthesia Risk:

History of malignant hyperthermia

Malignant hyperthermia is a rare but potentially life-threatening syndrome. It is an inherited, autosomal dominant disorder of the skeletal muscle that is triggered by volatile anaesthetics and depolarizing muscle relaxants. Once malignant hyperthermia is triggered, this results in a hypermetabolic state, with the following clinical signs: tachycardia, muscle rigidity, hypercapnia, and hyperthermia; and is potentially lethal.[35] Thus, before planning anesthesia, the physician needs to determine if the patient is susceptible to malignant hyperthermia. Patients must be asked for any history of malignant hyperthermia, and any family history of this disorder. Complete information about previous anesthetic/surgical procedures of the patient, including complications or adverse events is needed. Moreover, one has to avoid use of any triggers and ensure the availability of dantrolene during the contemplated surgery, in case of any unexpected malignant hyperthermia event.

Table 4: Triggers of Malignant Hyperthermia

Volatile anesthetics	Depolarizing muscle relaxants
Isoflurane Sevoflurane Desflurane Halothane Enflurane Methoxyflurane	Succinylcholine

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Clinical Question 2: What are the components of a complete history in preoperative evaluation?

KEY POINTS / RECOMMENDATIONS:

Preoperative medical history should include the following:

- **Medical History and indication for surgical procedure**
- **Past medical history and complete review of systems**
- **Allergies**
- **Medications**
- **Surgical and anesthesia history**
- **Family history**
- **Psychosocial history**

A good medical history should include identification of the patient's risk factors mentioned above.

The objectives of the interview in patients who are presumed to be basically healthy is to detect unrecognized disease that could increase the risk of surgery above the baseline. The preoperative medical history should focus on the indication for surgical procedures, allergies, undesirable side effects to medications or other agents, known medical problems, surgical history, major trauma, and current medications.

The health history should include:

1. History of present illness and indication for surgical procedure
   The duration of illness and degree of incapacitation are related to the degree of patient compromise (e.g., Hemodynamic, respiratory, renal and hydration status).

2. Medical history and complete review of systems, past medical history, previous visits to specialists
   A focused review of issues pertinent to the planned anesthesia and procedure should be done:
   - current status of pertinent known medical problems
   - cardiac status
   - pulmonary status – focus on history of chronic cough or unexplained dyspnea
   - hemostasis status (personal or family history of abnormal bleeding)
   - possibility of severe (symptomatic) anemia
   - possibility of pregnancy
   - snoring - should be asked to screen for presence of OSA as an important risk factor for adverse events during anesthesia. Specific query regarding signs and symptoms of sleep-disordered breathing and OSA may be helpful.[1]

One may utilize the Snoring, Trouble Breathing, and Un-Refreshed (STBUR) Questionnaire. It is a 5-item questionnaire that has been validated in children with sleep disordered breathing. There was an observed three-fold increased risk of perioperative respiratory adverse events in the presence of any 3 STBUR symptoms, and a ten-fold increased risk with 5 STBUR symptoms.[2] The three core issues in the STBUR questionnaire include the following: 1. Does your child regularly snore at night?, 2. Does your child demonstrate labored breathing during sleep?, and 3. Does your child have breathing pauses during sleep?

Please see Section on Clinical Question 1 for OSA as risk factor

3. Allergies

   Allergies to food, drugs, and other substances (e.g., eggs or latex) should be noted.

4. Medications
   a. Current medications – information that pertains to any recent intake of over-the-counter drugs, NSAIDs, aspirin, herbal and dietary supplements (e.g., garlic, ginseng, and ginkgo biloba may inhibit platelet function). Certain herbal medicines may alter drug pharmacokinetics through inhibition of cytochrome p 450 system resulting in prolonged drug effect and altered blood drug concentration.
   b. Maintenance medications – check compliance

5. Surgical and Anesthesia history

   Information about difficulties or complications encountered in previous anesthetic experiences should be obtained, especially those related to intubation with respiratory or cardiovascular compromise.

6. Family history:

   Five items of family history that are particularly important and needs to be asked in the medical history include: malignant hyperthermia, prolonged paralysis after receiving succinylcholine (pseudocholinesterase deficiency), bleeding diathesis, muscular dystrophy, and post-operative nausea and vomiting (PONV).

7. Psychosocial history:

   Psychosocial history evaluates the child's mental health and social well-being, as well as any psychiatric or psychologic concerns in the past (e.g., depression, anxiety disorder, bipolar disorder). This would aid the physician in providing the best care to the patient and attain optimal health.

Clinical Question 3: What components of the physical examination should be given emphasis?

KEY POINTS / RECOMMENDATIONS:

A complete physical examination should be done prior to surgery with emphasis on the following:

- **Weight and height**
- **Vital signs**
- **Airway examination**
- **Cardiac and Pulmonary examination**
- **Neurologic examination**
- **Presence of congenital anomalies/features**
- **Other Pertinent PE in relation with the present illness**

Weight and Height

Obtaining the weight and height of a pediatric patient is essential to check for growth assessment. The presence of growth failure or obesity would help in the pre-operative evaluation of the child. Growth failure may imply that the disease is severe. Meanwhile, obesity may be associated with other co-morbidities and increase the risk of perioperative complications. Furthermore, the doses of all drugs should be calculated using the body weight. In obese children, drug doses are calculated based on the ideal body weight.

Vital signs

The following vital signs should be included in the physical examination: blood pressure, pulse (rate and regularity), respiratory rate, temperature, and oxygen saturation.

Airway examination (Difficult airway)

The anatomy of a child's airway is different from that of an adult. The proximity of the pharyngeal structures, smaller mandible, smaller tracheal diameter, and a relatively large tongue all contribute to an increased risk of airway obstruction in infants and young children.[2] The most common physical finding in children with difficult airways is micrognathia.[3]

Difficult airway is defined as an airway in which there is difficulty with face mask ventilation, direct or indirect laryngoscopy (videolaryngoscopy), tracheal intubation, supraglottic airway device (SAD) use, or front of neck airway (FONA). Although its incidence is very low, the need to assess the presence of a difficult airway is crucial because it is one of the major causes of anaesthesia-related cardiac arrest, death, and brain injury in healthy children. Its early recognition will significantly increase the chances of successful airway management during the perioperative period.[3]

Evaluation of the airway is thus crucial to assess the anatomical conditions for intubation and sedation. The presence of tonsillar hypertrophy/abnormal anatomy, and assessment of the Mallampati score would help in determining any increased risk of airway obstruction.[4] (Table 5 and Fig. 2)

Table 5: LEMON mnemonic for predicting the difficult airway.

Look externally	***Look for external signs of difficult intubation (e.g. short neck, small opening of the mouth, loose teeth, jaw abnormalities)***
Evaluate 3-3-2	*- Can the patient fit **3** fingers between the incisors?* *- Is the mandible length **3** fingers from the mentum to the hyoid bone?* *- Is the distance from the hyoid to the thyroid 2 fingers away?*
Mallampati	*- Class I and II – predicts adequate oral access* *- Class III – predicts moderate difficulty* *- Class IV – predicts a high degree of difficulty*
Obstruction/Obesity	*Assess for any conditions that may cause obstruction (e.g. epiglottitis, hematoma, mass, foreign body) as this can make laryngoscopy and ventilation difficult.*
Neck mobility	*Extension of the neck is an important maneuver during anesthesia. Check for any conditions that may reduce neck mobility.*

Adapted from UpToDate 2021 [5]

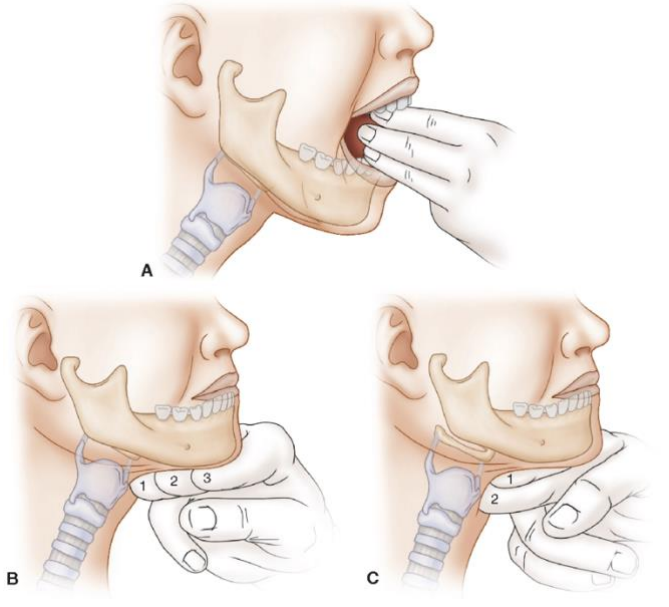

Figure 2. Evaluate 3-3-2. Adapted from: Brown and Walls 2018 [6]

Cardiac and Pulmonary Examination

The presence of a cardiac murmur should always be assessed. One should also recognize physical examination findings suggestive of unrecognized pulmonary disease such as the presence of decreased breath sounds, dullness to percussion, wheezes, rhonchi, and prolonged expiratory phase.

Neurologic Examination

A thorough neurologic exam should be done and the extent of any neuromuscular disease *(e.g. hypotonia)*, if present, should be evaluated.

Presence of congenital anomalies/features

Most difficult airways are not anticipated. However, there are some patients with syndromic and dysmorphic features which can be recognized during the preoperative evaluation. These craniofacial syndromes are the most common reasons for difficult airways in the pediatric population.

Table 6: Congenital features associated with airway abnormalities

Features	Abnormalities*
Misshapen head	Apert syndrome, Crouzon syndrome, Pfeiffer syndrome
Maxillary hypoplasia	Apert syndrome, Crouzon syndrome, Pfeiffer syndrome
Abnormal neck mobility	Down syndrome, Klippel-Feil syndrome, mucopolysaccharidoses
Microstomia	Freeman-Sheldon syndrome, Hallermann-Streiff syndrome
Mandibular hypoplasia	Hallerman-Streiff syndrome, Pierre-Robin sequence, Treacher-Collins syndrome, unilateral hypoplasia of the mandible (Goldenhar syndrome)
High arched or narrow palate	Achondroplasia, Apert syndrome, Crouzon syndrome, de Lange syndrome, Hallerman-Streiff syndrome, Pfeiffer syndrome, Treacher-Collins syndrome
Cleft palate	Branchio-Oculo-Facial syndrome, Cleft lip sequence, Ectrodactyly-Ectodermal Dysplasia-Clefting syndrome
Large or protruding tongue	Beckwith-Wiedemann syndrome, Down syndrome, mucopolysaccharidoses, Pierre-Robin sequence
Neck masses	Cystic hygroma, hemangioma
Laryngeal or subglottic abnormalities	Laryngeal cysts or webs, subglottic stenosis

*Partial list of representative disorders
Adapted from Uptodate 2021: : Congenital features associated with congenital anomalies[5]

Other Pertinent PE in relation with the present illness

Examination should emphasize on the airway, cardiovascular, respiratory, and neurologic systems and the body system that is pertinent to the specific operation, hydration status, and other organ systems as they relate to the present illness or significant past medical illnesses.

The preoperative basic health assessment is usually done within 30 days of the planned procedure. However, a review of the current history and focused physical examination will occur at the surgical facility prior to the procedure.

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Clinical Question 4: What routine laboratory examinations are necessary for preoperative evaluation?

KEY POINTS / RECOMMENDATIONS:

Routine preoperative laboratory testing is NOT recommended in the low risk patient for elective surgery or ambulatory procedure.

Selective preoperative tests maybe requested based on the clinical characteristics of the patient and the planned procedure.

Summary of Evidence:

Possible medical reasons for ordering preoperative tests are: to detect unsuspected but modifiable conditions that may alter the assessment of risk to surgery; to detect unsuspected conditions in which interventions may lead to a lower risk of surgery; to obtain baseline results that may be helpful in decision making during and after surgery; screening for conditions unrelated to the planned surgery; satisfying institutional criteria; and habit.[1] Tests that are done in the absence of any specific clinical indication or purpose are defined by the American Society of Anesthesiologists as "routine" preoperative tests.

Preoperative testing is aimed at detecting and quantifying underlying abnormalities associated with known disease that can lead to life-threatening complications during anesthesia.[2] However, the prevalence of unrecognized disease that impacts upon surgical risk is low in healthy individuals.[3] Numerous studies and guidelines outline the lack of evidence for benefit in routine preoperative testing in low risk surgical patients.[4,5]

The following studies support the rationale for selective testing:
In a study of 2000 patients undergoing elective surgery, 60% of routinely ordered tests would not have been performed if testing had only been done for recognizable indications; only 0.22 percent of these revealed abnormalities that might influence perioperative management. [6]

In a review of studies of pooled data of routine preoperative tests, the incidence of abnormalities that affect patient management and the positive and negative likelihood ratios for a postoperative complication showed that for nearly all potential laboratory studies, a normal test did not substantially reduce the likelihood of a postoperative complication (the negative likelihood ratio approached 1.0) . Positive likelihood ratios were modest, and they exceeded 3.0 for only three tests (hemoglobin, renal function, and electrolytes). However, clinical evaluation can predict most patients with an abnormal result. This was illustrated by the low incidence of a change in preoperative management based on abnormal test result (0-3%). Several review articles support a selective approach to preoperative testing. [6,7,8,9,10,11] A practice advisory from the American Society of Anesthesiologists recommends against routine preoperative laboratory testing in the absence of clinical indications .[8]

All tests should be justified by a specific symptom, sign or diagnosis identified during the history or physical examination.[12] Age, type of surgery, and medical history are appropriate predictors of perioperative complications; whereas abnormalities in laboratory tests seem to have restricted ability in predicting adverse perioperative outcome.[13] The type and extent of evaluation required should be guided by the patient's underlying medical condition and the planned procedure.[8.] Roizen, et. al. said that "history taking and the physical examination are still the best means of preoperative screening, and laboratory tests other than those indicated by history and physical examination are not cost effective, do not provide medicolegal protection, and in fact may harm patient" .[14]

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Clinical Question 5: What are the indications for requesting laboratory tests for preoperative evaluation?

