ORIENTATION

WELCOME TO CHEO

Dear Resident,

The anesthesia staff of the Children’s Hospital of Eastern Ontario welcomes you during your rotation. This manual has been designed to help you become orientated with CHEO. Please refer to it during your stay.

As this is a teaching hospital, numerous research studies are being carried out. You might be involved in many of these studies during your rotation. If you have any problem following a protocol, please feel free to ask.

Most of our patients are daycare admissions but there are some in-patient surgeries. Please check the OR list each day and make sure you assess your inpatients the day before surgery. The OR schedule is not found online. Copies are printed at the end of the day at the Main OR desk. If you are post-call or away you can either page the anesthesia resident on call or call the Main OR at 2444 to find out where you are scheduled.

Charting is of utmost importance. Please chart accurately and completely. It is our responsibility to ensure that the anesthesia record is complete with the necessary and relevant information.

Several policies on different topics can be found in the policy manual located in the Anesthesiology Office. Please familiarize yourself with the manual and its content.
Further manuals can also be found in the departmental administrative coordinator's office.

We hope you enjoy your rotation with us at CHEO.
SURGICAL UNIT FLOOR PLAN
GENERAL INFORMATION

The OR area is located on the 3rd floor.

CALL ROOM
The Call room is adjacent to the Booking Office of the OR area. There is a key that is attached to the on-call pager and another one in the anesthesia lounge. There is a bathroom with a shower attached to the call room that is shared with the office of the anesthesia assistants. Please remember to unlock the door that connects to their office when you are finished using the washroom.

LOCKER
Lockers are assigned to each resident on their first day. You will be given a key to a locker in the OR change room on the 3rd floor. This will be left in your file folder in the anesthesia lounge. There is a shower available in the OR change rooms. You will need to find out the code for the woman/male change room and the anesthesia lounge at the beginning of your rotation. The code is often changing. It is suggested to either ask a resident that has just rotated at CHEO or email/call Jennifer Borup or the Main OR.

FIRST DAY
You will need to go to Human Resources on the first floor to get a CHEO ID badge. The hours are 8-9am or 2-3pm. You will need to leave a $10 deposit. All residents must wear their CHEO ID badge at all times.

You will be given a username and password for Sunrise Clinical Manager (the hospital computer system that manages patients’ lab and images results) and PACs to view patients’ images.

You will be given a tour of the OR by one of the anesthesia assistants. You will also meet Jennifer
Borup who will guide you through the various administrative issues.

Pagers will be provided for the resident on call and will be exchanged between residents on morning rounds daily.

Parking passes are available through CHEO Security, which is located on the Main Level by the Emergency Room.

If you are sick make sure you contact the OR desk at ext. 2444/2445 and the department secretary at ext. 2431.

FOOD
The Cafeteria is located on Level 1 and the hours of operation are from 06:30-14:00 Monday-Friday. It serves hot and cold meals as well as Timothy’s coffee.

There is also a Coffee Shop located on Level 2 serving Mr. Sub, Starbucks coffee and Pizza. It opens daily from 07:30-23:00.

LIBRARY
The Hospital Library is located on Level 1 near the elevators and it is open on weekdays from 0900 – 1600.

The Anesthesia Library is located by the Anesthesia Office, Room 3348. You are welcome to use the books in this library. Most recent purchased books can be found in the secretary’s office. Please make sure to sign your name and return them to the secretary.
LIST OF FREQUENTLY CALLED CHEO NUMBERS

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<tr>
<th>Service</th>
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<tr>
<td>Library</td>
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<tr>
<td>Dr. Mossdorf's (Chief)</td>
<td>3644</td>
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<tr>
<td>Jennifer Borup (Chiefs Office)</td>
<td>2431</td>
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<tr>
<td>Carrie Haffner</td>
<td>2432</td>
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<tr>
<td>Fellow's Rm./Anesthesia library</td>
<td>3642</td>
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<tr>
<td>Nancy Lauzon PAU</td>
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Or Extensions:

<table>
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<td>General Surgery</td>
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<tr>
<td>Urology/Plastics</td>
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<tr>
<td>Ophthalmology</td>
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<tr>
<td>ENT</td>
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<td>MRI</td>
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<tr>
<td>CT</td>
<td>2617</td>
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Department of Anesthesia Pagers/office numbers:

Dr. Ibrahim Said 368-7501/ ext. 3041
Dr. Antoinette Corvo 593-4632/ ext. 3042
Dr. Dermot Doherty 593-4006/ ext. 3643
Dr. Marion Gould 239-7591/ ext. 3044
Dr. Leslie Hall 239-8514/ ext. 2558
Dr. Gary Johnson 239-7963/ ext. 3080
Dr. Jarmila Kim 239-6426/ ext. 3144
Dr. Christine Lamontagne 593-4314/ ext. 3110
Dr. Philipp Mossdorf 593-4316/ ext. 3644
Dr. Kimmo Murto 239-7951/ ext. 3065
Dr. Joanna Nawrocka 594-2255/ ext. 3643
Dr. Victor Neira 788-1000/ ext. 3642
Dr. Gillian Ramsey 239-8906/ ext. 3643
Dr. David Rosen 566-5221/ ext. 2597
Dr. Gail Ryan 368-7503/ ext. 3142
Dr. Uwe Schwarz 593-4484/ ext. 3010
Dr. William Splinter 782-9019/ ext. 3360

NB/ for home phone #s see Call Schedules

ANESTHESIA ASSISTANTS

Vicky Legare 593-3942
Diane Lefrancois 239-7799
Kimberly Villeneuve 594-1065
Chris MacLeod 593-2548
Ana Ramirez 594-2649
Lee Kirk ext. 3972 (MRI)
Laurie Logan ext. 3972 (MRI)

Anesthesia Resident On-Call Pager: 239-7957
DEPARTMENT OF ANESTHESIOLOGY
ROUNDS SCHEDULE

Daily ICU/Pain Service Rounds @ 07:30
All residents and fellows are expected to attend.
One staff member is assigned to meet with residents and discuss ICU patients and Pain Service patients.
The resident coming off-call is to round on all these patients prior to 07:30 and be prepared to handover their care to the on-call coming resident.

Weekly Anesthesia Grand Rounds - Wednesday @
07:50-08:50-room 3232
Attendance is mandatory for everyone.
Usually a complete literature review of a topic

Pediatric Anesthesia Resident/Fellow Teaching Rounds
Attendance is mandatory for residents/fellows:
- Mondays at 07:00 in room 3232
- Tuesdays at 15:30 in room 3232
- Every second Thursdays - Journal club at 07:00 in room 3232

RECOMMENDED READING:
- A Practice of Anesthesia for Infants and Children
  Cote, Todres, Goudsouzian, Ryan, 3rd Edition

- Pediatric Anesthesia Principles and Practice
  Bruno Bissonnette, Bernard Dalens

- Pediatric Anesthesia
  Gregory, 4th Edition

- Anaesthesia and Uncommon Paediatric Diseases
CHEO LIBRARY USERS MANUAL

The Department of Anesthesiology at CHEO has a small Pediatric Anesthesiology library for your use while studying at CHEO.

We have many books and textbooks on the subject of Pediatric Anesthesiology, Critical Care, Acute Pain Management and Pediatric Cardiac Anesthesiology.

In addition we have an assortment of standard anesthesiology textbooks, such as Miller and Barash.

The CHEO Anesthesiology Library also has a variety of journals in various formats; standard paper bound, online via the Web and TEAL (The Electronic Anesthesia Library). We also have a very extensive set of files, which contain hundreds of articles relating to pediatric anesthesia. During your studies at CHEO we welcome you to make full use of these resources.

Here are just a few reminders when using our library:

**PLEASE** sign out any book you wish to borrow in the sign out book located in the library. Please limit your borrowing to 1 week.

The books marked with YELLOW tape and placed on the Yellow shelf are standard reference texts and should never be signed out of the library.

Please keep the library clean and tidy so everyone can make full use of this resource. If you do not wish to
properly reshel your books place them on the reshelving shelf so that they can be properly replaced. You may sign out the TEAL CD ROM for a period of 48 hrs. Please see our secretary Jennifer Borup in the department office.