KEY POINTS / RECOMMENDATIONS:

Selective preoperative test are requested based on the specific information obtained from the patient's history, physical examination and the planned procedure or surgery with the aim of guiding and optimizing the perioperative management.

The clinical parameters mentioned for each laboratory test is not exclusive or limited to the conditions mentioned below. Each laboratory test requested should be individualized or indicated rather than routine.

HEMOGLOBIN

KEY POINTS / RECOMMENDATIONS:

Preoperative hemoglobin and hematocrit determination may be requested in patients who are at an increased risk of having anemia:

- **infants less than one year old especially those ex-premature**
- **adolescent menstruating females**
- **children with chronic disease**

Preoperative hemoglobin and hematocrit may be requested in children undergoing elective major surgical procedure associated with significant blood loss.

Summary of Evidence:

Anemia is present in approximately 1% of asymptomatic patients; surgically significant anemia has an even lower prevalence.[1] Several studies in children showed low incidence of anemia in healthy pediatric patients and low rate of deferral of surgery in anemic children. [2,3,4] These authors made three observations from their study: (a) the incidence of anemia is rare but is more likely to occur in those less than 1 year of age, (b) the presence of a mild degree of anemia does not alter the decision to proceed with surgery, and (c) physicians could not reliably detect anemia clinically. Based on these observations, Patel recommends hemoglobin determination in infants less than 1 year of age, adolescent menstruating females, and those with chronic disease.[5] The American Academy of Pediatrics supports this recommendation and adds that infants younger than 6 months should have their preoperative Hgb level measured because the physiological nadir of red blood cell production may cause the Hgb level to decrease as low as 7 g/dL.[6] In addition, in ex-premature infants, Hgb levels of less than 10 g/dL have been associated with an increased incidence of postoperative apnea.[7]

Preoperative hemoglobin/hematocrit may be indicated in patients undergoing surgical procedures associated with considerable blood loss. However, the optimal hemoglobin level that provides a reserve for unexpected blood loss or cardiopulmonary stress varies by patient and type of procedure.[8] Patient with preoperative anemia have higher rates of morbidity and mortality and increased risk of transfusion.[9, 10] Optimization of preoperative anemia in adult patients undergoing major surgery has been proposed.[11,12]

The frequency of significant unsuspected white blood cell or platelet abnormalities is also low.[1] O'Connor and Drasner noted abnormal WBC in 13 (2.7%) of 486 patients. None of the children in the study had their surgeries cancelled.[13].

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COAGULATION TESTS

KEY POINTS / RECOMMENDATIONS:

Preoperative coagulation tests in healthy children with no personal or family history of bleeding does not predict perioperative bleeding.

Preoperative bleeding time, clotting time and PT and aPTT may be requested in the following clinical conditions:

- **Children with significant bleeding history and physical examination suggestive of bleeding problems**
- **Positive family history of bleeding disorders**
- **Children on anticoagulant medications**
- **Type and invasiveness of surgical procedure**

Summary of Evidence:

Coagulation screening tests which include prothrombin time (PT) and activated partial thromboplastin time (aPTT) are commonly requested before surgery in children to predict perioperative bleeding. Several studies and recent guidelines strongly recommends against routine coagulation testing without clinical indication.[1,2,3,4,5,6] Systemic reviews by the British Committee for Standards in Haematology (BCSH) found poor positive predictive value and low likelihood ratio for bleeding with an abnormal coagulation test; whereas the perioperative bleeding rates were similar in patients with and without abnormal coagulation tests.[7] Pediatric bleeding assessment tools are available but bleeding history may be negative in pediatric patients due to lack of hemostatic challenges. Therefore, if a positive family history exists, some laboratory workup will be required to confirm or exclude a bleeding disorder.[8] BCHS recommends that a bleeding history, including family history, evidence of excessive post-traumatic or postsurgical bleeding and use of antithrombotic drugs should be taken in all patients prior to surgery or invasive procedures.[7] Physical examination should be performed

and evidence of anemia or bleeding like presence of bruising, ecchymoses, hematoma and petechia should be sought. Clinical signs of possible liver dysfunction should also be noted.

When surgery is performed on anticoagulated patients, appropriate testing can be useful in excluding over-anticoagulation at the time of surgery.

Preoperative coagulation tests may be requested in children undergoing any surgery that would disturb coagulation (e.g. cardiopulmonary bypass), any surgery/procedures that needs adequate hemostasis (e.g. tonsillectomy) and invasive surgery wherein in even minimal postoperative bleeding could be critical (e.g., those patients undergoing neurosurgery.[9]

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ELECTROLYTES

KEY POINTS / RECOMMENDATIONS:

Routine electrolyte determination is NOT recommended unless that patient has a history that increases the likelihood of an abnormality.

Preoperative electrolytes determination may be requested in children:

- **with underlying renal conditions**
- **on diuretic therapy**

Summary of Evidence:

Electrolyte abnormalities of any consequence are extremely rare in healthy children. Preoperative screening for such deviations is usually unhelpful and does not alter the anesthetic management.[1] Preoperative electrolyte determination is not recommended unless there are clinical indicators of likelihood of abnormal results.[2,3,4,5] The American Academy of Pediatrics recommends that serum electrolytes be evaluated in children with an underlying condition such as renal insufficiency or in those who are taking diuretics, angiotensin-converting enzyme inhibitors, or other medications that increase the likelihood of an abnormal result.[1]

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BLOOD GASES:

KEY POINTS / RECOMMENDATIONS:

Consider doing blood gas determination in patients with underlying pulmonary or cardiac pathology.

Summary of Evidence:

There are very few studies looking at routine blood gas determination preoperatively. In the few that were done, abnormal values were seen in 0-22% of patients. Of these, no patients were observed to undergo a change in their clinical management.[1]

An arterial blood gas (ABG) is not routine preoperatively in normal children, but may help clarify the severity of underlying pulmonary disease in those with known or suspected pathology . In patients undergoing surgical correction of scoliosis, the incidence of postoperative pulmonary complications in patients with abnormal PaO_2 was 1.53 times that in patients with normal PaO_2 , but other ABG parameters did not predict the risk of postoperative complications.[2]

A published local study entitled "Proposed Pediatric Risk Stratification Method (PediaRiSM) for Post Operative Pulmonary Complication for Cardiothoracic Surgery" found that an arterial blood pH of 7.35 and below was seen to be independently predictive of postoperative complications.[3`]

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CHEST X-RAY (CXR)

KEY POINTS / RECOMMENDATIONS:

Routine preoperative chest x-ray is NOT recommended in asymptomatic low risk patients.

Preoperative chest x-ray may be requested in children with signs and symptoms of an underlying cardiac disease and those with history of lower airway or pulmonary disease.

Summary of Evidence:

Abnormal chest x-rays occur with increasing frequency with age. However, chest x-rays add little to the clinical evaluation in identifying patients at risk for perioperative complications.[1] Several systematic reviews and independent advisory organizations in the US and Europe recommend against routine chest radiograph in healthy patients.[2,3,4,5] A meta-analysis was done on the value of routine preoperative chest x-rays and found that on average, abnormalities were found in 10% of routine preoperative chest films. In only 1.3% of films were the abnormalities unexpected, i.e., were not already known or would not otherwise have been detected (95% CI: 0 to 2.8%). These findings were of sufficient importance to cause modification of management in only 0.1% (95% CI: 0 to 0.6%).[6]

As early as 1983, the American Academy of Pediatrics recommended that routine preoperative chest x-ray is not mandatory and should be done only upon the discretion of the attending physician.[7] Routine preoperative chest radiographs in well children have failed to detect abnormalities of major anesthetic or surgical consequence.[8,9]

Chest x-ray may be done in children with signs and symptoms suggesting new or unstable cardiopulmonary disease, or in children with history of lower airway disease, chronic aspiration (neuromuscular disease) or chronic lung disease such as bronchopulmonary dysplasia and severe asthma.[10]

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PULMONARY FUNCTION TEST:

KEY POINTS / RECOMMENDATIONS:

Pulmonary function tests may be done for patients who will undergo thoracic surgery for prognostication and for patients with unexplained pulmonary symptoms.

Summary of Evidence :

Routine pulmonary functions tests (PFTs) are not indicated for healthy patients prior to surgery.[1] Lawrence et al. have shown that clinical findings are more predictive of pulmonary complications than spirometric results.[2] These findings include decreased breath sounds, prolonged expiratory phase, rales, rhonchi, or wheezes. It further showed that FEV1 (forced expiratory volume in 1 second), FVC (forced vital capacity) and FEV1/FVC (ratio of the forced expiratory volume in 1 second to the forced vital capacity) were nearly identical among patients with or without pulmonary complications and NO spirometric value was associated with pulmonary risk. Mostly, PFT abnormal parameters only confirm the clinical assessment of the severity of the illness. PFTs may however be useful to confirm an improvement in the clinical condition of the patient related to the preoperative preparation.[3]

Pulmonary function test should be reserved for patients with unexplained dyspnea, but bearing in mind that the results of spirometry do not improve risk assessment over that of clinical evaluation alone and should not be used to deny surgery if the reason for the surgery is compelling.[1]

FEV1%, FVC%, and PEF% in PFTs were lower in patients with postoperative pulmonary complications than in patients without postoperative pulmonary complications, suggesting that preoperative PFTs provide information to assess the risk of patients with moderate or severe pulmonary dysfunction.[4]

PFTs may also be done for patients who will undergo thoracic surgery or lung resection as it will identify patients who are unlikely to survive resectional thoracic surgery. While data is minimal, FEV1 and DLCO (diffusion capacity of the lung for carbon monoxide) serve as initial predictors of postoperative outcomes. Marginal results of these tests may prompt additional studies, including postoperative predicted FEV1, V/Q (ventilation/perfusion) scans, and VO2max (exercise function testing of maximal oxygen uptake).[5,6]

Patients with congenital heart defects with abnormal infant-specific VPEF/VE (ratio of volume until peak expiratory flow to expiratory volume), TPTEF/TE (ratio of time until peak expiratory flow to expiratory time) , or lung compliance are at high risk for the development of postoperative pulmonary complications.[7] Dela Cruz et al found that in children who underwent surgery for congenital heart disease , a higher proportion of those with complications had FVC less than 80 (51% vs. 43%) and while this was not statistically significant (p=0.26) , it did show that the mean FVC was slightly lower among those with complications (77.7% vs. 81.6%, p=0.092).[8]

Preoperative PFTs also have value in children undergoing spinal fusion, but the utility is more on pulmonary function tracking rather than acute postoperative pulmonary complications. In such cases, PFTs have not to-date been shown to be effective as a predictor for peri-operative respiratory events, post-operative intensive care unit admission or need for post-operative ventilation.[9]

Other than the aforementioned procedures, generally, the role of PFTs in preoperative function assessment for patients undergoing other types of operation is less clear .

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POLYSOMNOGRAPHY

KEY POINTS / RECOMMENDATIONS:

Where possible, patients suspected to have sleep-disordered breathing / obstructive sleep apnea may undergo pre-operative polysomnography.

Summary of Evidence :

Obstructive sleep apnea syndrome (OSA) affects 1%-6% of children, with most studies indicating a prevalence within this range depending on the population studied.[1,2,3,4] Clinical evaluation of the snoring, obese or child at risk is an essential component of every child assessed preoperatively and a formal polysomnography (PSG) is the gold standard for diagnosis. Children with OSA may present for all types of surgical and diagnostic procedures requiring anesthesia, with adenotonsillectomy being the most common surgical procedure for OSA in the pediatric age group. In OSA, there are episodes of upper airway obstruction during sleep, and sedatives and anesthetics may enhance the airway collapsibility.[5,6,7,8] Several papers have reviewed studies by authors exploring the high incidence of perioperative risks of patients with OSA.[9,10] Whether children with OSA were identified by PSG or by clinical evaluation, they are at risk for perioperative problems including difficult or ineffective mask ventilation and/or intubation, postoperative airway obstruction, and complications arising from other comorbid conditions.[9,11] Younger age group is associated with a higher risk of postoperative respiratory complications.[12,13,14] In a study by Statham et al, of 2315 patients younger than 6 years undergoing an adenotonsillectomy for treatment of OSAS, 149 (6.4%) developed a postoperative respiratory complication with the risk almost doubling in those under 3 years old.

Practice guidelines by the AAP and ATS promote for routine PSG prior to adenotonsillectomy procedures, while the test is only optional under AAOHNS (American Academy of Head and Neck Surgery) guidelines. Standard PSGs entail a sleep laboratory or set-up, trained technician, and time for reading and interpretation. Recognizant that in many settings, PSG may not be readily available, methods that have been shown to identify patients who are at risk for OSA including questionnaires, nocturnal pulse oximetry, and home sleep testing are employed.[9,16]

Studies have not definitively evaluated which polysomnographic criteria predict morbidity, but the severe OSAs identified on polysomnography are at risk for post-operative respiratory complications for OSAs patients undergoing adenotonsillectomy, and other major surgeries.[12,13,14,17,18]

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ELECTROCARDIOGRAM (ECG)

KEY POINTS / RECOMMENDATIONS:

ECG may be considered in:

- **Children who have obstructive sleep apnea, bronchopulmonary dysplasia, congenital heart disease, or severe scoliosis.**
- **Children with murmur or arryhthmia**

Summary of Evidence:

The value of routine ECG in children in preoperative evaluation is unknown. A preoperative ECG should be performed in case of heart murmur of uncertain interpretation, suspicion of congenital heart disease, obstructive sleep apnea syndrome (OSAS), severe scoliosis, bronchopulmonary dysplasia (BPD), and neuromuscular disease.[1,2]

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URINALYSIS

KEY POINTS / RECOMMENDATIONS:

Preoperative routine urinalysis test is NOT recommended.

Preoperative urinalysis may be requested involving urinary tract surgery when the presence of a urinary tract infection would influence the decision to operate.

Summary of Evidence:

Routine preoperative testing of children has historically included urinalysis (UA). The rationale for performing routine UA before surgery includes detecting and treating children with unsuspected renal disease and urinary tract infections. A study of O'Connor and Drasner et. al. showed that more than 80% of the abnormal UA results were known, clinically insignificant, or false-positives.[1] The data indicated that a routine UA adds little to the preoperative evaluation of a healthy child and should be omitted.[1] Systematic review by Munro et al. showed that there is no good evidence that preoperative abnormal urinalysis is associated with any postoperative complication.[2]

Screening preoperative urinalysis also has failed to discover serious underlying problems in most children studied and therefore is unnecessary in the absence of known renal or bladder abnormalities.[2] Urinalysis may be requested in children undergoing urinary tract surgery.[3] Consider microscopy and culture of midstream urine sample before surgery if the presence of a urinary tract infection would influence the decision to operate.[3]

PREGNANCY TEST:

KEY POINTS / RECOMMENDATIONS:

Preoperative pregnancy testing may be appropriate for menarche adolescent in whom the history is unreliable or those who admit that pregnancy is possible.

Summary of Evidence:

The overall frequency of an incidentally found positive preoperative pregnancy test ranges from 0.34% to 2.4%.[1] The ASA Practice Advisory for Preanesthesia Evaluation recommended that pregnancy testing may be offered to female patients of childbearing age for whom the result would alter the patient's medical management.[2] After ethical considerations and insufficient current evidence on harmful effects of anesthesia during pregnancy, ICSI recommends against routine pregnancy testing and recommends that patients of childbearing age should be asked if there is a possibility they might be pregnant. Shared decision- making discussions can help guide decisions whether to test.[3]

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Clinical Question 6: What is the duration of validity of laboratory examinations for preoperative evaluation?

KEY POINTS / RECOMMENDATIONS:

When preoperative tests are felt to be necessary, it is probably safe to use test results that were performed and were normal within the past four months as preoperative tests unless there has been an interim change in clinical status.

Summary of Evidence:

Ramos et al in 2013 study with an adult population showed that preoperative tests with normal results done for an initial surgery changed very little over time and in Ruetler's 2018 study, morbidity and mortality of low-risk patients was not different with blood testing up to 2 months before surgery. Both suggest that it is unnecessary to retest patients shortly before surgery.[1,2]

Normal laboratory test results obtained 4 to 6 months before surgery may be used as preoperative tests, provided there has been no change in the clinical status of the patient. Less than 2% of test results conducted 4 months before surgery had changed at the time of the clinical evaluation.[3] The American Society of Anesthesiologists' guideline states that the results of preoperative tests performed within 6 months prior to surgery are acceptable if the patient's medical history has not changed and this seems to be in effect in several health care centers abroad.[4]

Because of the paucity of data clearly defining the period of time by which preoperative tests can still be considered valid, individual centers and clinicians may dictate the time limits but emphasis is always on indicated testing for the patient's present clinical status, rather than routine testing.[4]

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CLINICAL QUESTION 7: What effect does malnutrition have on an elective procedure?

KEY POINTS/ RECOMMENDATIONS :

The presence of malnutrition increases the risk of morbidity and mortality in pediatric surgical patients.

Consider the use of preoperative nutritional screening tools in assessing risk of malnutrition among pediatric patients who will require nutritional support for elective major surgery.

Nutritional therapy is recommended for 7-14 days prior to elective major surgery for patients with severe nutritional risk.

Early oral feeding is recommended post operatively.

Summary of Evidence:

Compromised nutritional status is a risk factor for postoperative complications. Malnutrition defined as requiring nutritional support, stunting, and preoperative hypoalbuminemia are all associated with postoperative complications such as surgical site infections, pneumonia and catheter associated blood stream infections, as well as longer length of hospital stay. [1]

Prospective cohort studies from around the world suggest that malnourished hospitalized and surgical patients have significantly worse clinical outcomes, including a greater risk of mortality; higher readmission rates; greater odds of complications; more frequent re-admissions and longer hospitalizations.[2] A prospective adult cohort study used Subjective Global Assessment (SGA) to assess the nutritional status on admission of 818 adults. Malnourished patients had longer hospital stays and were more likely to be readmitted within 15 days. Mortality was higher in malnourished patients at 1 year, 2 years and 3 years and overall, malnutrition was a significant predictor of mortality.[3]

Nutritional assessment before surgery is recommended to patients with malnutrition and those at nutritional risk before and after major surgical procedure.[4] There are several nutritional screening tools developed for children although none of these are fully validated and generally accepted for clinical use in children. The most commonly used are: Subjective Global Nutrition Assessment (SGNA), Screening tool for the Assessment of Malnutrition in Pediatrics (STAMP), Pediatric Yorkhill Malnutrition Score (PYMS), and Screening Tool Risk on Nutritional Status and Growth (STRONGkids).[5] A local pediatric nutrition assessment tool designed by the Clinical Nutrition Service of St. Luke's Medical Center may be considered; however, further studies are needed to validate its clinical use. [6]

There is still a lack of high-quality evidence on the use of nutritional screening tools which are predictive of clinical outcomes in pediatric surgical patients, however data

outcomes are promising.[7] In this review article, 5 out of the 6 studies included focused on children with congenital heart defects. Four anthropometric parameters which include the weight for age at birth, BMI z score, triceps skin fold thickness and the length/height for age showed significant correlation with post-operative clinical outcomes. Only one study by Secker et al [8] examined the correlation on malnutrition via SGNA with postsurgical clinical outcome in a heterogenous cohort of pediatric patients. Malnutrition in pediatric surgical patients by SGNA standards correlated with a statistically significant increase in postoperative infectious complications, minor infectious complications, increased length of hospital stay, and increased minor complications when compared to well-nourished patients.[7] A local unpublished cohort study by Roxas et al reported a sensitivity of 78.7%, specificity of 98.2%, positive predictive value of 97.4%, negative predictive value of 84.4%. using the SGNA nutritional screening tool in predicting pulmonary complications in pediatric cardiac patients.[9] The SGNA is a promising assessment tool as a predictor of malnutrition in the pediatric surgical patient.[7]

Preoperative malnutrition is a potential modifiable risk factor for the prevention of surgical complications. The European Society for Clinical Nutrition and Metabolism (ESPEN) guideline on clinical nutrition in surgery recommended nutritional therapy for a period of 7-14 days to patients with severe nutritional risk prior to major surgery. [10.] Enhanced Recovery After Surgery (ERAS) protocols recommends to limit fasting to 3 hours prior to surgery. In addition, early oral feeding postoperatively has been shown to resolve postoperative ileus, reduces length of hospital stay, improves infection rates and wound healing. If early feeding cannot be done, then nutrition either through enteral or parenteral route should be initiated within 24-48 hours after surgery.[11]

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Clinical Question 8: How should a patient with seizure disorder be assessed for an elective surgical procedure?

KEY POINTS / RECOMMENDATIONS:

Patients with seizure disorder under optimal control may be assessed as low risk.

Unless there is a contraindication, anticonvulsant should be continued until the time of surgery and should be restarted as soon as possible after operation/procedure.

Summary of evidence:

The type of seizures, medication, and the frequency of the child's seizures should be recorded. These data as well as the time the seizure disorder was under optimal control are useful information for the anesthesiologist.[1] Co-existing medical conditions in children with seizures should be evaluated. In poorly controlled epilepsy, plasma levels of anti-convulsant drugs should be measured and optimized before operation.[2]

Unless there is a contraindication, anticonvulsants should be continued until the time of surgery and should be restarted as soon as possible after operation/procedure.[2] Suggestions regarding peri-operative seizure medication management would also be helpful to the surgeon and anesthesiologist.[1]

Epileptic seizures are rare during preoperative period, occurring during induction & recovery time from anesthesia, but may happen up to 72 hours after surgery. [3]

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Clinical Question 9: What are the available risk stratification tools for pediatric surgical patients?
How do we classify low risk vs high risk pediatric surgical patients?

KEY POINTS / RECOMMENDATIONS:

Pediatric surgical risk stratification tools recommended are :

1. **ASA-PS for which the main purpose is to communicate the patient's pre-anaesthesia medical co-morbidities.**
2. **NARCO-SS has better discrimination in terms of perioperative adverse effects and escalation of care.**

Pediatric Risk Classification will depend on the risk stratification tool that has been utilized

Summary of Evidence:

The American Society of Anesthesiology Physical Status (ASA–PS) classification system was originally made for adults. For several years, it remains the only perioperative risk stratification tool. Locally, ASA-PS has also been widely used in many pediatric hospitals and institutions to stratify patient risks for both surgery and other ambulatory procedural/therapeutic interventions that needs sedation or anesthesia. The latest 2014 definitions and pediatric examples of the ASA-PS is summarized in Table 7.[1] Note that the latest version of ASA-PS has no specific classification assigned to patient with moderate systemic disease.[2] The main purpose of the ASA-PS is to assess and communicate a patient's pre-anesthesia medical co-morbidities. The classification system alone does not accurately predict the perioperative risks.[1] There are several limitations of the ASA-PS including difficulty defining 'functional limitation' in children, the lack of consideration of self-limiting illnesses or congenital abnormalities, non-specified timing of assessments, and perceptions about its reliability and validity. [3]

Table 7: 2014 ASA-PS definition and pediatric examples

ASA-PS Classification	Definition	Pediatric examples including but not limited to:
ASA I	A normal healthy patient	Healthy (no acute or chronic disease), normal BMI percentile for age
ASA II	A patient with mild systemic disease	Asymptomatic congenital cardiac disease Well controlled dysrhythmias Asthma without exacerbation Well controlled epilepsy Non-insulin dependent diabetes (DM) Abnormal BMI percentile for age Mild/moderate OSA
ASA III	A patient with severe systemic disease	Uncorrected stable congenital cardiac abnormality Asthma with exacerbation Poorly controlled epilepsy Insulin dependent DM

		Morbid obesity Severe OSA Oncologic state Renal failure Muscular dystrophy Cystic fibrosis History of organ transplantation Brain/spinal cord malformation Symptomatic hydrocephalus Premature infant PCA < 60 weeks Autism with severe limitations Metabolic disease Difficult airway Long term parenteral nutrition Full term infants < 6 weeks of age
ASA IV	A patient with severe systematic disease that is a constant threat to life	Symptomatic congenital cardiac abnormality , congestive heart failure Active sequelae of prematurity Acute hypoxic-ischemic encephalopathy Sepsis Shock Disseminated intravascular coagulation Automatic implantable cardioverter-defibrillator Ventilator dependence Endocrinopathy Severe trauma Severe respiratory distress Advanced oncologic state
ASA V	A moribund patient who is not expected to survive without the operation	Massive trauma Intracranial hemorrhage with mass effect Patient requiring ECMO Respiratory faire or arrest Malignant hypertension Decompensated congestive heart failure Hepatic encephalopathy Ischemic bowel or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	

Surgical risk assessment tools assist the clinicians and surgeons in preoperative risk discussion with the patient to make a consensual decision for the procedure. A systematic review on pediatric surgical risk assessment tools has identified four risk models that can be applicable across pediatric surgical specialties.[4] Table 8 shows the characteristics of these pediatric surgical risk assessment tools.[4]

Table 8: Characteristic and risk of bias of included pediatric surgical risk assessment tools

Characteristics and risk of bias of included pediatric surgical risk assessment tools.

Source	Name of risk model	Study design	Sample size	Preoperative and intraoperative variables assessed	Risk of bias
Kraemer *et al.*, 2016[16]	ACS NSQIP pediatric surgical risk calculator	Retrospective cohort	183,233	18 preoperative variables	Low
Malviya *et al.*, 2011[17]	NARCO	Retrospective cohort	340	NARCO categories of clinical variables	Low
Rhee *et al.*, 2013[18]	Seven-category point scale: multispecialty risk model	Retrospective cohort	2,169,989	70 preoperative variables	Low
Weinberg *et al.*, 2011[19]	The Boston Children's hospital pediatric surgical risk assessment scoring system (BCH-PSRASS)	Retrospective case-control	128 cases and 770 control	42 preoperative and 22 intraoperative variables	Low

Source: Ji D, Goudy SL, Raval MV, Raol N. Pediatric Surgical Risk Assessment Tools: A Systematic Review. J Surg Res. 2019 Feb;234:277-282. doi: 10.1016/j.jss.2018.09.051. Epub 2018 Oct 23. PMID: 30527485. [4]

NARCO-SS

A new valid system based assessment tool for predicting pre-operative risk in children, the NARCO-SS has been described in the literature.[5] (Table 9) Compared to the ASA-PS, the NARCO-SS has better discrimination for adverse events and escalation of care.[5] Udupa et al proved in their study that the NARCO-SS had a greater ability to discriminate children with perioperative adverse events and need for escalation of care compared to the traditional ASA- PS.[5]

Table 9: NARCO-SS Preoperative Risk Assessment System for Children

APPENDIX (on line only material). NARCO-SS Preoperative Risk Assessment System for Children