We have a subscription to the Journal "Pediatrics in Review". You may access this via the web: http://pedsinreview.aapjournals.org
Institutional Subscription number 509732

Here is a list of useful anesthesiology related Web sites:

WEB SITES:

General Anesthesiology

Various Aspects related to the field of Anesthesiology:
www.gasanet.org
www.virtual-anesthesia-textbook.com

Includes pediatric airway managements, useful links:
www.metrohealthanesthesia.com/links.htm

Provides links to Canadian and US sites including that of the Association of Ottawa Anesthesiologists:
www.anesthesia.org/professional/linfages.html

Pediatric Anesthesia
www.vh.org/VCH/providers/information.html

Stanford University Pediatric Anesthesia Teaching Materials:
Section on ambulatory anesthesia, anesthesia in remote locations, preoperative evaluation, MRI, TIVA, resuscitation, complex pediatric cases, organ transplantation, regional anesthesia and pain management
http://pedsanesthesia.stanford.edu/education/teaching_materials.html

Regional Anesthesia and Pain Management

Good site for regional anesthesia, demonstration videos:
www.anesthesiaregional.com

Home page for the American Society of Regional Anesthesia and Pain Medicine:
www.asra.com

New York Society of Regional Anesthesia, excellent website with pictures, techniques for blocks:
www.NYSORSA.com

Medical Sites of Interest to Anesthesiologists

A site maintained by the American Heart Association, ACLS algorithms simulations:
www.acls.net

Free online literature search:
www.ncbi.nlm.gov/entrez

Brief descriptions of hundreds of less common syndromes and diseases:
www.rarediseases.org/
www.pediatricradiology.com
**Colleges and Societies**

Website for the Society of Pediatric Anesthesia:  
www.pedanesthesia.org

Website for Canadian Anesthesiologists' Society:  
www.cas.ca

Homepage for the American Society of Anesthesiologists:  
www.asahq.org/homepageie.html

Homepage for the Royal College of Anesthetists:  
www.rcoa.ac.uk

Homepage for the Australian and New Zealand College of Anesthetists:  
www.anzca.edu.au

Homepage for the International Anesthesia Research Society:  
www.iars.org

**Hospital and Anesthesia Departments**

CHEO:  
www.cheo.on.ca

HSC in Toronto:  
www.sickkids.on.ca

Boston Children’s Hospital:  
www.childrenshospital.org

Children’s Hospital of Philadelphia:  
www.chop.edu
LIST OF TOPICS FOR THE ANESTHESIA RESIDENT DOING A PEDIATRIC ROTATION AT CHEO

The following is a base of knowledge and skills that we believe a resident should possess to be a consultant in pediatric anesthesia. This list is intended to be a starting point for study and is not intended to represent the total of necessary knowledge. The depth of comprehension of a resident knowledge base and their technical skills is expected to increase, as residents become more senior.

Please make a point of discussing at least one topic/day with the attending anesthesiologist or the fellow in the OR. This is not meant to be a didactic session but rather an interactive discussion between the staff anesthesiologist and the resident.

I trust you will find the list helpful. Please also review the pediatric anesthesia objectives on the web eval website.

PREOPERATIVE EVALUATION, CONSULTATION, AND PERIOPERATIVE MANAGEMENT OF PEDIATRIC PATIENTS AND DISEASES IN THE PEDIATRIC POPULATION

• Psychological preparation of children and their parents
• Pre-anesthetic management strategies and their peri-operative consequences
• Perioperative management of emergent surgery, seizure disorders, reactive a/w disease, URTI, former pre-term children, sickle cell disease, CP, CF, mentally handicapped children, latex allergies,
endocrine disorders, coagulation disorders, muscular dystrophies
• Perioperative management, patient selection and medical optimization for outpatient surgery

PATHOPHYSIOLOGY, MEDICAL MANAGEMENT AND PERIOPERATIVE MANAGEMENT OF NEONATAL EMERGENCIES
• General principles of overall management of the neonate for emergent surgery including fluid, a/w, pain management and temperature regulation
• Esophageal atresia and tracheoesophageal atresia
• Neonatal herniorrhaphy
• Necrotizing enterocolitis
• Omphalocele and gastroschisis
• Congenital diaphragmatic hernia

ANESTHESIA FOR GENERAL SURGERY
• Perioperative management of anterior mediastinal masses
• Neuroblastomas
• Pyloromyotomy

ANESTHESIA FOR NEUROSURGERY
• Understanding the pathophysiology of intracranial compartments, intracranial Pressure and cerebrovascular autoregulation, blood volume and blood flow
• Venous air embolism
• Diabetes insipidus
• Craniotomy for tumours, AVM, aneurysms and seizure surgery
• Hydrocephalus
• Craniosynostosis
• Neurosurgical trauma
• Shunts, shunts revision
ANESTHESIA FOR ORTHOPEDIC SURGERY
- Perioperative management of scoliosis surgery
- Understanding of motor and sensory monitoring of the spinal cord

ANESTHESIA FOR OTOHINOLARYNGOLOGY
- Perioperative management of adenoidectomy and tonsillectomy and associated complications, including understanding of the clinical implications of OSA
- Epiglottitis
- Bronchoscopy
- Ear surgery
- Stridor and esophageal or tracheobronchial foreign bodies

ANESTHESIA FOR PLASTIC SURGERY
- Cleft lip and cleft palate
- Familiarity with different types of craniofacial defects and their a/w management implications
- Burn patient

ANESTHESIA OUTSIDE THE OPERATING ROOM
- Administrative and patient care issues of satellite anesthesia such as evaluation of facilities and the requirements for pediatric sedation
- CT
- MRI
- Invasive radiology, angiography & embolization
- Radiation therapy

CLINICAL SCIENCES OF PEDIATRIC ANESTHESIA
- Understanding of temperature regulation
- Understanding of respiratory system physiology
- Pharmacology and pharmacokinetics of drugs in neonates, infants and toddlers
- Fluid management in pediatric patient
- Blood product management and blood loss conservation and coagulation disorders
- Understanding fetal circulation, transitional circulation and neonatal CVS system
- Cardiac catheterization
- PONV

**PAIN MANAGEMENT IN PEDIATRICS**
- Administrative management of an acute pain management service
- Postoperative pain management of epidural analgesia
- PCA and nurse-controlled analgesia
- Pain management of medical problems including cancer, sickle cell disease, AIDS
- NSAIDs: Do's and Don'ts
PEDIATRIC ANATOMY AND PHYSIOLOGY

AIRWAY
- Large occiput
- Large tongue and small mouth
- Narrow nasal passages
- Prominent arytenoid cartilages
- Short trachea and neck
- Shape of the epiglottis: long, floppy
- Narrowest portion is the cricoid cartilage (subglottic), glottis in adults
- Larynx position-anterior and cephalad:
  - At birth: C3-C4
  - Adult: C4-C7

RESPIRATORY SYSTEM
- Obligate nasal breathers until 3-5 months
- Less efficient ventilation
  - Weak intercostal and diaphragmatic muscles
  - Horizontal and more pliable ribs
  - Protuberant abdomen
- Increased airway resistance
  - A relative reduction of small airways
  - Alveolar maturation not complete until age 8
- Elevated respiratory rate
- Increased work of breathing
- Respiratory muscles fatigue easily
- Frequent upper airway obstruction under anesthesia
- Decreased FRC per weight basis
- Larynx, trachea, and bronchi highly compliant and more subject to distending and compressive forces
Tidal volume and dead space per kg remain constant during development.

- Increased likelihood of chest wall collapse during inspiration
  - Due to noncompliant lungs, in association with compliant chest wall.
- Increased incidence of hypoxemia with apnea
  - Decreased FRC
  - Increased rate of oxygen consumption.
- Hypoxic and hypercapneic drives are not well developed
  - Hypoxia and hypercapnia can paradoxically depress ventilation.

**CARDIOVASCULAR**

- Stroke volume relatively fixed
  - Due to noncompliant and poorly developed LV in neonates and infants.
  - Cardiac output is HR dependant, assuming adequate preload.
- Sympathetic system and baroreceptor reflex not fully developed
  - Increased risk of bradycardia/asystole with parasympathetic activation, anesthetic overdose, or hypoxia.
- Lower catecholamine stores, with a blunted response to exogenous catecholamines.
- Vascular tree less able to vasoconstrict
  - Hallmark of hypovolemia is hypotension without tachycardia.
## THE RELATIONSHIP OF AGE TO RESPIRATORY AND HEART RATES

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<tr>
<th>Age</th>
<th>Mean Heart Rate</th>
<th>Respiratory Rate</th>
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<td>40 to 50</td>
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<tr>
<td>1 to 7 days</td>
<td>30 to 50</td>
<td>30 to 50</td>
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<td>8 to 30 days</td>
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<td>3 to 12 months</td>
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<td>8 to 12 years</td>
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<td>2 to 16 years</td>
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## The Relationship of Age to Blood Pressure

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<tr>
<th>Age</th>
<th>Mean Systolic (mmHg)</th>
<th>Mean Diastolic (mmHg)</th>
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<tbody>
<tr>
<td>0 to 12 hours (pre term)</td>
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<td>35</td>
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<tr>
<td>0 to 12 hours (full term)</td>
<td>65</td>
<td>45</td>
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<tr>
<td>4 days</td>
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<td>6 weeks</td>
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<td>9 years</td>
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<td>75</td>
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<tr>
<td>12 years</td>
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METABOLISM AND TEMPERATURE CONTROL
- Larger surface area per kg than adults
- Greater heat loss
- Metabolism correlate better with surface area than with weight
  - Increased O2 consumption, CO2 production, cardiac output, alveolar ventilation