	0	1	2	
N	No neurologic abnormality, age appropriate development and behavior; Alert and oriented	Seizures, mild - moderate cognitive impairment, spasticity or hypotonia; depressed sensorium but arousable	Status epilepticus, severe cognitive impairment, spasticity or hypotonia; Unresponsive to painful stimulation? Active posturing, dysconjugate gaze.	
A	Normal airway anatomy; Full range of neck mobility	Possible difficulty with ET intubation but mask ventilation expected to be easy e.g. microstomia , c/spine immobility, obesity; established tracheostomy	Known or likely difficult mask ventilation and/or ET intubation e.g. facial trauma, c/spine instability, maxillary or mandibular hypoplasia, laryngeal stenosis, asymmetry of the airway; fresh tracheostomy	
R	No signs or symptoms of` respiratory illness	Mild respiratory illness, current or recent URI; well-controlled asthma that is not active	BPD, COPD, restrictive pulmonary disease, lower respiratory infection, steroid dependent asthma; active X ray or auscultatory findings; sleep apnea; respiratory support	
C	No cardiac disease	Non-complex CHD, corrected CHD, compensated CHF, well controlled HTN, stable non-sinus rhythm	Uncorrected/partially corrected CHD, poor ventricular function, CHF, PH, single ventricle physiology, significant dysrhythmia, poorly controlled HTN; requires vasoactive drugs	
O	No hepato-renal or musculoskeletal abnormality; born at full term; no reflux or well-controlled.	Mild abnormality of hepatic and/or renal function or musculoskeletal system; controlled metabolic/endocrine disturbances; mild coagulation defect; born prematurely but >50 wk PCA; Mild-mod reflux w/freq spitting up or upper GI symptoms; BMI > 30	Severe hepatic and/or renal dysfunction severe musculoskeletal abnormality; uncontrolled metabolic/endocrine disease; profound anemia or severe coagulation defect; DIC; born prematurely and < 50 wk PCA; severe reflux w/assoc aspiration; Full stomach; BMI > 35	
Surgical Severity Score:	**A -** Non-invasive diagnostic procedure, superficial or peripheral surgery with anticipated minimal blood loss.	**B-** Invasive diagnostic or therapeutic procedure, airway procedure, invasive procedure with anticipated moderate blood loss, emergent procedure	**C -**Major intra-abdominal, thoracic, intracranial, cardiac or airway procedure, anticipated excessive blood loss	**D -** Organ Donor

Scoring instructions:

I	Total score **0-3** with **no** individual score >1	Low risk, suitable candidate for ambulatory surgery if procedure permits
II	Total score **4-5** with **no** individual score >1	Moderate risk, may not be suitable for ambulatory surgery, may need close observation in PACU or monitored hospital bed following surgery
III	Total score **6-8** or **any individual score of 2**	High risk, requires high degree of vigilance, may need invasive monitoring and/or ICU bed following surgery, balance need for optimization of clinical status vs. risk
IV	Total score of **9-10**	Poor anesthetic risk, requires careful consideration of risk vs. benefit, May or may not survive surgery

ET = Endotracheal; URI = Upper Respiratory Infection; BPD = Bronchopulmonary dysplasia; COPD = Chronic Obstructive Pulmonary Disease; CHD = Congenital heart disease; CHF = Congestive heart failure; HTN = Hypertension; PH = Pulmonary hypertension; DIC = Disseminated Intravascular Coagulation; PCA = Post conceptual age; GI = Gastrointestinal; BMI = Body Mass Index; PACU = Post anaesthesia care unit; ICU = Intensive care unit

Source: Udupa A., Ravindra M., Chandrika Y., Chandrakala K., Watcha B., Watcha M. Comparison of pediatric perioperative assessment by ASA physical status and by NARCO-SS (neurological, airway, respiratory, cardiovascular, other-surgical severity) scores. Pediatric Anesthesia 25 (2015) 309-316 [8]

To note, there are other specific risk assessment tools that may be used to special pediatric populations e.g. those with congenital heart disease undergoing cardiac surgery. [6,7]

Pediatric Surgical Risk Classification will depend on the risk stratification tools used as suggested in Table 10.

Table 10: Pediatric Surgical Risk Classification based on risk stratification tools used

Risk Classification	ASA-PS	NARCO-SS	Definition
Low risk	ASA I and ASA II	0-3 score suitable candidate for ambulatory surgery if the procedure permits	Healthy normal children with no co-morbidities or other risk factors identified e.g. Age, anatomic airway problems PLUS consideration of low risk surgical procedures
Moderate risk		4-5 score may not be suitable for ambulatory surgery May need close monitoring at PACU or monitored hospital bed following surgery	Those children not qualified as low or high risk patients
High risk	> ASA 3	6-8 score or any individual score of 2 Requires high degree of vigilance May need invasive monitoring and/or ICU bed following surgery Balance need for optimization of clinical status vs risk	Children with multiple uncontrolled co-morbidities or identifiable risk factors PLUS complex / major surgical procedure
Poor anesthetic risk		Poor anesthetic risk Requires careful consideration of risk vs benefit May or may not survive surgery	

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Clinical Question 10: When and who decides to cancel or proceed with surgery?

KEY POINTS / RECOMMENDATIONS:

The 3 variables - risk, benefit, and consequence - must all be considered in the decision to administer an anesthetic. The decision is a dynamic one predicated on optimization of a child's underlying disease, as well as consideration of the effect of any intercurrent processes on his overall physiology.

It is important to individualize the type of surgery, clinical history and the type of diagnostic tests needed. Overall, good clinical judgment is essential. Clinically appropriate objective measures of cardiac/pulmonary status should be used in the final medical analysis and recommendation.

The final decision to cancel or proceed with surgery rests on the clinical judgment of the surgeon and anesthesiologist after appropriate communication with the primary care physician and/or subspecialist.

Summary of Evidence:

The decision to cancel or proceed with surgery is based on the principle of balance of risk vs benefit and its impact to the clinical needs of the patient. The same principle used during the COVID pandemic to decide whether an elective surgery should proceed or be delayed. [1,2]

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Section B: Pediatric Procedural Sedation/Anesthesia outside the operating room

KEY POINTS / RECOMMENDATIONS:

- **Pediatric procedural sedation or anesthesia should be planned and a comprehensive presedation evaluation is advocated.**
- **Patient selection is likewise important when it comes to safety of pediatric sedation.**
- **Emergency preparedness with the presence of skilled personnel, monitoring and emergency equipments, and rescue medications are standards for safety in procedural sedation in pediatrics.**
- **Risk assessment tool is the same as that for preoperative risk tools.**

Summary of Evidence:

Due to the physiologic differences between children and adults, there is a higher risk for respiratory depression and life-threatening hypoxic events in pediatric procedural sedation. While serious adverse events were low, reported events have the potential to harm and safety depends on the monitoring and timely management of such events.[1] Patients should be carefully selected, prepared and monitored to prevent and minimize the occurrence of these adverse events. Before deciding to use sedation/analgesia, it is also best to consider other modalities like parental presence, distraction, topical local anesthesia, electronic device with games and other techniques advised by the child life specialty to reduce the need to sedation or decrease its intended depth of sedation.

Sedation of a pediatric patient presents as a continuum of levels of mild, moderate, deep sedation to general anesthesia.[2] (Table 1). It is sometimes difficult to achieve the intended level of sedation and the child often progress to a deeper unintended level of sedation thus it is always prudent to be prepared for emergency rescue. Individuals administering "Moderate Sedation/Analgesia (Conscious Sedation)" should be able to rescue patients who enter a state of *Deep Sedation/Analgesia* , while those administering "Deep Sedation/Analgesia" should be able to rescue patients who enter a state of general anesthesia.[2]

Table 1: Continuum of Depth of Sedation: Definition of General Anesthesia and Levels of Sedation/Analgesia

	Minimal Sedation Anxiolysis	Moderate Sedation/ Analgesia ("Conscious Sedation")	Deep Sedation/ Analgesia	General Anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful** response to verbal or tactile stimulation	Purposeful** response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired

**Reflex withdrawal from a painful stimulus is NOT considered purposeful response

Adapted from : American Academy of Anesthesiologist. Last Amended: October 23, 2019 (original approval October 13, 1999 [3]

What is the difference in preoperative evaluation and pre procedural evaluation for outpatient sedation/anesthesia?

Over the past decade, there had been an increase in the number of procedures done outside the operating room. Such procedures are done in physicians' offices, dental offices, subspecialty procedure suites, imaging facilities, emergency departments, other inpatient hospital settings, and ambulatory surgery centers. Although most of these procedures require mild sedation, they do not differ much from procedures done in the operating room since complications may arise even from the mildest form of sedation. Structural factors such as airway patency, diseases such as respiratory illnesses, and varying forms of allergies should be evaluated before a major surgery. Likewise, same factors are very much relevant for mild or moderate forms of sedation.

We should also remember that even if rates of life-threatening events and complications, such as apnea, laryngospasm, airway obstruction and pulmonary aspiration are low for mild levels of sedation, if it does occur, access to rescue drugs, instruments, and more capable health facilities maybe difficult if not none at all[i]. Therefore, pre-sedation assessment should be as detailed as preoperative evaluation. Patient who may undergo an out of the hospital sedation should be clearly delineated from those who would warrant sedation inside a hospital facility.

What are the factors to consider in preparation for sedation in children?

Factors that are thought to affect children who will undergo sedation for a minor procedure are similar to the factors that will affect them once they undergo general anesthesia for a major operation. Moreover, one must take in consideration that most of these minor procedures will be done outside the hospital setting (e.g. dental clinics, free standing imaging facility, a physician's private clinic). As such, besides careful examination of the patient himself, external factors should be looked into with utmost care. These include the following[i]:

a. Practitioner's skills in sedation and rescue sedation

Mild or moderate levels of sedation are used for outpatient procedures. However, it is well documented that the patient may progress into a deeper level

of sedation unintentionally. The patient may become obtunded and respiratory compromise is common. Reversal drugs should be readily available, and the practitioner should be able to administer it appropriately.

b. Practitioner's competency in airway management

Unintended level of sedation might require airway access. Respiratory compromise is the most common complication and once it occurs, the practitioner should be skilled to perform immediate resuscitation. Pediatric Advance Life Support (PALS) training is mandatory.

c. Availability of onsite monitoring, rescue drugs and equipment

An emergency cart must be readily available. It should contain not only emergency drugs such as epinephrine and atropine, but it should also house the varying sizes of bag-valve-mask device, endotracheal tubes, laryngoscope blades, laryngeal mask airway (LMA), face masks, intravenous catheters, and intravenous sets. Monitoring devices such as sphygmomanometer, ECG machines, pulse oximeters with pediatric probes, defibrillators with appropriate patches/ paddles must be in place and should be functioning properly.

d. Availability of Back-up Emergency Services

A protocol should be clearly outlined and should be known to the practitioner and support team just in case complications occur. Initial management will be done by the practitioner but contact numbers and emergency transportation should be able to bring the patient to a hospital facility at the soonest possible time.

e. Availability of a support personnel

The major roles of the support personnel are to monitor the patient's vital signs and to assist the practitioner in employing resuscitation measures. He or She should know how to use and maintain the medical equipment. He or She should routinely check the inventories of the emergency cart. It is highly recommended that the support personnel should also be trained in PALS and is skilled in providing Intravenous line access.

f. Availability of a suitably equipped recovery area for patients who will receive moderate sedation

A separate space where resuscitation measures can be freely done would be ideal. Moderate sedation will also require observation prior to discharge. Multiple patients can be observed simultaneously in this area. Emphasis would be given in patients who have undergone unintended level of deeper sedation. Reversal medications may be given but re-sedation can also occur. As a rule of thumb, a patient who can maintain wakefulness for at least 20 minutes when placed in a quiet environment can be discharged.

What medical or surgical conditions place a child at increased risk of complications from sedation/analgesia in the ambulatory setting?

A thorough selection of patients that are candidates for sedation/analgesia in the pediatric ambulatory setting is important to avoid unfavorable outcomes related to

surgery. (Identification of poor risk patients). Children with the lowest risk for adverse events in ambulatory surgical facilities include those classified as ASA I and II, age > 1 year old, with normal airways and empty stomachs. Any underlying health conditions of the pediatric patient and high-risk procedures may increase the risk for perioperative adverse events. [4]

There is no absolute contraindication to procedural sedation in the ambulatory setting. Relative contraindications include those with difficult airway (airway abnormalities) and underlying medical conditions (ASA III and IV). The latter include pediatric patients with congenital heart disease (associated with cyanosis or congestive heart failure), neurological impairment (with poor pharyngeal coordination), and severe obesity.[5]

Deep sedation in the ambulatory setting should be done with caution. Referral to a medical expert should be done on the following conditions:[5]

- Neonates (<1 month) or ex-premature infants less than 60 weeks post conceptual age
- ASA status III or IV (severe cyanotic CHD or CHF)
- Airway abnormalities that may cause obstruction (with stridor, craniofacial abnormalities)
- Obstructive sleep apnea
- Neurological impairment or increased ICP
- Severe obesity

Medical conditions that are associated with increased perioperative risk in the ambulatory setting will be discussed. [5]

Age

Full term infants with postconceptual age ≥45 weeks may undergo procedural sedation outside of the operating room with low risk.

ASA status

Children with ASA classes I and II are suitable candidates to undergo mild, moderate and deep sedation in the ambulatory setting

Previous Preterm

All previous preterm patients that would undergo sedation should be referred to a tertiary hospital, especially if the surgical procedure will be done in the first 6 months of life, as this poses a major challenge to the anesthesiologist. The risk of apnea with or without bradycardia in the post-operative period is a critical complication that needs to be anticipated in this group. Infants with a post conceptual age less than 46 weeks should be admitted and monitored for at least 12 hours post-operatively.

Please refer to Section on Preoperative considerations on common health conditions unique in pediatrics for former preterm infants

Obstructive Sleep Apnea

Numerous studies have also shown that children with OSA have increased perioperative and postoperative respiratory complications. Furthermore, OSA in

children has also been associated with numerous comorbidities including obesity, adenotonsillar hypertrophy, craniofacial abnormalities causing upper airway obstruction, decrease in muscle tone from congenital or acquired disorders, and Down syndrome. To date, there is insufficient evidence regarding the safety of preoperative sedation to pediatric OSA patients for ambulatory surgery. Studies recommend that sedation can be given to anxious children preoperatively, but patients should be monitored until after recovery.[7,8]

Children below 3 years of age who has been diagnosed with OSA by polysomnography, or those with severe OSA (AHI of 10 or more per hour, oxygen saturation <80%, or both), should be admitted for overnight monitoring. The clinical practice guidelines of the American Academy of Pediatrics illustrate that children with OSA are at a high risk for postoperative complications following adenotonsillectomy if they have any of the following conditions: (1) cardiac complications of OSAS (e.g. right ventricular hypertrophy); (2) craniofacial disorders; (3) neuromuscular disorders; (4) cerebral palsy; (5) Down syndrome; (6) failure to thrive; (7) morbid obesity; (8) prematurity; (9) sickle cell disease; (10) central hypoventilation syndromes; (11) genetic/metabolic/storage disease; and (12) chronic lung disease. Hence, children with these co-morbidities are not candidates surgery in the ambulatory setting.[8]

Please see Section on Risk reduction for OSA

Cardiovascular Disease

Perioperative cardiovascular adverse events are the most common episodes that occur during ambulatory surgery. Generally, a patient with a repaired congenital heart disease and has an exercise tolerance of 4 metabolic equivalents can tolerate mild to moderate levels of sedation. Examples of such are repaired patent ductus arteriousus, ventricular septal defect and atrial septal defects.