RENAL
- Normal kidney function not present until 6 months, and does not reach adult levels until 1 year
- Preemies often possess multiple renal defects, including decreased creatinine clearance, impaired sodium retention, glucose excretion, and bicarbonate reabsorption

GI
- Neonates have a relatively high incidence of GERD
- A relatively immature liver causes impaired hepatic conjugation early in life

INHALATIONAL AGENTS
- Rapid induction
  - Increased alveolar ventilation, and decreased FRC
  - Higher blood flow to vessel rich group
  - Blood/gas coefficients of halothane and isoflurane are lower in neonates than adults
- MAC higher in infants than in neonates and adults
PHARMACOKINETICS

- Volume of distribution of water soluble drugs increased:
  - Larger boluses required to achieve desired plasma concentration
  - A longer half life, assuming clearance unchanged
- Protein binding:
  - Albumin (binds weak acids) levels only slightly reduced in newborn period
  - A1-acid-glycoprotein (binds weak bases e.g. local anesthetics) not fully produced until first year. Increased risk of LA toxicity
- Metabolism:
  - In general, clearance increased because of relatively higher proportion of blood traversing the liver.
  - However, in neonates, liver redox reactions not fully developed, and therefore action of certain drugs might last longer
- Excretion:
  - GFR continues to rise in first weeks of life, and reach adult values at 8-12 months of age

PRE-OP

PREOPERATIVE CLINIC

It is located in the C-3 area and runs daily. A variety of patients are seen here prior to their scheduled surgery.

As of September 2nd 2003, we assess all preop patients, including consultations requested by the surgeon, patients with coexisting disease, patients
booked for major surgery, dental patients and patients with specific anesthetic challenges.

If special needs are identified, such as MH precautions, post-op ICU, apnea monitoring or need for invasive monitoring, the appropriate areas must be notified.

Also additional investigations and consults must be arranged if indicated and follow up.

GUIDELINES FOR SERVICES PROVIDED IN CHEO PAU

1. If the referring surgeon has requested a consultation:

   Please thoroughly complete a yellow ‘Request for Consultation and Report’ form, and attach the white copy of that form to your bill. Write on the anesthetic record “Please see consult of (date seen)” and add to the anesthetic record any information that you feel is warranted. Anticipate that your colleagues will follow your recommendation and read your consultation. Bill this as a consultation/A015A.

2. If there is no request for a consult, and the referring surgeon has not completed the yellow ‘Day Care / Short Stay Record’:

   Please complete the yellow ‘Day Care / Short Stay Record and write on the anesthetic record “Please see history of (date seen)” and add to the anesthetic record any information that you feel is warranted. Anticipate that your colleagues will follow your recommendation and read your history and physical. Bill this as a preoperative assessment /A903A.
3. **If there is no request for a consult, and the referring surgeon has already completed the yellow 'Day Care / Short Stay Record':**

   Please do a specific assessment adequate to ensure that this child has been properly evaluated and prepared for his/her upcoming anesthetic. Document your assessment on a pink *Progress Notes* form. Please **DO NOT** complete a second yellow history form! Write on the *anesthetic record* "Please see assessment of (date seen)" and add to the *anesthetic record* any information that you feel is warranted. Anticipate that your colleagues will follow your recommendation and read your assessment note. Bill this as a specific assessment/A013A.

   It is not acceptable to complete only the anesthetic record. Thank you for your cooperation in keeping our services consistent and well documented. Please direct questions or comments to Dr. Ryan.

   Please ensure to keep an anesthesia bill for each patient. Mark the date, the surgeon, the diagnosis and the type of assessment on each bill.

**PERIOPERATIVE FAMILY WEBSITE**

The following is a website that the family and patients can review prior to coming for surgery. It is a virtual tour of the entire perioperative experience including PAU, Day care, the operating room, PACU and the in-patient ward.

Feel free to give this link to the families:
http://www.cheo.on.ca/virtual_tour/index.html
There are usually pamphlets available in PAU to hand out referring to the website.

**FASTING GUIDELINES FOR ELECTIVE SURGERY IN HEALTHY PATIENTS.**

Formula up to 6 hrs before surgery

Breast milk up to 4 hrs before surgery

Clear fluids up to 2 hrs before surgery.

Solids 6-8 hrs before surgery; in general NPO after midnight for elective surgery.

There are fasting guidelines pamphlets that can be handed out to the parents as reminders. In addition, day care surgery calls the families the night before surgery to remind parents about the time of surgery and fasting guidelines.

**PREMEDICATION**

There is a standardized order form where the drug needs to be chosen, the dose specified for each drug and your signature at the bottom of the form.

**MIDAZOLAM**
- 0.5 mg/kg PO 30 min preop (maximum=15-20 mg)
- It is made up by CHEO Pharmacy as cherry flavored syrup
- Separation from parents is usually successfully achieved 10-30 min post-admin.

**CONTRAINDICATIONS TO ANXIOLYSIS**
- Upper airway obstruction
- Poor airway reflexes/coughing
• Aspiration/uncoordinated swallowing
• Lack of knowledge of the drug
• Borderline respiratory function
• Lack of monitoring

ORAL ACETAMINOPHEN:

• Tylenol elixir 30 mg/kg:
  • PO 30 min preop for children > 3 months old, to a max. dose = 1300 mg

• Tylenol elixir 20 mg/kg:
  • PO for infants < 3 months old
  • Used commonly as part of premed. Absorption is faster and more complete than when given rectally.
  • Dosage is limited by the risk of toxicity.
  • Currently, the recommended maximum daily dose is 90 mg/kg/day for 3 days and a dosing interval of 4-6 hrs.
  • Less than 3 months old, the recommended maximum dose is 60 mg/kg/day for 2 days, with a longer dosing interval of 8 hours, which is increased to 12 hrs in pre-term infants.
  • Thus, a dosing regime of 30 mg/kg preop, followed by 20 mg/kg 6-hourly could be used for up to 3 days.

Acetaminophen is suggested for the following patients:
• ENT patients
• Dental patients
• Ortho patients
• Patients for strabismus repair
• Patients for ptosis repair
• Patients for inguinal hernia repair
• Patients for orchidopexy

Consult with the attending anesthesiologist if there is a question.
EMLA (EUTECTIC MIXTURE OF LOCAL ANESTHETIC)
- Lidocaine 2.5% and prilocaine 2.5%
- Requires application 60-90 minutes to achieve anesthesia
- Analgesia lasts up to 1hr after removal
- Blanching of the skin occurs because of prilocaine induced vasoconstriction, not beneficial for IV insertion but reduces bleeding following injections (SC, IM)
- The prilocaine dose is usually small enough to not be concerned about methemoglobinemia, but systemic toxicity can occur in small children if too much cream is applied

AMETOP
- Tetracaine 4%: causes local vasodilatation making this better for venipuncture and less suited for IM/SC injections
- Onset 30-45 minutes to achieve adequate anesthesia
- Duration 4-6hrs after removal
- Contraindicated in pre-term infants or babies <1 month because of immature metabolic pathways for tetracaine

ROUTINE LABORATORY TESTING

A CBC is suggested for patients undergoing surgery with potential for blood loss, infants less than 1yr of age or less than 10kg, and those with risk factors for a hemoglobinopathy. It is CHEO policy to order a CBC in children <1yr old however this may be waived at the discretion of the staff anesthetist.

Other laboratory tests are dependent on the patient’s medical conditions or the surgical procedure.
PREOPERATIVE SCREENING FOR SICKLE CELL DISEASE

Children with sickle cell disease (Hb SS, SC, SB-thal) are at increased risk of developing sickle cell crisis during surgery, probably due to one or more of the following: stress, stasis, hypothermia and regional or general hypoxia. Often exchange transfusion occurs preoperatively to reduce the HB S level to 30% or lower which may decrease the risk of sickle cell crisis.

All Black children except of Somalian origin should be screened for sickle cell disease.

This is because not only is Hb S prevalent in the Black population but Hb C is also frequent and double heterozygote patients with Hb SC may have normal Hb and manifest sickle cell crisis for the first time in association with surgery.

Almost all non-Black patients (Mediterranean and Arabic) with sickle cell disease will have Hb < 100 g/l. Therefore, screening for sickle cell disease (SS, SB-thal) in these populations should be carried out in those with anemia (Hb < 100 g/l) and in those with microcytosis (MCV < 72 fl).

In order to facilitate urgent surgery, children who require such surgery may have blood drawn for a CBC, sickle cell prep and Hb electro-phoresis. These samples can be sent to hematology lab where CBC and sickle cell prep will be immediately performed.

It takes about 1 hr. Note that these results are preliminary, not definitive.
In view of the protective effect of fetal Hb and transfused blood, children less than 3 months chronological age may be operated without prior screening.

Currently at CHEO all children at risk for sickle cell anemia are screened, however this may change as more studies are done. At Sick Kids they performed a retrospective chart review of 1906 children screened preoperatively for sickle cell anemia. They only identified one patient that was asymptomatic and undiagnosed with a negative family history. They suggested that screening should be based on the following points: if the patient has a known family history or an unknown family history, anemia, symptoms suggestive of sickle cell anemia, and patients undergoing procedures where there is a risk of hypothermia or use of a tourniquet.

**Reference**

**SBE PROPHYLAXIS (GUIDELINES MAY 2007)**

CARDIAC CONDITIONS ASSOCIATED WITH THE HIGHEST RISK OF ADVERSE OUTCOME FROM ENDOCARDITIS FOR WHICH PROPHYLAXIS WITH DENTAL PROCEDURES IS RECOMMENDED:
1. Prosthetic cardiac valve
2. Previous IE
3. Congenital heart disease (CHD):
   a) un repaired cyanotic CHD (including palliative shunts and conduits)
   b) completely repaired CHD with prosthetic material or device during the first 6mths after
the procedure (time it takes for endothelialization)
c) repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)

4. Cardiac transplantation recipients who develop cardiac valvulopathy

**In addition to Dental procedures, SBE prophylaxis indicated in the following situations:**
- Procedures on infected skin, skin sutures, or MSK tissue only for patients with underlying cardiac conditions associated with the highest risk of adverse outcomes from IE (staphylococci and B-hemolytic streptococci)
- Procedures in patients with underlying high-risk cardiac condition that involves incision or biopsy of the respiratory mucosa (ex. T & A, Bronchoscopy with incision of mucosa, drainage of empyema/abscess—antibiotics should cover S viridans)

ENDOCARDITIS PROPHYLAXIS NOT RECOMMENDED:
- Isolated secundum ASD
- Post repair of ASD, VSD and PDA without residual defects beyond 6 months.
- Previous CABG
- MVP
- Functional heart murmurs
- Previous rheumatic fever without valvular dysfunction.
- Cardiac pacemakers and implanted defibrillators
- GI/GU procedures
ANTIBIOTIC REGIMENS:
Single Dose 30-60min before procedure (if inadvertently not administered before, may be given up to 2hrs after the procedure)

1. Ampicillin 2mg IM/IV (adults) or 50mg/kg IM/IV (peds) Or Cefazolin/Ceftriaxone 1g IM/IV (adults) or 50mg/kg IM/IV (peds)

2. Allergic to penicillin or ampicillin:
   Cefazolin/ceftriaxone 1g IM/IV (adult) or 50mg/kg IM/IV (peds) Or Clindamycin 600mg IM/IV (adult) or 20mg/kg IM/IV (peds)

* Do not give cephalosporins if history of anaphylaxis, angioedema, or urticaria with penicillins or ampicillin
GUIDELINES FOR SURGICAL
MANAGEMENT IN DIABETIC PATIENTS

(Rhodes, E. T. et al. Perioperative Management of
Pediatric Surgical Patients with Diabetes Mellitus
Anesth Analg 2005; 101:986-999)

Figure 1
To convert mg/dL to mmol/L glucose divide by 18
Figure 3
Figure 4
URTI

DDX URTI:
- Croup
- Influenza
- Bronchiolitis
- Herpes simplex
- Pneumonia
- Epiglottitis
- Strep throat
- Allergic rhinitis
- Vasomotor rhinitis

POTENTIAL INTRA-OP COMPLICATIONS:
- Bronchospasm
- Laryngospasm
- Arterial desaturation
- Severe coughing
- Breath holding
- Minimal long-term adverse sequelae
Severe symptoms that should have elective surgery postponed for a minimum of 4 weeks:
- mucopurulent secretions
- productive cough
- fever $>38\,^\circ C$
- lethargy
- signs of pulmonary involvement

It is suggested that residents check with the supervising staff before deferring a case.

Reference
CHICKENPOX MANAGEMENT/EXPOSURE:

Chickenpox (varicella-zoster virus) is a disease predominantly of early childhood with approximately 90% of individuals infected in the first decade of life. The incubation period is between 7-21 days. The period of infectiousness is felt to be 48 hours prior to the onset of lesions and at least 5 days after the skin rash appears, although in immune compromised patients, the virus may be recoverable from lesions for a very long time. It is predominantly a disease of late winter and early spring with one attack considered to provide immunity. Varicella Ab is transported across the placenta and is present in about 50% of children at 5 months of age.

There usually is no significant antecedent illness although mild URI symptoms may precede the rash. Usually the first sign of illness is pruritis with small red, vesicular lesions appearing and continuing to erupt for 4-5 days with a mild fever for 2-3 days. In immune compromised patients complications include bacterial superinfection, pneumonia, encephalitis, necrotizing fasciitis and hepatitis.

Patients with an exposure are best kept out of the hospital to avoid infecting other children or immune compromised patients until after 21 days from the last exposure.

Patients recovering from chickenpox should have all of their lesions crusted over prior to elective surgery. However, administering anesthesia to the patient with an acute infection probably poses no significant increased risk to the patient, but it may be very difficult to sort out the causes of subsequent postoperative problems (i.e. pneumonia, hepatitis, etc.).
PEDIATRIC MEDICAL CONDITIONS

ANTERIOR MEDIASTINAL MASS

CLINICAL SYMPTOMS:
- Cough, hoarseness, dyspnea, wheezing, orthopnea, stridor, CP, syncope, SVC syndrome, tracheal deviation, retractions
- Symptoms often worse when supine
- Symptoms due to compression

DDX:
- 4Ts: teratoma, thymoma, thyroid goiter, “terrible” lymphoma
- Neuroblastoma, germ cell tumor, broncogenic cyst, foregut cyst, mesenchymal tumor

PRE-OP:
- Consider preoperative decompression (radiation, chemo), stenting SVC
- Review CXR, echo, CT to assess for airway CV compromise
- PFTs and flow volume loops

INTRA-OP:
- Lower extremity IV access
- Arterial line
- Multiple sizes ETT available
- If symptomatic consider performing procedure under LA or regional anesthesia
- If GA required maintain spontaneous ventilation: consider awake FOB vs. volatile induction
- Avoid muscle relaxants
- If problems consider:
  - Rigid bronchoscope
  - CPB (consider pre-op for severe cases)
  - Lateral position
POST-OP
Concerns: airway obstruction, hypotension, hypoxemia
Recover in lateral position

Reference:

CONGENITAL DIFFICULT AIRWAY

Achondroplasia: midfacial hypoplasia, small nasal passages and mouth

Apert’s (acrocephalosyndactyly): Maxillary hypoplasia, prognathism, cleft soft palate, tracheobronchial cartilaginous anomalies

Beckwith’s (infantile gigantism): Macroglossia

Cherubism: Tumorous lesion of mandibles and maxillae with intraoral masses

Cornelia de Lange syndrome: high arch palate, micrognathia, large tongue, short neck, +/- cleft palate

Craniofacial dysostosis of Crouzon: maxillary hypoplasia with inverted V shaped palate, +/- large tongue

Cretinism (congenital hypo-thyroidism): Macroglossia, goiter, compression of trachea, deviation of larynx/trachea

Cri du chat: Chromosome 5-P abnormal: microcephaly, micrognathia, laryngomalacia, stridor
Down syndrome: Poorly developed or absent bridge of the nose, macroglossia, microcephaly, cervical spine abnormalities

Freeman-Sheldon syndrome: small mouth, high palate

Goldenhar’s (oculoauriculovertebral syndrome): Auricular and ocular defects; malar and mandibular hypoplasia; occipitalization of atlas, TEF

Hallerman-Streiff syndrome: malar hypoplasia, micrognathia, narrow high arch palate, anterior displacement of TMJ

Hurler’s (mucopolysaccharidosis I), Hunter (type II—less severe): Stiff joints, macroglossia, upper airway obstruction due to infiltration of lymphoid tissue, narrowing of tracheobronchial tree

Klippel-Feil: Congenital fusion of a variable number of cervical vertebrae; restriction of neck movement

Marfan syndrome: narrow facies with narrow palate

Meckel’s: Microcephaly, micrognathia, cleft epiglottis

Pierre Robin: Micrognathia, macroglossia, glossoptosis, cleft soft palate

Rubinstein-Taybi syndrome: maxillary hypoplasia, narrow palate

Smith-Lemli-Opitz syndrome: micrognathia, +/- cleft palate

Treacher Collins (mandibulofacial dysostosis): Auricular and ocular defects; malar and mandibular hypoplasia, microstomia, choanal atresia
**Turner syndrome**: narrow maxilla, small mandible, short neck

**Von Recklinghausen disease** (neurofibromatosis):
Increased incidence of pheochromocytoma; tumors may occur in the larynx and right ventricle outflow tract