Local anesthetic drugs can suppress the cardiac function. Therefore, unrepaired cardiac defects, especially those with significant cardiac dysfunction should be prevented from undergoing office-based anesthesia. Moreover, patients with decompensated heart failure, pulmonary hypertension, coronary artery abnormalities, new-onset arrhythmias, ventricular failure, and obstructive valvular disease are not considered suitable candidates for procedures in the ambulatory surgery setting. [9,10]

Bronchial Asthma and Smoking

Hyperactive reactive airway disease and smoking have been correlated with an increased risk of peri- and post-operative respiratory complications during outpatient surgery.[11,12,13] Patients with asthma who are asymptomatic are at low risk for complications whereas those with asthma symptoms have demonstrated a 50% risk of complications. Meanwhile, several studies have shown that smoking is an independent predictor of perioperative respiratory complications (laryngospasm) in children undergoing anesthesia.[14,15]

Please see Section on Preoperative Risk reduction strategies for Bronchial Asthma

Obesity

Although obesity alone has not been correlated with unanticipated admission following ambulatory surgery, obesity has been associated with a greater risk of perioperative respiratory events, including desaturation and bronchospasm. Lower respiratory events were also observed to be more common in obese patients undergoing ambulatory surgery.[16]

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Section C: Preoperative consideration on common health conditions unique in pediatrics

A. Previous preterm infants

Prematurity (born prior to 37 weeks Gestational Age) may be associated with a number of comorbidities that can affect anesthetic management, including bronchopulmonary dysplasia, neurodevelopmental disabilities, gastrointestinal disorders, and cardiac abnormalities. Longitudinal risk analysis of patients suggests that preterm and formerly preterm children are at increased risk for developing adverse sedation/ anesthesia events.[1]

Even after minor surgical procedures, ex-premature infants are at higher risk for postoperative apnea, periodic breathing, and bradycardia up to 24 hours after surgery (14.7% vs 8.5%)[1] when compared with term infants.[2]

Postmenstrual age (PMA) is the most important risk factor for postoperative apnea in ex-premature infants, with gestational age (GA) as the next most important variable.[3] The risk of postoperative apnea in ex-premature infants without other risk factors is markedly diminished after 43 weeks PMA but does not reliably decrease to a level of <1 percent until a PMA of approximately 60 weeks.[4-6]

The following recommendations are suggested for the preoperative evaluation of an ex-preterm infant or child:

- A thorough preoperative history should be sought – history of poor postnatal history, comorbid conditions such as bpd, cardiac anomalies, neurologic disease, GI disorders.
- Monitoring apnea at home. Episodes of apnea at home seem to predispose patients to postoperative apnea.
- Check for anemia. Anemia increases the incidence of postoperative apnea. Hematocrit values less than 30% in this group are associated with a higher incidence of postoperative apnea.[7]

The timing of the surgery should be optimized. It is recommended to delay elective procedures until 60 weeks PMA for infants born prior to 37 weeks gestation. If urgent surgery is performed prior to 60 weeks PMA, the infant is monitored for apnea and bradycardia with nurse observation, pulse oximetry, and electrocardiography (ECG) overnight. If apnea occurs during the first 12-hour monitoring period, the patient must be admitted to the intensive care unit (ICU) for more intensive observation.[6]

Definition of terms:
GA (Gestational Age) - time elapsed between the first day of the last menstrual period and the day of delivery
Chronological age – time elapsed from birth
PMA (Postmenstrual Age) - GA plus chronological age

B. Cardiac Disease: Congenital Heart Disease

Pediatric patients may present with a cardiac murmur on preoperative physical examination. Whether the patient was a previously diagnosed cardiac patient or not, it entails a thorough review of the history and a complete physical examination.

Most murmurs are innocent in nature, with the incidence of a serious congenital heart disease being below 1%. Differentiating between innocent and pathological murmurs, can help one identify those children in which it is safe to proceed with surgery and refer for investigation after operation. Table 1 summarizes the auscultatory features of innocent and pathological heart murmurs.[8]

Table 1 Differentiating clinical features of innocent and pathological murmur. HOCM, hypertrophic cardiomyopathy

MURMUR	**INNOCENT**	**PATHOLOGICAL**
Cardiac symptoms	Asymptomatic	Symptomatic
Timing	early systolic or continuous	Diastolic, pansystolic, or late systolic
Quality of murmur	(venous hum) Blowing/ musical/ vibratory	Variable/harsh Sometimes
Precordial thrill	Never	Rarely (HOCM murmur increases on standing)
Variation with posture	Often	

*Bhatia N, Barber N. Dilemmas in the preoperative assessment of children. British Journal of Anesthesia October 2011

A detailed history of a child with murmur may uncover a pathologic heart disease with the presence of the following :

- History of recurrent respiratory infections
- Cyanosis
- Tachypnea
- Sweating
- Failure to thrive
- Feeding difficulties
- Presence of congenital syndrome e.g. Downs, CHARGE, VATER, Turner or DiGeorge syndrome
- Exercise intolerance
- Squatting position
- Syncope
- Family history of sudden death

A child with a “pathologic murmur” must be referred and evaluated by a pediatric cardiologist to determine the presence of an intracardiac shunt and/or obstruction to flow.[6] It should always be considered that congenital heart defects are the most common of all congenital anomalies, the incidence occurring in 7–10/1,000 live births. [9,10] The presence of a cardiac anomaly may have a major impact in the outcome of surgery. Several studies have shown that patients with major and severe CHD undergoing non cardiac procedures have an increased risk of cardiac arrest, mortality, and major morbidity compared with children without CHD.[11-19]

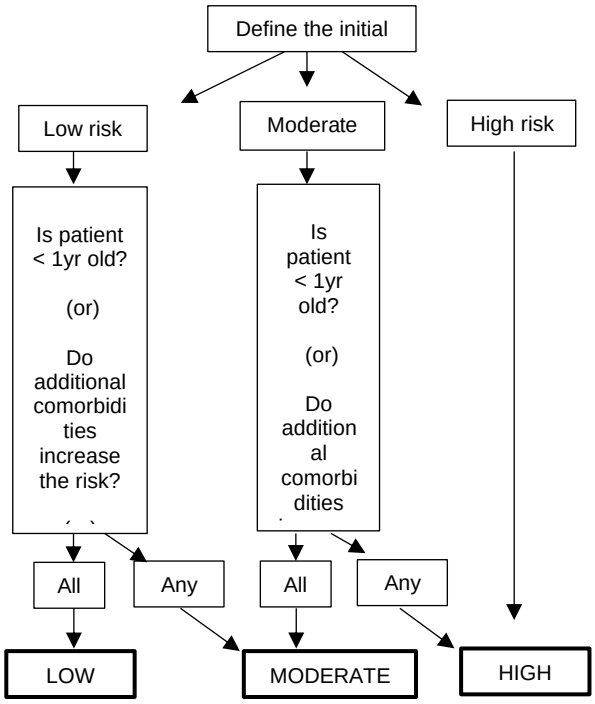
Seattele AK et al proposed a risk stratification method for children with heart disease for non-cardiac surgery.[20] These cardiac patients were classified as low, moderate or high risk patients based on the child’s underlying cardiac condition, presence of medical co-morbidities or other risk factors such as age of less than a year old and the type of surgery. (Table 2 and Figure1) The major risk factors for increased mortality are cyanosis, younger age, more complex cardiac defects, poor general health, and current treatment for cardiac failure. These patients are recommended to be evaluated by a cardiologist before anesthesia. A similar risk classification for pediatric cardiac patient for non-cardiac surgery was suggested by White et al. with other factors being considered. [21] (Table 3)

Table 2: Risk stratification of specific cardiac lesions

	Low risk	**Moderate risk**	**High risk**
Conduction Abnormalities		Wolff Parkinson white Long QT syndrome Pacemaker dependence	
Structural lesions	Repaired atrial or ventricular septal defect Mild regurgitation or stenosis of a single valve	Simple unrepaired lesions such as ventricular or atrial septal defect Complex cardiac defects with full repair Single ventricle with Glenn or Fontan palliation	Unrepaired complex cardiac lesions Systemic arterial to pulmonary arteria shunts Severe valvular disease
Pulmonary hypertension		New York Association functional class 1 Normal cardiac index	New York Association functional class or IV Pulmonary artery pressure equal or higher than systemic pressures Decreased cardiac index
Miscellaneous		Heart or lung transplant	Severe heart failure Ventricular assist devices William syndrome Hypertrophic Obstructive cardiomyopathy

Saettele AK, Christensen J, et al. Children with heart disease: Risk stratification for non-cardiac surgery. Journal of Clinical Anesthesia, 2016

Figure 1: Flowsheet to determine anesthesia risk



* Comorbidities are defined as acute or chronic renal disease, insulin dependent diabetes, significant developmental delay to less than half age appropriate normal and other co-morbid critical illness

* High risk surgical procedures include vascular, thoracic, upper abdominal with large amount of expected fluid shifts, intraparenchymal neurosurgery of spinal fusion.

Table 3: Risk classification of children with heart disease undergoing non-cardiac surgery

High risk	Intermediate risk	Low risk
Physiologically poorly compensated and/or presence of major complicatio a. cardiac failure b. pulmonary hypertension c. arrythmias d. cyanosis	Physiologically normal or well compensated	Physiologically normal or well compensated
Complex lesions (single ventricle, balanced circulation physiology, cardio myopathy, aortic stenosis	Simple lesions	Simple lesions
Major surgery (intraperitoneal, intrathoracic, anticipated major blood loss anticipat transfusion)	Major surgery (intraperitoneal, intrathoracic, anticipated major blood loss anticipating transfusion)	Minor or body surface surgery
Under 2 years old	Under 2 years old	Over 2 years old
Emergency surgery	Emergency surgery	Elective surgery
Preoperative hospital stay more than days	Preoperative hospital stay mor than 10 days	Preoperative hospital stay less than 10 days
ASA physical status IV or V	ASA physical status IV or V	ASA physical status I - III

Michelle C White, MB ChB DCH FRCA, James M Peyton, MB ChB FRCA, Anaesthetic management of children with congenital heart disease for non-cardiac surgery, Continuing Education in Anaesthesia Critical Care & Pain, Volume 12, Issue 1, February 2012, Pages 17–22 [21]

Patients who had previous corrective repair for CHD and those with prosthetic valves must be evaluated and proper coordination must be done. Anticoagulants prior to surgery and prophylactic antibiotics are started when indicated. The American Heart Association (2007), European Society of Cardiologists (2015) and The United Kingdom's National Institute for Health and Clinical Excellence (NICE) guidelines (2015 with amendments in 2016) are all in agreement that antibiotic prophylaxis prior to a procedure is indicated only for patients who are at high risk for developing infective endocarditis (table 4).[22]

Results from various studies, however, have demonstrated that operative procedures can be safely conducted in a non-specialized cardiac center with pediatric surgeons and pediatric anesthetists. Conducting the procedure safely depends on close liaison and careful planning between multiple subspecialists including the pediatric cardiologist. A multidisciplinary planning conference for surgical patients that includes surgeons, anesthesiologists, cardiologists, intensivists, radiologists and other subspecialists is a key component of the preoperative care of the patient with CHD.[11,19,23,24]

TABLE 4: Guidelines on antibiotic prophylaxis to prevent infective endocarditis (IE)

2007 AHA GUIDELINES	2015 ESC GUIDELINES	2015 NICE GUIDELINES with 2016 Amendments
Those Recommended for Antibiotic Prophylaxis Cover		
Those at highest risk of an adverse outcome	**Those at highest risk of IE undergoing a high-risk procedure**	**Antibiotic prophylaxis against infective endocarditis is not recommended routinely for people undergoing dental [or other] procedures. ('routinely' added 2016**
• Prosthetic cardiac valve or prosthetic material used for valve repair • Previous IE Unrepaired cyanotic CHD, including palliative shunts and conduits • Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or catheter intervention during the first 6 months after the procedure • Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch • Cardiac transplantation recipients who develop valvulopathy	• Patients with any prosthetic valve, including a transcatheter valve, or those in whom any prosthetic material was used for cardiac valve repair • Patients with a previous episode of IE • Any type of cyanotic CHD • Any type of CHD repaired with a prosthetic material, whether placed surgically or by percutaneous techniques, up to 6 months after the procedure or lifelong if residual shunt or valvular regurgitation remains after the procedure	• Acquired valvular heart disease with stenosis or regurgitation • Valve replacement • Structural congenital heart disease, including surgically corrected or palliated structural conditions, but excluding isolated atrial septal defect, fully repaired ventricular septal defect or fully repaired patent ductus arteriosus, and closure devices that are judged to be endothelialised • Previous infective endocarditis • Hypertrophic cardiomyopathy.
Moderate/Intermediate risk		
	• Patients with a previous history of rheumatic fever • Patients with any other form of native valve disease (including: bicuspid aortic valve, MVP and calcific aortic stenosis) • Patients with unrepaired congenital anomalies of the heart valves	
High-Risk Procedures for which Antibiotic Prophylaxis Should Be Considered		
• All dental procedures that involve manipulation of the gingival tissue or the periapical region of teeth or perforation of the oral mucosa*.	• Antibiotic prophylaxis should only be considered for dental procedures requiring manipulation of the gingival or periapical region of the teeth or perforation of the oral	• Advice not given

• Procedures on respiratory tract or infected skin, skin structures or musculoskeletal tissue.	mucosa*.	
Recommended Antibiotic Prophylaxis Regimen (for those not allergic to penicillin)		
• Amoxicillin 2g orally 30-60 mins before the procedure**	• Amoxicillin 2g orally 30-60 mins before the procedure**	• Advice not given
Recommended Antibiotic Prophylaxis Regimen for those Allergic to Penicillin		
Clindamycin 600mg orally 30-60 mins before the procedure**	Clindamycin 600mg orally 30-60 mins before the procedure**	Advice not given

CHD congenital heart disease, MVP mitral valve prolapse, ASD atrial septal defect, VSD ventricular septal defect

*Excluding local anaesthetic injections through uninfected tissue (see original guidelines for all other exclusions)

** Please see original guidelines for children's doses and parenteral and other alternative regimens

-Thornhill M, Dayer M, Lockhart P, Prendergast B. Antibiotic Prophylaxis of Infective Endocarditis. Curr Infect Dis Rep 2017

C**. Neuromuscular Disorders**

Patients with neuromuscular disorders are at risk for postoperative complications that are related to anesthetic drugs administered intraoperatively. A comprehensive preoperative assessment and laboratory work ups such as basic metabolic panel, creatinine kinase, myoglobin, arterial blood gas, ECG, chest radiograph and pulmonary function tests should be considered.[25]

The anesthetic implications of muscular dystrophies depend on the stage and severity of the disease. Total IV anesthetics are preferred over inhalation anesthetics which can cause rhabdomyolysis & hyperkalemia resulting to cardiovascular instability among patients with muscular dystrophies. [26]

Preoperative considerations in children with cerebral palsy varies with the disease severity and its associated comorbidities such as gastroesophageal reflux & epilepsy. An adequate course of antibiotics should be considered in patients with aspiration pneumonia before surgery. Wheezing should also be assessed with bronchodilators. Anticonvulsants should be continued until the day of surgery.[26]

Cerebral Palsy

A study looking into the effects of general anaesthesia and the risk for perioperative adverse events among patients with cerebral palsy was 63.1% (95% confidence interval 59.8%–66.5%). However, hypothermia and clinically significant yet non–life-threatening hypotension represented the majority (80%) of these complications. When these 2 events are excluded, the rate of adverse perioperative events was 13.1% (95% confidence interval 10.8%–15.5%). [27]

Patient characteristics found to be univariately associated with an increased risk for these events included older age (P = .05), higher American Society of Anesthesiologists

physical status (P < .001), presence of feeding tube (P = .003), gastrointestinal reflux (P = .01), malnourished (P = .005), history of pneumonia (.001), reactive airway disease (P = .01), history of aspiration (P = .002), scoliosis (P = .02), history of seizures (P = .01), and upper airway hypotonia (P < .001). [27]

After backward elimination of nonsignificant variables, the characteristics found to be multivariately associated with these adverse perioperative events among patients with cerebral palsy included American Society of Anesthesiologists physical status score exceeding 2, history of seizures, upper airway hypotonia, general surgery procedures, and adults.

Aspiration Risk Considerations in Neurologically Impaired Children During Anesthesia

There are a number of medications that are routinely used during anesthesia that are known to decrease lower esophageal sphincter tone, loss of consciousness and loss of protective reflexes. These include:

• Propofol
• Volatile anesthetic agents • β-agonists
• Opiods
• Atropine
• Thiopental
• Trycyclics
• Glycopyrrolate

Pre-existing conditions in addition to loss of protective reflexes can also lead to subsequent risk of aspiration during anesthesia:

- Gastrointestinal obstruction
- Need for emergency surgery
- Previous esophageal surgery
- Lack of coordination of swallowing or respiration
- Hiatal hernia
- Obesity

Preemptive NGT placement:

There is currently a lack of evidence to support this. There are no prospective and/or randomized, and limited retrospective data evaluating the efficacy of preemptive nasogastric tube placement. Hence, the use of a nasogastric tube should be determined by the operating surgeon and the anesthesiologist based on the patient's condition and the factors necessitating operation. [28]

According to the American Society of Anesthesiologists, the interview should include, at a minimum, assessment for **predisposing risk factors** which contribute to increased risk of volume regurgitation, including:

- Gastroesophageal reflux disease

- Esophageal dysmotility
- Difficulty swallowing
- Diabetes
- Gas bloat or other signs of delayed gastric emptying
- Obstructing cancer causing stasis within the esophagus

American Society of Anaesthesiologists recommendations on pre-operative fasting:

- Consumption of a light meal or nonhuman milk up to 6 hours prior to elective procedures
- Clear liquids up to 2 hours prior to elective procedures (e.g. water, clear tea, carbonated beverages, pulp less fruit juice and black coffee).

They also strongly agree that for otherwise healthy infants (younger than 2 yr.), children (2– 16 yr.), and adults, fasting from the intake of clear liquids at least 2 h before elective procedures requiring general anesthesia, regional anesthesia, or sedation/analgesia (i.e., monitored anesthesia care) should be maintained. [29]

It is appropriate to fast from intake of breast milk at least 4 h and intake of milk formula for at least 6 hours before elective procedures requiring general anesthesia, regional anesthesia, or sedation. [29]

Kluger and colleagues evaluated the timing of regurgitation and aspiration during anesthesia and found that the vast majority of events occurred during induction of anesthesia; a smaller proportion occurred during the maintenance phase of anesthesia and during emergence from anesthesia. [30]

D. Neurodevelopmental Disorders:

Some autistic spectrum disorder (ASD) patients with good verbal communication and mild learning difficulties are able to tolerate treatment under local anesthesia with behavioral management alone. There are also some ASD patients who are suitable for conscious sedation depending on their level of learning difficulty and cooperation, while others with severe ASD will not even permit the physician to examine them.[31]

A study in 2018cited the difference in perioperative management for patients with or without spectrum disorders undergoing general anesthesia. The clinical data of 10 ASD patients and 10 non-ASD patients undergoing general anesthesia were analyzed and the induction mode, premedication patterns, narcotic drugs, time to wake up, post-anesthesia care unit stan and perioperative vital signs were compared. They concluded that compared with non-ASD patients, ASD patients tend to use combined IV and inhaled anesthesia as the induction mode and tends to have longer wake up time.[32]

Another study in 2015 measured and compared the premedication patterns, complications, pain, anesthetic type , PACU time and time to discharge among ASD patients undergoing general anesthesia for dental rehabilitation. They concluded that children with ASD have similar perioperative experiences as non-ASD subjects and that their postoperative period did not pose any special challenges. [33]

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Section D: Risk reduction strategies in common pediatric respiratory conditions

A. Presence of Upper Respiratory Tract Infection

KEY POINTS / RECOMMENDATIONS:

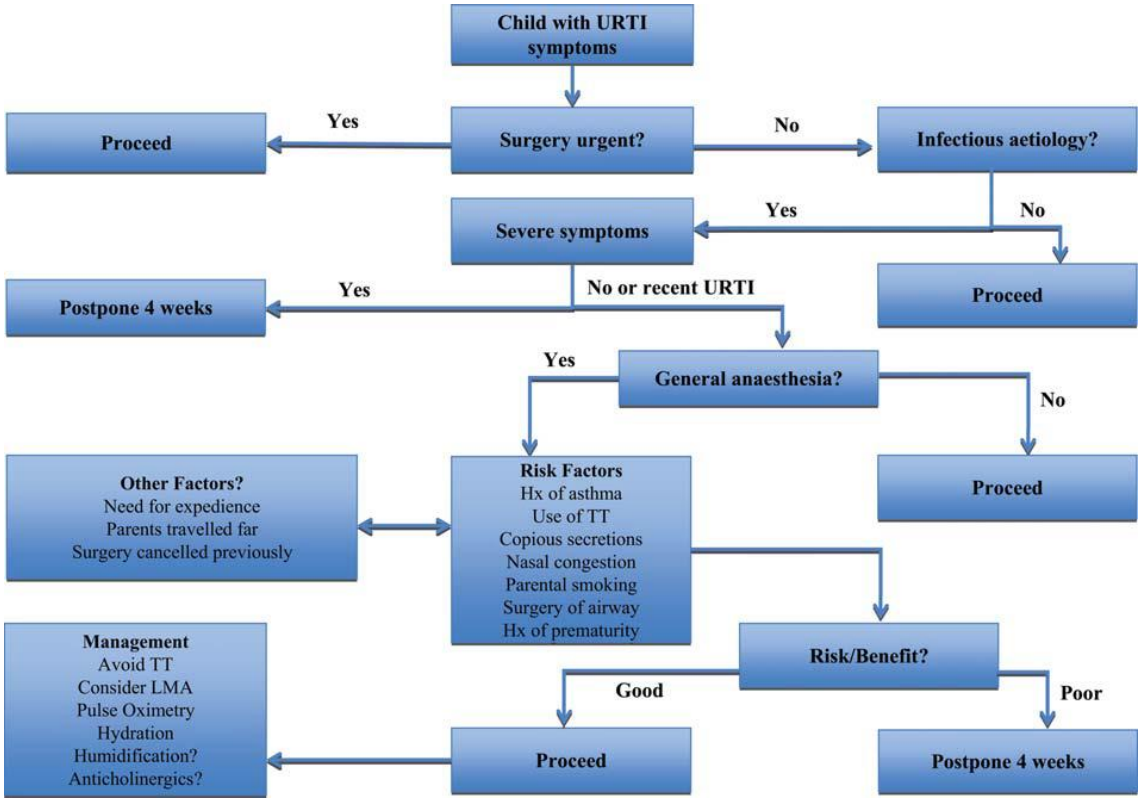
- **The presence of an upper respiratory tract infection is NOT an absolute contraindication to proceed with surgery. The decision should take into account the risk to benefit ratio of the procedure.**
- **Elective surgery may be delayed until 2–3 weeks after resolution of URTI symptoms.**
- **Evidence based perioperative management can be done to decrease the respiratory events in children with upper respiratory tract infection to avoid cancellation of surgery.**

Summary of Evidence:

Recent URTI (<2 weeks) increases the risk of respiratory adverse events perioperatively, which includes laryngospasm, bronchospasm and hypoxemia. These complications, however, do not have a long-term sequelae. Elective surgery may be delayed 2-3 weeks after resolution of URTI symptoms. [1,2,3,4,5,6]

Tait and Malviya proposed an algorithm for managing the child who has URTI (Figure 1). Factors considered include the urgency of the procedure, the likelihood that symptoms are due to an infectious etiology, the severity of symptoms, the planned mode of anesthesia administration, potential risk factors for respiratory complications, and related nonmedical factors.

Figure 1: Proposed algorithm for the preoperative management of the child who has an upper respiratory tract infection



From Tait AR. Malviya S. Anesthesia for the child with an upper respiratory tract infection: still a dilemma? Anesth Analg 2005:100(1):62. [7]

Another preoperative screening tool that has been developed is the COLDS Scoring Tool. This tool has been validated in children < 6 years old[5] and is useful for predicting perioperative respiratory adverse events such as bronchospasm, oxygen desaturation, need for beta-agonist treatment, and prolonged cough[1]. The COLDS score assigns a score of 1, 2 or 5 to each risk factor to quantify the risk as nil, mild or moderate/severe, respectively. A higher COLDS score suggests a greater perioperative risk. The COLDS score may also be useful for predicting case cancelations (COLDS score of 19 and higher)[1,5]. An advantage of this preoperative tool is that it is simple, easy to use and objective, and helps the physician and family to make more informed choices in weighing the risk/benefit ratio when a child had a recent URTI.

Table 1: COLDS Scoring Tool

	1	2	5
Current signs and symptoms **C**	None	Mild (Parent confirms URI AND/OR congestion rhinorrhea, sore throat, sneezing, low fever, dry cough)	Moderate/Severe (Purulence, wet cough, abnormal lung sounds, lethargy, toxic appearance or high fever)
Onset of symptoms **O**	> 4 weeks ago	2-4 weeks ago	< 2 weeks ago
Presence of Lung Disease **L**	None	Mild (Hx of RSV, mild intermittent asthma, BPD if > 1 y/o, loud snoring, or passive smoker)	Moderate/Severe (Moderate persistent asthma, infant with BPD, OSA or pulmonary hypertension)
Airway Device **D**	None or Facemask	LMA or supraglottic airway	Endotracheal tube
Surgery **S**	Other (Including pressure equalizer (PE) tubes/ear tubes)	Minor airway (Tonsil nasal lacrimal duct probing, flexible bronchoscopy and dental extractions)	Major airway (Cleft palate, rigid bronchoscopy, maxillofacial surgery)

Adapted from: Lee LK, Bernardo ML, Grogan TR, Elashoff DA, Ren WH. Perioperative respiratory adverse event risk assessment in children with upper respiratory tract infection: Validation of the COLDS score. 2018. Pediatric Anesthesia;28:1007–1014[1].

COLDS is an acronym for the risk factors for perioperative respiratory complications: C for current signs and symptoms; O for onset of symptoms; L for lung disease; D for the device to be used for airway management; and S for surgery type.