**Reference**
CONGENITAL HEART DISEASE

A DIAGRAM OF VARIOUS PALLIATIVE PROCEDURES IN CHILDREN WITH CHD

Figure 10-1 A, Various palliative procedures that can be used in patients who have congenital heart disease with a decreased pulmonary blood flow. B, Pulmonary artery banding procedure to reduce the pulmonary blood flow.
ATRIOVENTRICULAR SEPTAL DEFECT (A-V CANAL)

CHARACTERISTICS:
- Complete AVSD: Absence of septal tissue immediately above and below the level of the A-V valves and defects in the A-V valves (common AV valve)
- Partial AVSD: ostium primum defect, cleft or commissure in left-sided AV valve with 2 functionally distinct AV valve orifices
- Associated conditions: Trisomy 21, asplenia, polysplenia syndrome, DiGeorge, Ellis-van Creveld syndrome
- Direction of blood flow dependent on pressure/compliance in chambers and ratio of PVR/SVR
- Usually L to R shunt at both levels, early pulmonary HTN

SURGICAL REPAIR:
- Complete: repair of ASD/VSD (single or two patch technique), repair of valves, attach valves to patch

EBSTEIN'S ANOMALY

CHARACTERISTICS:
- Dysplastic TV, "atrialization" of RV
- RV dysfunction, TS, TR
- Shunt R to L across the PFO from large RA

SURGICAL REPAIR:
- Early palliation with Norwood staged repair
- Late ASD closure and TV replacement

HYPOPLASTIC LEFT HEART SYNDROME:
CHARACTERISTICS:
- LV hypoplasia
- MV hypoplasia
- AV atresia
- Hypoplasia of the ascending aorta
- Single ventricle physiology
- Systemic circulation dependent on PDA
- Distribution of blood dependent on PVR/SVR ratio

SURGICAL REPAIR:
- **Norwood** Stage 1 (newborn): the ascending aorta has been reconstructed from the prox PA to form a neo-aorta, a right sided modified B-T systemic-to-PA shunt to provide PBF
  - SpO2 approx 80%
- **Bidirectional Glenn** procedure Stage II (4-6 months): remove shunt, SVC to R pulmonary artery anastomosis to provide non arterial PBF
  - SpO2 approx 75-85%
- **Fontan** procedure Stage III (18 months - 4 yrs): adds IVC flow to pulmonary arteries to create a total cavopulmonary connection, fenestration in the lateral tunnel connection allows for R-to-L shunting (ameliorates the effects of increased PVR and myocardial dysfunction)
  - SpO2 approx 90-95%

Stage II and III PBF is passive and dependent on CVP and low PVR

INTERRUPTED AORTIC ARCH

CHARACTERISTICS:
- Type A: interruption distal to the L subclavian artery
- Type B: interruption distal to the L common carotid artery
- Type C: interruption proximal to the L common carotid artery

**SURGICAL REPAIR:**
- **Complete:** end-to-end anastomosis/tube graft
- **Ross-Konno procedure:** aortic outflow regions enlarged, aortic valve replaced with pulmonary valve autograft, coronary ostia moved to graft and RV to pulmonary artery conduit created
- **Norwood-Rastelli procedure:** interventricular baffle created, main PA anastomosed to ascending aorta, distal portion connected to a conduit from RV

**TETRALOGY OF FALLOT:**

**CHARACTERISTICS:**
- valvular and infundibular pulmonary stenosis (RVOTO)
- RVH
- overriding aorta
- VSD
- Associated conditions: DiGeorge syndrome, pulmonary atresia, VACTERL syndrome absent pulmonary valve
- If pre-repair: at risk of TET spells (hypercyanotic episode)
- If severe RVOTO, PBF dependent on PDA

**TET SPELLS:**
- Features: increased cyanosis, hyperpnea, irritability, crying
- Increased R to L shunt across VSD
- Treatment: quiet environment, increase SVR/decrease PVR (knee-chest position, fluid bolus, oxygen, morphine, esmolol infusion, bicarbonate, phenylephrine, GA if prolonged/severe spell)
- Prophylaxis: propranolol
SURGICAL REPAIR:

**Complete repair**: VSD closure and RVOT patch

**Palliation**:
- PA atresia: shunt (RV-PA conduit)
- anomalous right coronary: Rastelli
- Rastelli: patch closure of the VSD, reconstruction of the RVOT, conduit placed between the RV and the PA

In the past the palliative procedures to increase pulmonary blood flow were the following:
- **Waterson** procedure: side-to-side anastomosis of the ascending aorta and the R pulmonary artery
- **Potts** operation: side-to-side anastomosis of the descending aorta to the L pulmonary artery
- **Blalock-Taussig** operation: end-to-side anastomosis of the subclavian artery to the pulmonary artery

TOTAL ANOMALOUS PULMONARY VENOUS RETURN

**Characteristics**:
- Drainage of all four pulmonary veins into the systemic venous system:
  - Most common presentation is drainage into the L innominate vein
  - Supracardiac: connection to the SVC
  - Infracardiac: connection to the IVC
  - Intracardiac: drainage directly into RA
- Physiology depends on mixing and shunting to L heart via PFO, ASD, PDA

SURGICAL REPAIR:
• **Complete**: anastomosis of pulmonary veins to LA and closure of ASD
• If late presentation and severe pulmonary HTN, surgical repair not feasible

**TRANSPOSITION OF THE GREAT ARTERIES:**

**CHARACTERISTICS:**
• the aorta arises from the RV and the PA arises from the LV
• systemic and pulmonary circulations in parallel causing cyanosis
• oxygenation relies on mixing via VSD, PDA, ASD/PFO

**SURGICAL REPAIR:**
• **Complete**: arterial switch
• **Palliation** (unfavorable coronary arteries): atrial switch (Mustard or Senning)
  o **Atrial switch**: resection of the atrial septum and its replacement with a baffle to direct the systemic venous blood into the LV and pulmonary venous blood across the TV into the RV
  o **Outcome**: heart failure as young adult, TR, loss of sinus node function, atrial dysrhythmias

**TRICUSPID ATRESIA**

**CHARACTERISTICS:**
• No connection between RA and RV
• arterial hypoxemia, small RV, large LV, decreases in PBF
• blood shunts from RA to LA via PFO and LV to RV via VSD if present
• if no VSD: cyanosis, PBF depends on PDA
SURGICAL REPAIR:
• Palliation:
  o BT shunt
  o Glenn
  o Fontan-anastomosis of the RA appendage to the R pulmonary artery to bypass the RV and provide a direct atrio-pulmonary communication

PULMONARY ATRESIA

SURGICAL REPAIR:
• Palliation: Fontan

TRUNCUS ARTERIOSUS

CHARACTERISTICS:
• A single arterial trunk serves as the origin of the aorta and pulmonary artery
• Trunk overrides both ventricles, connected by a VSD
• Truncal valve has 2-6 cusps and is usually incompetent
• Blood flow determined on SVR/PVR balance

SURGICAL REPAIR:
• Complete: closure of VSD, creation of RV-PA conduit with a valve, aortic reconstruction

References
MURMURS

The vast majority of children found to have a murmur preoperatively have an innocent murmur. These innocent murmurs are characterized by being soft, early systolic murmurs with no thrill or abnormal cardiac impulses and are not associated with cardiac signs or symptoms.

If a child is found to have a murmur prior to elective surgery a history and cardiac examination should be performed and an ECG done.

FUNCTIONAL OR INNOCENT MURMURS

- Still's: musical vibratory systolic murmur along LSB (young children)
- Pulmonary flow: soft blowing murmur at upper LSB (older children)
- Pulmonary flow of newborn (PPS): as above, but radiates to back (resolves by 3-6mos)
- **Carotid bruit**: 2/6 intensity systolic murmur over clavicles along carotids (all ages)
- **Venous hum**: continuous murmur over clavicles; intensity changes with rotation or head and compression of jugular vein, and disappears when supine (young children)

If the murmur is thought to be innocent, the surgery should proceed and antibiotics given if the surgery is likely to cause bacteremia.

Non-urgent referral for cardiological opinion should be arranged post-operatively or follow-up with pediatrician.

An echocardiogram and cardiology consult is indicated prior to surgery if:
- The child is younger than a year
- The murmur fits pathological criteria (i.e. all diastolic murmurs, all pansystolic murmurs, late systolic, very loud or continuous murmurs).
- Evidence of LVH or RVH

**PATHOLOGIC MURMURS**
- All diastolic murmurs
- Systolic murmur (>3/6, thrill, radiates widely)
- Abnormal splitting of S2
- Additional heart sounds (gallops, clicks)
- Abnormal pulses
- S & S of CV disease
- Abnormal CXR, ECG

**Reference**
OBSTRUCTIVE SLEEP APNEA SYNDROME

OSA SCORING SYSTEM

A. Severity of OSA (based on sleep study or clinical indicators)
   - None (0)
   - Mild (1)
   - Moderate (2)
   - Severe (3)

B. Invasiveness of surgery and anesthesia
   - Superficial surgery under local or peripheral nerve block anesthesia w/o sedation (0)
   - Superficial surgery with mod. sedation or GA (1)
   - Peripheral surgery with spinal/epidural anesthesia (no more than moderate sedation) (1)
   - Peripheral surgery with GA (2)
   - Airway surgery with moderate sedation (2)
   - Major surgery, GA (3)
   - Airway surgery, GA (3)

C. Requirement for postoperative opioids
   - None (0)
   - Low-dose oral opioids (1)
   - High-dose oral opioids, parenteral or neuraxial opioids (3)

Subtract 1 pt. if patient has been on CPAP or NIPPV
Add 1 pt. if resting PaCO2 >50mmHg
Score 4: increased perioperative risk from OSA
Score 5/6: significantly increased perioperative risk from OSA
### OSA: ADULT VS. CHILDREN

<table>
<thead>
<tr>
<th>Features</th>
<th>Children</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak age</td>
<td>Preschool</td>
<td>Middle age</td>
</tr>
<tr>
<td>Gender ratio</td>
<td>Equal male and female</td>
<td>Male predominance, postmenopausal</td>
</tr>
<tr>
<td>Causes</td>
<td>Adenotonsillar hypertrophy, Obesity, Craniofacial abnormalities, Neuromuscular disorder</td>
<td>Obesity</td>
</tr>
<tr>
<td>Body habitus</td>
<td>FTT, normal, obese</td>
<td>Obesity</td>
</tr>
<tr>
<td>Excessive daytime somnolence</td>
<td>Uncommon</td>
<td>Very common</td>
</tr>
<tr>
<td>Neurobehavioral</td>
<td>Hyperactivity, developmental delay, cognitive impairment</td>
<td>Cognitive impairment, impaired vigilance</td>
</tr>
</tbody>
</table>

#### Polysomnographic findings:

<table>
<thead>
<tr>
<th>Features</th>
<th>Children</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstructive respiratory events</td>
<td>Cyclic obstruction or prolonged obstructive hypoventilation</td>
<td>Cyclic obstruction</td>
</tr>
<tr>
<td>Sleep architecture</td>
<td>Normal</td>
<td>Decreased delta and REM sleep</td>
</tr>
<tr>
<td>Cortical arousal</td>
<td>&lt;50% of apneic episodes</td>
<td>At termination of apneic episodes</td>
</tr>
<tr>
<td>Sleep state</td>
<td>REM sleep</td>
<td>REM or non-REM</td>
</tr>
<tr>
<td>Treatment</td>
<td>Primarily surgical (T&amp;A) CPAP secondarily</td>
<td>Primarily CPAP, surgery secondarily (UPPP)</td>
</tr>
</tbody>
</table>
Sleep Study

<table>
<thead>
<tr>
<th>Severity of OSA</th>
<th>Adult AHI</th>
<th>Pediatric AHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0-5</td>
<td>0</td>
</tr>
<tr>
<td>Mild OSA</td>
<td>6-20</td>
<td>1-5</td>
</tr>
<tr>
<td>Moderate OSA</td>
<td>21-40</td>
<td>6-10</td>
</tr>
<tr>
<td>Severe OSA</td>
<td>&gt;40</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

AHI = apnea-hypopnea index, number of episodes of sleep disordered breathing per hour

Pediatric OSAS: RF for respiratory distress after surgery for OSAS

- Age <3 yrs
- Bleeding
- Concurrent resp infection
- Congenital heart defects
- Craniofacial disease
- FTT
- Hx cor pulmonale
- Hx premature birth
- Neuromuscular disease
- Obesity
- Throat pack not removed
- Genetic syndrome

Reference

Practice Guidelines for the Perioperative Management of Patients with Obstructive Sleep Apnea: A Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Obstructive Sleep Apnea Anesthesiology 2006; 104:1081-1093

CHEO RECOMMENDATIONS FOR ADMISSION AFTER TONSILLECTOMY WITH PATIENTS WITH OSAS:

RECOMMENDATION #1 - All patients with documented severe OSAS will be admitted after tonsillectomy for apnea monitoring. The attending surgeon should arrange for the appropriate sleep studies when indicated preoperatively.

RECOMMENDATION #2 - All patients with prolonged apnea after anesthesia for tonsillectomy will be admitted after tonsillectomy for apnea monitoring.

RECOMMENDATION #3 - All patients with symptomatic airway dysfunction leading to emergent tonsillectomy will be monitored for apnea monitoring after surgery. It is expected that most of these patients will be admitted preoperatively with a compromised airway, such that continuous monitoring will be indicated preoperatively.

RECOMMENDATION #4 - Patients with major craniofacial abnormalities will undergo preoperative screening for OSAS prior to elective tonsillectomy, unless the history and physical examination do not in anyway justify such an investigation. Those patients with documented OSAS will be admitted after tonsillectomy for apnea monitoring.

RECOMMENDATION #5 - Age is not a screening factor for admission after tonsillectomy. It is acknowledged that younger children (less than 36 months) who undergo tonsillectomy are at greater risk.
of having other factors which will lead to an indication for admission to hospital after tonsillectomy.

**RECOMMENDATION #6** - Children with sleep disturbances will not require admission after tonsillectomy unless otherwise indicated. Attending surgeons will arrange appropriate preoperative investigations, such as sleep studies, when indicated.

**POSTOPERATIVE APNEA MONITORING IN INFANTS**

**CAUSES:**
- metabolic causes: hypothermia, hypoglycemia, hypocalcemia, acidosis, hypoxemia
- CNS immaturity
- pharmacologic: inhalation agents, narcotics, and sedatives depress the central response to carbon dioxide and decrease muscle tone in upper airway
- sepsis
- CNS trauma/intracranial hemorrhage
- immature chest wall/diaphragm/lung

Factors that increase risk:
- anemia (Hct<30%), lower GA, lower chronological age, BPD, RDS, PDA, history of apnea of prematurity, poor general health

Children born prematurely (under 37 weeks) with a post-conceptual age under 60 weeks will be monitored:
- Pulse oximetry and cardio-respiratory monitoring until 12 hr apnea-free period is observed
- Nurse in attendance in patient’s room for the duration of monitoring.
- Notify 5E and PAR nurses prior to induction.
Full term infant less than 48 weeks requires overnight hospital stay with pulse oximetry and apnea monitor.

Healthy full term infant more than 48 weeks PCA old may have Day Surgery and may be discharged home after 2 hrs in PACU.

There is no official consensus between centers about the age for both premature and full term infants that require monitoring. On occasion depending on the situation the cut-off ages will be lowered by the attending anesthesiologist. Text books recommend a range of ages:

- Barash: monitor all infants <50wks PCA
- A practice of Anesthesia for Infants and Children by Cote et al.: full term infants monitored <44 wks
- Miller: monitor ex-prem infants <45-60wks PCA
- Stoelting: monitor preterm infants <60wks PCA

SCOLIOSIS CORRECTION SURGERY
CLASSIFICATION:
- Idiopathic (70%)
- Congenital: spina bifida, hemivertebra or congenital rib fusion
- Neuromuscular: cerebral palsy, spinal muscular atrophy, myopathies i.e. Duchenne
- Neurofibromatosis
- Mesenchymal Diseases: Marfan's, RA, Osteogenesis imperfecta etc.)
- Trauma

INDICATION:
- >40 degrees with nonoperative treatment
- >50 degrees in a mature teen
- to improve wheelchair position
- prevent progression of restrictive lung defect
SURGICAL TECHNIQUE:
- posterior approach: more common
- anterior approach: thoraco-abdominal incision, single lung ventilation, retroperitoneal dissection
- Combined approaches are for the more severe and rigid curves

PRE-OP:
- CBC, Coags, Type & cross
- Consider autologous blood donation in teens
- Focus assessment on cardiorespiratory function (exercise tolerance)
- Idiopathic scoliosis has 25% chance of mitral valve prolapse, rarely of significance
- Duchenne/myotonic dystrophy: cardiomyopathy as possibility, ECG, ECHO
- Spirometry: usually restrictive defect
- Document any neurological deficit
- Discuss invasive cardiovascular monitoring (art line, CVP), urinary catheterization, neurophysiological monitoring, post-op analgesia

INTRA-OP:
- Monitors: Large bore IV, art line, temperature monitor, fluid warmer, +/- CVP, foley catheter, +/- SSEP, cell saver
- Prone: protect eyes, ensure free movement of abdomen, avoid compression neuropathies
- Sensory evoked-potentials (SSEP):
  - Involves stimulation of a peripheral nerve, and detects a spinal response with epidural electrodes or a cortical response with scalp electrodes
  - For reliable recording: volatiles 0.5MAC, remifentanil infusion, propofol infusion
- If muscular dystrophy avoid succinylcholine
- Blood loss (usually >50% EBV)
24hr loss = 200mL/segment fused
- increased bleeding with neuromuscular disease
- antifibrinolytics
- controlled hypotension as indicated

POST-OP:
- Pain control:
  - Intrathecal morphine: pre-op or intra-op 5-20mcg/kg
  - PCA IV morphine
  - NSAIDS controversial

COMPLICATIONS:
- Air embolism
- Visual loss
- Superior mesenteric artery syndrome:
  - compression of the third part of the duodenum
  - between the superior mesenteric artery and the aorta; distorted by correction of scoliosis
- Atelectasis
- Neurological injury:
  - Direct contusion of the cord
  - Reduction of spinal cord blood flow by compression of vessels
  - Distraction injury of cord
  - Epidural hematoma

References
INTRA-OP

RESIDENT RESPONSIBILITY FOR CASE PREPARATION

OUT-PATIENTS:
- Residents may see the charts for the following days' cases in day care. They are usually locked up after 3pm so you will have to ask one of the nurses for the key. Please make sure you keep the charts as you found them as a lot of work went into organizing them.