A systematic review on perioperative management of child with URTI to decrease perioperative respiratory adverse events is shown in table 2. [8]

Table 2: Evidence-based perioperative management of children with URTIs undergoing elective surgery

Premedication	Salbutamol	Salbutamol puff 10-30 mins before induction 2.5 mg if weight < 20kg 5 mg if weight > 20 kg
Anaesthetic agents	Lidocaine (IV), 1.5mg/kg Propofol Volatile anaesthetic agents	To suppress airway reflexes either before intubation or extubation Propofol has good airway reflux blunting properties with mild bronchodilator effects Volatile anaesthetic agents have good bronchodilator properties but limited effects in suppressing airway reflexes. When using volatile anaesthetic agents sevoflurane followed by halothane anaesthetic agents. In high risk children, IV induction with propofol over inhalational induction Optimal depth of anesthesia during intraoperative period Adequate suctioning under optimal depth of anesthesia
Extubation		Awake extubation Immediate oxygen supplementation and CPAP
Post operative		Meticulous monitoring of SPO2, oxygen supplementation via nasal prongs Adequate hydration and analgesia

G.F. Lema et al. Evidence-based peri-operative management of a child with upper respiratory tract infections (URTIs) undergoing elective surgery; A systematic review. International Journal of Surgery Open 12 (2018) 17e24[8]

Most children with perioperative URTI can be anesthetized safely. However, it is optimal for the pediatrician to collaborate with an anesthesiologist to determine whether a patient can proceed with elective surgery. [9] The decision to proceed with elective surgery should be individualized. Careful consideration should be based on the severity of presenting symptoms, patient's respiratory history, need for an endotracheal tube, choice of anesthetic agent, and the anesthesiologist's overall comfort with anesthetizing children with URTIs. The final decision should take into account the risk-to-benefit ratio of the procedure.

B. Bronchial Asthma

KEY POINTS / RECOMMENDATIONS:

- **Elective surgery should be performed 4- 6 weeks after the last asthma attack.**
- **Optimal control of asthma symptoms in children is recommended before an elective surgery.**
- **All maintenance asthma medications should be continued up to the day or the surgery.**
- **Risk reduction strategies recommendations are the following:**
    - **For well controlled asthma, use of inhaled beta 2 agonist 1-2 hrs. before surgery**
    - **For partly controlled asthma, use inhaled corticosteroids with inhaled beta 2 agonist one week before surgery**
    - **Poorly controlled asthma, use of systemic corticosteroids 3-5 days prior to surgery and inhaled beta 2 agonist.**
    - **Asthmatic patients on long term high dose ICS or who have received systemic corticosteroid for more than 2 weeks within the previous 6 mos. should receive hydrocortisone perioperatively due to risk of adrenal crisis during surgery.**

Summary of Evidence:

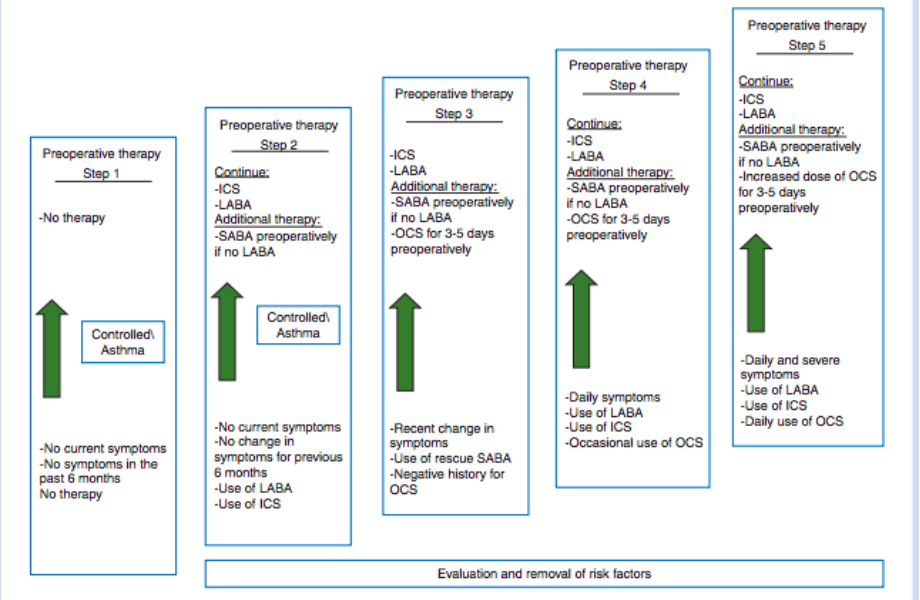
In the preoperative evaluation of a child, it is crucial to establish if the child has undiagnosed asthma or a known case of bronchial asthma. For a child who was previously diagnosed with asthma, it is important to review the level of asthma control, level of activity of the child, present medications, use of rescue medications, hospital visits, and history of allergies since the risk of bronchospasm is very high in this subset of patients[10,11].

For children with uncontrolled asthma, elective surgery should be postponed and rescheduled after the optimization of therapy. Lung function should be improved to baseline by optimizing asthma medications, or considering a short course of oral corticosteroids. For a child with well controlled asthma, risk reduction strategies can include use of an inhaled beta-2 agonist 1-2 hours before surgery. For partly controlled asthma, additional use of inhaled corticosteroid coupled with regular use of inhaled beta-2 agonist 1 week before surgery can be done to optimize the patient. Children with poorly controlled asthma may need additional use of systemic steroids (oral prednisone 1 mg/kg/day (max: 60mg/day) 3-5 days prior to surgery; or oral dexamethasone 0.6 mg/kg (max: 16 mg/day); or oral methylprednisolone 1 mg/kg/day for 48 hours prior to

surgery[11,12]. Another study show that use of oral methylprednisolone for 5 days before surgery decrease post-intubation wheezing in newly diagnosed or poorly compliant patients with reversible airway obstruction. Meanwhile, IV corticosteroids may be useful for patients who are first evaluated immediately before operation, in whom steroids are indicated [10,13]. Elective surgery should ideally be performed 4-6 weeks after the last asthma attack[10,11,12,13,14]. All asthma medications should be continued up to and including day of surgery[5].

For a child who has a long standing history of asthma and would undergo elective surgery, a pre-operative pulmonary function test (PFT) is advised to determine the severity of obstructive airway disease and bronchodilator reversibility. However, interpretation of results should be done with caution as PFTs may be normal in between exacerbations[14].

Figure 2 : A stepwise approach of pre-operative planning in children with asthma, proposed by Liccardi et al.

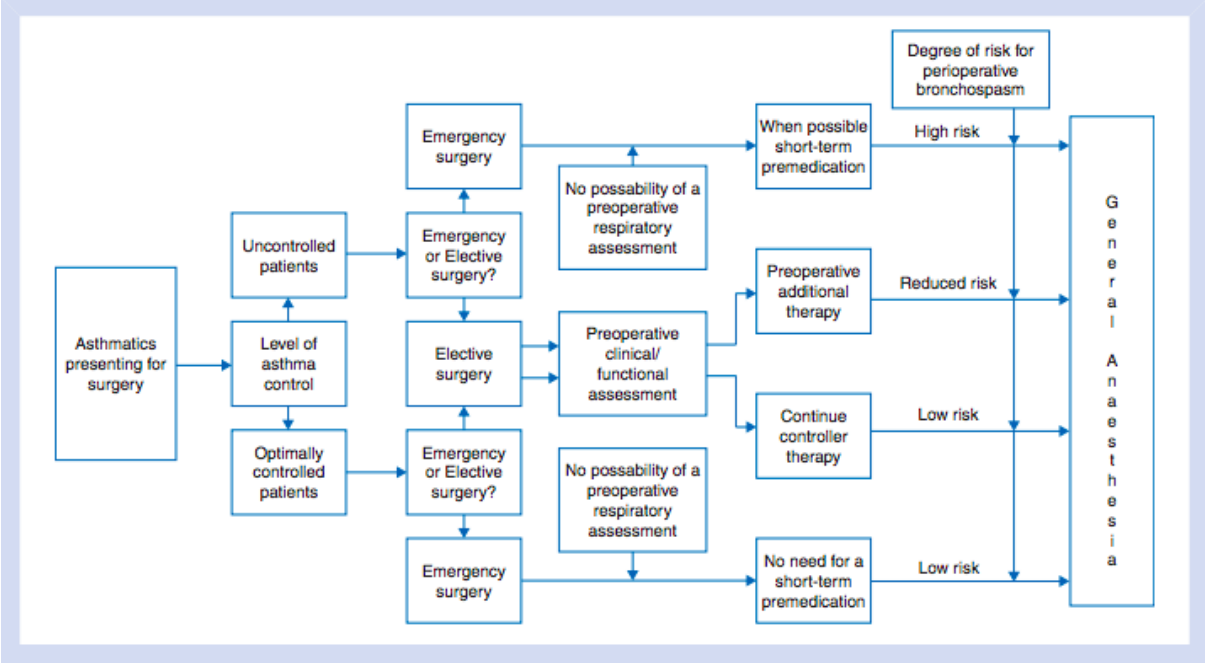


Adapted from: Lauer and Vaci et al : Anesthetic management of the child with co-existing pulmonary disease British Journal of Anaesthesia Vol 9 Dec. 2012. [9]

For patients who require emergency surgery, the risk of proceeding without an optimized asthma control should be weighed against the need for immediate surgery. Patients who are taking long-term high dose ICS or who have received OCS for more than 2 weeks within the previous 6 months should receive hydrocortisone perioperatively because of the risk of adrenal crisis during surgery[4,12,17].

For a child with status asthmaticus who is in need of surgery, the benefit-risk ratio should be thoroughly evaluated. The mainstay of treatment remains to be beta-2 agonists administered via inhaled route. Continuous nebulization has also proven to be more superior than intermittent doses[12].

Figure 3. Approach to asthmatic patients in need of Emergency and elective surgery.



Adapted from: Liccardi G, Salzillo A, Sofia M, D'Amato M, D'Amato G. Bronchial asthma. Curr Opin Anaesthesiol 2012; 25: 30 –7 [16]

C. Obstructive Sleep Apnea (OSA)

KEY POINTS / RECOMMENDATIONS:

- **Children with OSA identified to be at risk for post-operative respiratory complications should be admitted and monitored closely.**
- **Pre-operative polysomnography is NOT an absolute requirement FOR ALL children with OSA.**
  - **It is recommended in those with additional risk factors (<2 years old, with comorbidities, with discordant history and physical exam)**
  - **it can be utilized for surgical planning especially in severe OSA**
- **Use opioid and sedative sparing anesthesia, monitor closely when not possible.**
- **Use NSAIDs for postoperative pain management.**
- **CPAP/BiPAP should be resumed at the pre-operative settings after surgery.**

Summary of Evidence:

Risk Identification . Obstructive sleep apnea (OSA) is a common co-morbidity in, and at the same time the reason for, children with this condition to undergo elective surgery. Adenotonsillectomy is one of the most common elective pediatric surgeries and is currently the treatment of choice for OSA. The principles of perioperative management of a child with OSA presenting for adenotonsillectomy are generally applicable as well to a child with OSA presenting for other surgical procedures[18-21].

Children with OSA are at risk for peri and post-operative respiratory complications (PRCs) and need surgical planning, expert care, observation and monitoring . PRCs range from postoperative apnea or hypopnea, hypoxemia, hypercarbia, to more severe manifestations such as pulmonary edema, laryngospasm, bronchospasm and respiratory failure, among others [20, 21] .

Risk factors for complications of children with OSA undergoing adenotonsillectomy have been well-identified Table 3. These children tend to be younger and have significant associated medical problems that are contributing to or resulting from their OSA, in addition to the large tonsils and adenoids . In these cases, admission for post-operative monitoring should be strongly considered by the pediatrician, anesthesiologist, and surgeon, and promoted to the child's family[18,19,22].

Table 3. Risk factors for postoperative respiratory complications after adenotonsillectomy in Childhood OSA

Age < 3 years old	Severe OSA by PSG(AAP: AHI >10 ; AAO-HNSF AHI >24)
Failure to thrive	Prematurity
Obesity	Down syndrome
Cor pulmonale or right ventricular hypertrophy	Craniofacial abnormalities
Chronic lung disease	Neuromuscular disease
Sickle cell disease	Presence of URTI

PSG (Polysomnography); AAP (American Academy of Pediatrics);AAO-HNS (American Academy of Otolaryngology-Head and Neck Surgery Foundation; AHI (Apnea/Hypopnea Index)

Pre-operative Polysomnography (PSG). PSG helps to stratify disease severity which is proportional to peri-operative risk . It is still the gold standard for diagnosis and classification of severity of the OSA, despite limitations in equipment availability and cost. Before adenotonsillectomy, refer children with obstructive sleep-disordered breathing for polysomnography if they are <2 years of age OR if they exhibit any of the following: obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell disease, or mucopolysaccharidoses OR when there is discordance between the physical examination and the reported severity of OSA [19, 23] .
Figure 4 is a sample decision tool to guide site of surgery and post-operative care based on the OSA severity.

Figure 4: Criteria for Determination of Surgical Location and Postoperative Disposition in Children with Obstructive Sleep Apnea .

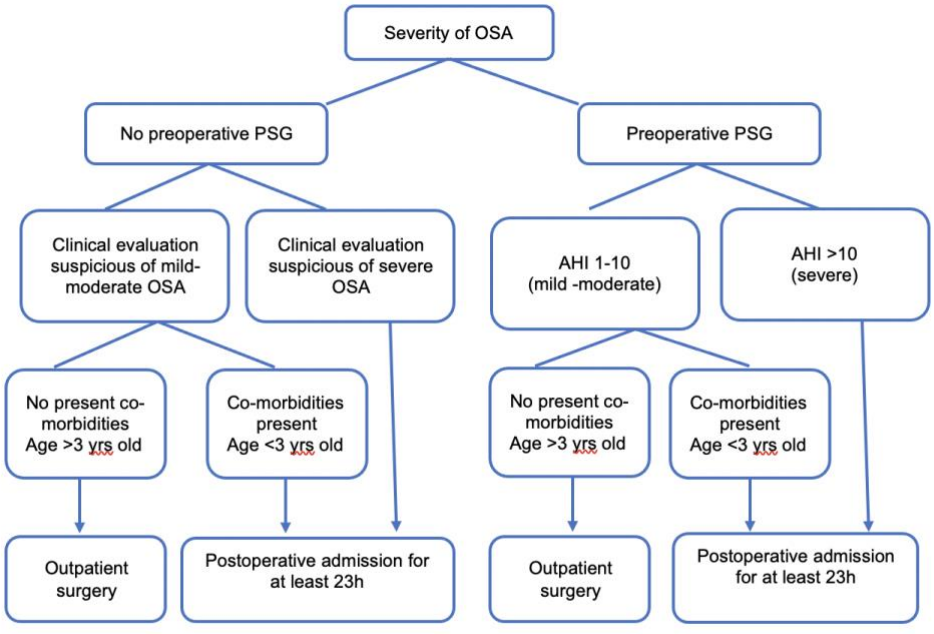


Figure from Children's Hospital of Philadelphia. Tonsillectomy and/or Adenotonsillectomy Pathway To Triage Patients with or without Preoperative Polysomnography
PSG = polysomnography. AHI =Apnea/Hypopnea Index

and anatomic factors restricting the upper airway processes are enhanced and magnified by some anesthetic drugs and procedures . Children with severe OSA and craniofacial syndromes can quickly obstruct and desaturate from induction of inhalational anesthesia[24]. Advanced airway interventions may be necessary to maintain airway patency, oxygenation and adequate ventilation. Various airway management and difficult intubation tools should be available[21].