IN-PATIENTS:
- The resident scheduled to be in that room the next day is to see the in-patients the day before unless the resident is:
  - Post-call
  - On vacation or sick
  - Or the patient is unavailable during regular OR-hours

  In that case the resident on-call will see the patient. Information regarding the patient as well as the anesthetic plan will be discussed with the assigned anesthesia staff if they are still in hospital. If anesthesia staff is not available the information can be discussed with them first thing the following morning or discussed with the anesthesia staff on call.

- The resident on-call will see all remaining in-patients and communicate with the anesthesia staff assigned to the case for the next day. If the staff is unavailable, they can discuss the case with the assigned staff the following morning or with the anesthesia staff on call.
CASE PREPARATION:

- The resident will be responsible for contacting the anesthesia staff he or she is working with the next day and discuss the anesthetic plan. This will particularly include:
  - All in-patients
  - Infants/neonates
  - Patients with complex health issues
  - Complex/long procedures

In general, any case should be discussed prior to the day of surgery. If the anesthesia staff is unavailable the case may be discussed with them first thing the following morning.

- Residents are responsible for the OR set-up the next morning. If there are rounds at 7h00 a.m., residents may have to come in before 7h00 a.m. for room set-up, particularly if they have to be present during pain-rounds at 7h30.

DRUG DISPENSING SYSTEM

All controlled substances are obtained in the morning from the OR nurse in charge. The nurse will be waiting in the PACU with a sign out sheet for the boxes of drugs. Please mark the box number, the staff anesthetists' name and your signature on the sign out sheet.

Usually these are checked out in a standardized kit containing:

- 6x5cc vials of fentanyl (50mcg/mL)
- 2x1cc vials of sufentanil (50mcg/mL)
- 3x1cc vials of morphine (10mg/mL)
- 3x2cc vials of ketamine (50mg/mL)
- 1x10cc vial of epimorph (0.5mg/mL)
- 5x 2cc vials of midazolam (1mg/mL)
- 2x1cc vials of hydromorphone (2mg/mL)
• 5x1cc vials of remifentanil (1mg/mL)

Any extra narcotics can be obtained by asking the OR nurse.

When these drugs are signed out, a standard form should be filled out with the patient’s first and last name, date and amount of drug administered, wasted and returned. This form should be completed at the end of the day and included in the kit before returning it to the pharmacy. There is a drop-off box in the wall of the OR hallway between the anesthesia lounge and the main entrance of the OR. The person signing out the kit is responsible for the contents of the kit. It should never be left unattended at any time.

CENTRAL CORRIDOR

There are 4 large carts that contain the anesthesia supplies. Each drawer in the cart has a front half and a back half with the same supplies. When the front half of the drawer is empty remove the white clip off the drawer and place it on the ‘to be ordered board’. You may then start taking supplies from the back half of the drawer. When the back part of the drawer is empty remove the red clip from the drawer and place it on the ‘to be ordered’ drawer.

There is also a resuscitation cart, a difficult airway cart, a regional anesthesia cart and a neonatal cart located outside of the neurosurgery OR that may be brought into ORs for certain cases.

The Glidescope, BIS monitor and portable U/S machine are located in a small room beside the change rooms.

OR DAILY ROUTINE
OR START TIMES:
- ORs start at 8am everyday except Wednesday
- Dental room starts at 7:45am every day except Wednesday
- On Wednesdays ORs start at 9am after grand rounds

FIRST CASE:
All patients will be set up in the recovery room according to OR number. You will assess the patients there with their families and then bring them to the OR along with the nurse assigned to that OR once the staff anesthetist and surgeon are confirmed to be present. Patients are allowed to bring their favorite toy to the OR.

ALL OTHER CASES:
The patients will be waiting in the hallway outside of the main entrance of the OR or in the interview room. The charts will be waiting on the window ledge of the main OR office.

If there is a premedication that is required for the next patient ensure that daycare has been informed about when it should be given (i.e. 30 min before coming to the OR).

PARENTAL PRESENCE INDUCTION (PPI)

This is a new volunteer program that has been organized at CHEO. The coordinator is a child life worker named Lee. If there is a volunteer available their name will be written on the wipe board at the entrance to the main OR. If the patient is a good candidate the option will be given for the parent to be present for the induction. The volunteer, explains to the parent in daycare how the process will work. The
parent and volunteer will be dressed in an OR gown, hat, mask and foot covers. The volunteer is only there to support the parent if needed. It is the anesthetist’s responsibility to instruct the parents on what to do in the OR (i.e. what to expect, holding the patient and where to stand). After the child is anesthetized, the volunteer will walk the parent back to day care. If he/she faints, then a stretcher team is rushed to the scene.

PPI NOT INDICATED:
- Difficult airway
- Rapid sequence induction
- Medically complex patient
- Uncooperative parent
- No staff available to attend to the parent
- Neonate, infant

OR SET-UP SPECIFIC TO PEDIATRICS

- Normal saline in 10cc syringes for flushes
- Fentanyl diluted to 5mcg/mL if <10kg
- Propofol in 3cc or 10cc syringe according to weight
- Lip smackers lip balm: scents to be placed sparingly in mask
- ETT (cuffed/uncuffed), oral airway, and laryngoscope blade sizes smaller and larger than expected
- Appropriate BP cuff size
- IV line: Buretrol with pediatric T-piece on end
- IV pump in room
- Appropriate sized arm board for IV (it is very traumatic for all involved if IV comes out in PACU)
- Tape ready to go for IV and airway
- Emergency drugs:
  - Succinylcholine: 1-2mg/kg in a syringe with a 25G needle (in case of lack of IV access)
• Atropine: 0.02mg/kg in a syringe with a 25G needle

**Remember to not use needles in the IV ports, it is a needless system. Just use the syringe to attach to the ports and inject. There is also no valve to prevent backflow of the medications, make sure the line is kinked to prevent this.

NEONATAL SET-UP CHECKLIST:

It is very important to be prepared for this age-group and to have everything within your reach!

• Warm room
• Blanket warmer
• Shoulder roll
• Small donut for head
• Neonatal cart in room
• Appropriate sized airways (multiple sizes)
• White connector piece to attach to ETT (sized according to ETT size), allows ETCO2 sampling line to be closer to ETT
• Small HME filters
• Small ETT stylets
• Small metal suction yonker
• Small tourniquet (cut blue ones in strips and in half)
• White BP cord with appropriate sized cuff
• Small ECG wires/stickers
• Tape ETT to upper lip and chin
• Small blue breathing bag (0.5L)
• Oral temperature probe
ANESTHESIA EQUIPMENT

ENDOTRACHEAL TUBE GUIDELINES

Size Equation (age >2yrs):

- Uncuffed (ID, mm)= (age/4) + 4
- Cuffed (ID, mm) = (age/4) + 3
- Oral ETT depth at lips = 3 x size ETT
- Nasal ETT depth at nares = 3 x size ETT + 2

<table>
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<th>ETT SIZE</th>
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<tr>
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<tr>
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<td>Term-3mos</td>
<td>3.0-3.5</td>
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<tr>
<td>3-9mos</td>
<td>3.5-4.0</td>
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<tr>
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<td>4.0-4.5</td>
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<td>(age/4) +4</td>
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LARYNGOSCOPY

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</tr>
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</tr>
</tbody>
</table>

CENTRAL VENOUS LINES - GUIDELINES

Double Lumen:

- < 6 months 4FR
- 6-12 months GRAY ZONE
- > 1 year 5 FR
- > 10 years 7 FR

LENGTHS OF CATHETERS AVAILABLE:

4FR: 5 cm, 8 cm
5FR: 8 cm
7FR: 12 cm, 16 cm

**ARTERIAL LINES**

24G <10kg
22G >10kg
20G adolescents

**LMA**

Size 1 neonates/infants up to 5 kg
Size 1 1/2 infants 5-10 kg
Size 2 infants/children 10-20 kg
Size 2 1/2 children 20-30 kg
Size 3 children 30-50 kg
Size 4 adults 50-70 kg
Size 5 adults 70-100 kg
Size 6 adults over 100 kg

**AVERAGE BODY WEIGHT**

Newborn 3.5kg
1year 10kg
7years 25kg
12yrs 40kg

*Formula:* \(2 \times \text{age (years)} + 9 = \text{weight in kilograms}*
REMOTE ANESTHESIA

TREATMENT ROOM

The Treatment Room is located within the Recovery Room area and is used for short surgical procedures and E.U.A.'s, i.e. joint injections, line insertions, EEG, ERG, bone marrow aspiration, renal biopsies, lumbar punctures etc.