Children with OSA, especially if severe, have an increased sensitivity to intraoperative and postoperative opioids. The result is a higher risk of respiratory depression and decreased ventilatory response to hypoxemia. Opioid sparing and sedative sparing anesthesia, especially the shorter acting anesthetic agents are preferred. These provide faster recovery of pharyngeal tone to avoid postoperative hypoxemia and hypercarbia. When used for children with significant OSA, doses of opioids are reduced (typically 50% of usual) accompanied by careful titration , and continuous monitoring including pulse oximetry[25]. Airway obstruction and severe desaturation can occur in children with severe OSA, even with just sedative premedication. The residual effects may persist into the recovery period . Regional anesthesia may be beneficial in select patients to decrease the opioid-induced respiratory depression [21].

Extubation should be done only when awake after full recovery of muscle strength. As with premedication and induction, the use of non-opioid analgesics for pain control such as ibuprofen, acetaminophen and other non-steroidal anti-inflammatory drugs (NSAIDs) are still recommended [19,21]. Some studies also support the pre-adenotonsillectomy administration of dexamethasone to decrease post-operative requirement for opioids and other analgesics in children.

Other Risk Reduction Modalities. Most adjunctive measures in the treatment of childhood OSAS that will significantly impact peri- and post-operative outcomes have not been prospectively evaluated but supportive modalities to decrease the pre-operative severity of OSA are still promoted. These include maximizing medical management of comorbidities, avoidance of environmental tobacco smoke , pollutants and allergens, and treatment of accompanying rhinitis (montelukast, intranasal corticosteroids), but adjunctive therapies should not delay specific treatment. Weight loss for obese patients should be promoted but is seldom practical from a temporal viewpoint. Oxygen therapy should be used sparingly as it does not prevent sleep-related upper airway obstruction and may worsen hypoventilation [18,24,26,27].

Post-operative Surveillance. The ASA task force on the perioperative management of OSA recommends extended monitoring and observation for signs of airway obstruction after anesthesia and surgery [28,29]. Clinical observation with regular frequent interval measurements of the respiratory rate, continuous pulse oximetry, continuous monitoring of adequacy of ventilation are highly recommended especially in children with higher risk. Early detection of changes in the child's airflow may make it possible to avert life-threatening alterations in ventilation and oxygenation. Options to monitor ventilation include the use of transthoracic impedance , nasal capnography, transcutaneous CO2 monitoring and acoustic monitoring. These methods carry their own indications, advantages and disadvantages but to date, there is no perfect method to monitor ventilation that can completely avoid respiratory complications in an extubated child [21].

The high risk for postoperative apnea or hypopnea does not immediately improve with tonsillectomy[30]. Children on continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) machines for obesity or neuromuscular disorders and those with tracheostomies should also be admitted for monitoring. The baseline PAP settings are utilized in perioperative ventilation planning. Patients are instructed to bring their machine on the day of surgery CPAP/BiPAP use should be resumed post-operatively and continued at the pre-operative levels or settings since recurrences of abnormal ventilatory responses might still persist even after several weeks from the surgery [24].

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Section E: Interim Preoperative/Pre-procedural Guidelines during the COVID 19 Pandemic

PEDIATRIC PRE-OPERATIVE EVALUATION IN CHILDREN

1) All children scheduled for surgery or other procedures that require general anesthesia, deep sedation or moderate sedation should be screened and tested for SARS-CoV-2.
   (*Strong recommendations, moderate grade evidence)*
2) Pre-operative / pre-procedure screening will include clinical signs and symptoms of COVID-19 and significant exposure to confirmed COVID-19 persons.
   (Strong recommendations, moderate grade evidence)
3) SARS-CoV2 PCR is the recommended screening test for asymptomatic patients scheduled for surgery/procedure.
   (Strong recommendation, moderate grade evidence)
4) The timing of SARS-CoV-2PCR testing should be done as close to the time of the procedure as possible and preferably done 48 hours prior to the procedure.
   (Strong recommendations, high grade evidence)
5) The use of antigen-detecting rapid diagnostic tests and the antibody testing for SARS-CoV2 are not recommended as pre-operative screening tools.
   (Strong recommendations, low grade evidence)
6) Radiographic imaging such as chest x-ray and/ or chest CT scan is not recommended as a screening or diagnostic tool for COVID-19.
   (Strong recommendations, low grade evidence)
7) Timing of urgent and elective surgeries:
   a. If the patient travelled to a country/locality with sustained community transmission, delay the surgery for 14 days following return, even if asymptomatic.
   b. If the patient has been in direct contact with a confirmed COVID-19 + patient, delay the surgery for 14 days following last contact, even if asymptomatic.
   c. If the patient presents with influenza-like illness or unexplained cough at the time of procedure, defer the surgery until they have recovered.
   d. For patients who had recent COVID-19 infection[20], the interval before operation may be the following:
      i. Four weeks for an asymptomatic patient or recovery from only mild, non-respiratory symptoms.
      ii. Six weeks for a symptomatic patient (e.g., cough, dyspnea) who did not require hospitalization.
      iii. Eight to 10 weeks for a symptomatic patient who is diabetic, immunocompromised, or hospitalized.
      iv. Twelve weeks for a patient who was admitted to an intensive care unit due to COVID-19 infection.

   (Strong recommendations, moderate-high grade evidence)

SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2) was named by the WHO in February 11, 2020 as the novel coronavirus responsible for the coronavirus disease (COVID-19) that began in Wuhan, China in the late 2019 and has now spread across 213 countries including the Philippines.

COVID-19 in children is not as common and as serious as in the adult population. There are relatively fewer cases of COVID -19 among children, with incidence ranging from 0.8 to 2.2% in reported cases.[1,2,3,4] However, the true incidence of pediatric COVID -19 may be higher because of asymptomatic cases and children are less likely to be tested because of mild and subclinical symptoms. In one study, up to 13% of pediatric cases with SARS-CoV-2 infection were asymptomatic.[5] The prevalence of asymptomatic SARS-CoV-2 infection and duration of pre-symptomatic infection in children are not well understood, as asymptomatic individuals are not routinely tested.[6]

There are limited studies on the incubation period among pediatric patients. Studies from China reported 2 to 10 days incubation period among pediatric patients.[7, 8]
Signs and symptoms of COVID-19 in children appear to be mild and similar to other common viral respiratory infections with most cases presenting with fever, cough, nasal congestion, rhinorrhea, and sore throat. Thus, it is important for pediatricians to have a high index of suspicion of COVID-19 especially in the presence of exposure to COVID positive household contacts.

The role of children in transmission to others is not clear. Limited studies show that transmission by symptomatic children is uncommon yet some reports indicate that transmission of SARS-CoV-2 by asymptomatic children is possible.[9] Patients who are scheduled for surgery, endoscopy[10] and other procedures should always be assumed to be potential carriers of the virus throughout the duration of their hospital stay, even if they pass the pre-assessment triage including normal temperature, no history of exposure or travel, and no respiratory symptoms.

The general principles in requesting for preoperative/pre-procedural testing for SARS-CoV-2 are:

Patients who are infected with the virus have been reported to have a higher perioperative morbidity and mortality when undergoing surgical procedures.[11] Asymptomatic patients may have the potential of transmitting the virus.[9] Viral transmission may occur up to three days before patients become symptomatic.[12]

PRE-OPERATIVE COVID-19 SCREENING AND TESTING

All children scheduled for surgery or other procedures that require general anesthesia, deep sedation or moderate sedation should be screened and tested for SARS-CoV-2. [11,13,14]

Pre-operative/ pre-procedure symptom screening of COVID-19 will include symptoms and significant exposure. Symptoms include , but are not limited to, the presence of any of the following : subjective or measured fever, cough, shortness of

breath, sore throat, muscle aches, diarrhea, fatigue, nasal congestion, headache, loss of smell, altered sense of taste, new onset of rash .

Significant exposure is history of travel to or residence in an area with local transmission, or exposure to contacts who are confirmed positive for COVID-19 for the past 14 days.[15] Patients will then be classified based on the guideline of the Philippine Pediatric Society and Pediatric Infectious Disease Society of the Philippines.[15]

If the patient is SYMPTOMATIC, non-emergent procedure / surgery should be postponed or cancelled. If the patient is ASYMPTOMATIC, proceed with COVID-19 testing. The recommended method of testing for SARS-CoV-2 is detection of SARS-CoV-2 RNA by reverse transcription polymerase chain reaction (RT-PCR) testing. The reported sensitivity of SARS-CoV-2 testing is approximately 70% to 90%, meaning that up to 30% of infected patients will be reported as free of the virus.[16] Clinicians must be mindful that a negative test does not negate the possibility that an individual is infected.

Timing of RT-PCR testing:

Patients should undergo SARS-CoV-2 PCR testing as close to the time of the procedure as possible and preferably done 48 hours prior to the procedure. The Philippine Society of Pediatric Surgeons recommends the surgery be done within 3-7 days when the sample has been obtained, allowing for a delay in turnaround-time of the laboratory results. [13]

After the patient is tested negative for COVID-19, the patient should remain self-isolated or on home quarantine until the procedure date.[17] In local areas, where there is limitation in RT -PCR testing facilities, resumption of elective surgeries is recommended to be delayed until the testing capacity of the country or institution can cater to preoperative testing of patients. [17]

Antibody testing does NOT have a role in pre-operative screening and risk stratification. Antibodies develop in the second week of symptoms and not all patients who are infected with SARS-CoV-2 develop detectable antibodies.[18] The use of antigen-detecting rapid diagnostic tests is NOT recommended for clinical diagnosis. [18]

Radiographic imaging such as chest x-ray and/or chest CT scan is NOT recommended as a screening or diagnostic tool for COVID-19. In congruence with our previous statement on pre-operative evaluation[19], chest radiograph is NOT a routine test and should be determined by patient indication and procedural needs.

TIMING OF SURGERY

We adopt the recommendations from the Philippine College of Surgeons and Philippine Society of Pediatric Surgeons[13,14] as follows:

Emergent surgeries shall be done even without RT-PCR results.(All patients should be swabbed on admission.)

For **urgent and elective surgeries**, the following are recommended:

1. If the patient travelled to a country/locality with sustained community transmission, delay the surgery for 14 days following return, even if asymptomatic.
2. If the patient has been in direct contact with a confirmed COVID-19 positive patient,

delay the surgery for 14 days following last contact, even if asymptomatic.
3. If the patient presents with influenza-like illness or unexplained cough at the time of the procedure, defer the surgery until they have recovered.
4. For patients who had recent COVID-19 infection[20]:

a) Four weeks for an asymptomatic patient or recovery from only mild, non-respiratory symptoms.
b) Six weeks for a symptomatic patient (e.g., cough, dyspnea) who did not require hospitalization.
c) Eight to 10 weeks for a symptomatic patient who is diabetic, immunocompromised, or hospitalized.
d) Twelve weeks for a patient who was admitted to an intensive care unit due to COVID-19 infection.

These timelines should not be considered definitive; each patient's preoperative risk assessment should be individualized, factoring in surgical intensity, patient co morbidities, and the benefit/risk ratio of further delaying surgery.

NOTE: Classification and examples of cases of surgery as emergent, urgent and elective is found in the Philippine Society of Pediatric Surgeons Interim Guidelines for Pediatric Surgery During Coronavirus Disease 2019 (COVID-19) Pandemic .[13]

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ANNEX 1: Pediatric Preoperative Questionnaire

Pediatric Preoperative Questionnaire

Patient Name: Date:
Reason for preoperative evaluation:

YES	NO	
☐	☐	1. Is your child less than 2 years old?
☐	☐	2. Was your child born premature at less than 37 weeks old?
☐	☐	3.Has your child been diagnosed with any medical condition(s) that affected his growth, development and daily activities?
☐	☐	4. Has your child had cough or colds within the last four weeks?
☐	☐	5. Does your child ever had noisy breathing or whistling sound in the chest?
☐	☐	6. Has your child been diagnosed to have asthma?
☐	☐	7. Does your child have cough of more than 3 weeks or unexplained shortness of breath?
☐	☐	8. Does your child have murmur or had been diagnosed with a heart condition?
☐	☐	9. Does your child snore?
☐	☐	10. Does your child have any allergies to food, medications or latex?
☐	☐	11. Did your child have recent weight loss or problems with feedings?
☐	☐	12. Does your child have seizures?
☐	☐	13. Does your child or anyone in your family have serious bleeding or bruising?
☐	☐	14. Has your child had problem with anemia?

YES	NO	
☐	☐	15. Has your child been given aspirin or similar medications in the past two weeks?
☐	☐	16. Is your child taking any maintenance medications including any herbal supplements?
☐	☐	17. Does our child have or anyone in the family with muscle weakness or neurologic problems?
☐	☐	18. Does your child have any behavioral or psychological problems?
☐	☐	19. Has your child or other family members ever had problems with anesthesia?
		For the adolescent female patients
☐	☐	20. has your child started her periods If yes when was the last period (date): _____
☐	☐	20. Is there a chance of pregnancy?

This is a questionnaire of the possible presence of a known risk factors for increase perioperative risk in children and needs further evaluation and optimization prior to the procedure.

_____