It needs to be booked at the main OR desk and discussed with the anesthesia staff in charge (AIC) that particular day.

It is equipped with an anesthetic machine, a cart and routine monitors.

The hematology/oncology patients often make frequent trips to the procedure room. It is important to establish a good long-term relationship with these children and their guardians.

These children usually have some sort of permanent IV access that is accessed in advance of our arrival. We allow considerable parental involvement during induction.

Typically, PPF bolus technique +/- Fentanyl is used in our practice. Vast majority of the time a natural airway and spontaneous ventilation is maintained.
The Radiology Department is located on the main level. We provide anesthetic services daily for children requiring diagnostic images and interventions by the radiologist. This includes children of young age, developmentally delayed, those with phobias, tremors or critically ill.

In order for imaging to be arranged with anesthesia available, the attending staff requesting the image must speak directly to the staff anesthetist in charge (AIC) and fill out an OR booking form. They must also book the image by sending a requisition to the appropriate imaging department. There is sometimes a misconception that if the physician requesting the image speaks to anesthesia or requests a consult for anesthesia that the imaging has been arranged with anesthesia but this is not the case.

MRI
Patients coming for MRI are usually seen in the pre-operative clinic if there are any co-morbidities. However occasionally there are in-patients that need to be seen the night before. Check the MRI schedule in the room across from the main OR desk.

It is not necessary to arrive early to set up the anesthesia machine and drugs in the MRI unit. This is routinely done by the anesthesia assistants that work in MRI.

All patients coming for MRI need to have a consent form for general anesthesia filled out on arrival. Usually our consent is included with the surgeon's consent however this is not the case when there is no
surgeon. In addition the parents need to fill out a MRI checklist.

Usually parents are present for the anesthetic induction of their child. It is very convenient since the induction area is very close by and there is no concern about sterility. One of the anesthesia assistants will show the parents where to go afterwards.

Please ensure that you remove all ferromagnetic metal objects prior to entering the MRI (i.e. Stethoscope, pager, ID badge, pens, scissors etc.).

Usually an inhalational induction occurs in the induction area. Intubation is rarely required. Generally no opioids are required to ensure a quick wake-up. Monitors are removed temporarily. The patient is transferred on the MRI bed into the MRI room. MRI compatible monitors are placed along with an MRI compatible IV pole. The IV pumps are not compatible in the MRI so verify the rate of the IV drip. There is a monitor that is outside the window looking into the MRI. After the MRI is complete, the patient is then transferred to the recovery area.

Occasionally breath holding may be required during images of the thorax. Either the anesthetist or one of the anesthesia assistants will need to be present in the MRI to hyperventilate the patient prior to the breath holding period.

For infants, if there are concerns about general anesthesia, attempts can be made to swaddle the infant and perform the image without anesthesia. In addition a soother or feeding the baby prior to the image may help calm the infant.

CONSIDERATIONS IN MRI:
- MRI compatible equipment
• Patient accessibility
• Burns (ensure wires are insulated, no loops within the MRI, no contact of wires/cables with each other and skin)
• Contrast agents (side effects, allergic reactions)
• Loud noise (auditory protection)
• No ferromagnetic metal (can become missiles)
• Patient anxiety/claustrophobia
• Need for immobility

CARDIAC CATH LAB

This is easily the toughest satellite location. It is located on the 3rd floor, across from the PICU.

Procedures include catheterization, coil occlusion, angioplasty, angioplasty with stent, device closure and valvuloplasty.

The challenges include a debilitated patient population with complex physiology, a difficult physical layout, and procedures that are not benign.

The anesthetic goals are unique. Children must be held in the physiologic range they "live in". Critical decisions are based on the results of the cardiac catheterization.

Common problems include hypothermia, arrhythmia, Qp/Qs changes, blood loss, contrast reactions and hypoglycemia. Mechanical damage to the heart and blood vessels can also occur. For procedures with the potential of blood loss, ensure that there is blood available and present in the room.

PRE-OP
• Review the echocardiogram to understand the patient's anatomy, ventricular function,
pulmonary pressures and cardiac shunts if present.

- Review labs, especially Hgb in cyanotic patients

INTRA-OP
- Ensure bubbles are removed from the IV lines and the air is removed from the injection ports
- Patient population is at higher risk for air embolism.
- Add IV extensions: the bed will be moving up and down and the fluoroscopy machine will be between the IV pole and the bed.
- Invasive monitoring: a femoral line is placed by the cardiologist and at times a jugular line is placed depending on the procedure and the cardiac anatomy
- Induction: if pulmonary hypertension, avoid myocardial depression and sudden changes in SVR/PVR
- Typically the patient will be on room air at the start of the case after the induction so that blood gas measurements can be done.
- Maintain normocarbia for accurate hemodynamic and blood gas calculations.
- Pressors should be available at all times. It is suggested to have set up:
  - Epinephrine: 1 amp (1mg) into 9cc NS (100mcg/cc), then 1cc of that into 9cc NS (10mcg/cc), then 1cc of that into 9cc NS (1mcg/cc)
    - Ensure that the syringe with 100mcg/cc is removed from the anesthesia drug cart
    - Dose: 1-10mcg/kg
  - Phenylephrine: 1amp (10mg) in 250cc NS (40mcg/cc), then 1cc into 9cc of NS (4mcg/cc)
    - Dose: 1-2mcg/kg
EMERGENCE:
- Ensure that the groin has been compressed long enough after the line was removed prior to waking up the patient.
- Coughing will increase the risk of a hematoma. Discuss with the cardiologist about the timing. If the patient is a good candidate, a deep extubation could be considered.
- ICU monitoring: Intra-op hemodynamic or rhythm disturbances, ongoing shunt imbalance with hypoxemia and poor systemic perfusion

Reference

BLOOD PRODUCT TRANSFUSION GUIDELINES:

ESTIMATES OF CIRCULATING BLOOD VOLUME:

<table>
<thead>
<tr>
<th>Category</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>60-70 mls/kg</td>
</tr>
<tr>
<td>Child</td>
<td>70-75 mls/kg</td>
</tr>
<tr>
<td>Infant (3mo-1yr)</td>
<td>70-80 mls/kg</td>
</tr>
<tr>
<td>Full term newborn</td>
<td>80-90 mls/kg</td>
</tr>
<tr>
<td>Prem</td>
<td>90-100 mls/kg</td>
</tr>
</tbody>
</table>

These numbers represent ranges that serve as guidelines only.
PRBCS

- Hct is now approximately 55% due to the addition of Adsol to CPD (that is why they are so slippery)
- Compatibility is as follows:

  A  
  O  AB (each can transfuse to itself)
  B

Beware of availability of particular blood groups: 0-46%. A-41%, B-9%, AB-4%

- To increase Hgb by 1gm/dl (10mg/L) or Hct by 0.03 transfuse 6 cc/kg (assuming no ongoing loss).
- Acceptable Hgb for 2000:
  - Neonate-Healthy require Hbg >80 mg/l (Hct-0.27)
  - critically ill Hgb> 100 (Hct -0.33)
  - If history of cyanotic heart disease then Hbg >140 (Hct-0.47)
  - Infant, child and adolescent - Healthy Hgb> 60-75 (Hct 0.20-0.25) and if critically ill Hbg >75-90 (Hct 0.25-0.30)

These are recommendations that have to be individualized according to the patient and that they are in keeping with normal urine output, normovolemia, no metabolic acidosis and normal mixed venous O2.

NEONATES:

- blood products should be CMV negative (very likely they have not been exposed) and irradiated.
- Avoid old blood near the expiry date (too much potassium)
- If anticipating massive transfusion in neonates, wash the cells and have them resuspended in normal saline to prevent hyperkalemia. This takes approximately one-half hour)
- Infants less than 4 months may receive either type specific or O negative; neonates are less likely to have a hemolytic reaction since they are unable to form alloantibodies to RBC antigens for the first few months.
- Filtration to leukocyte-deplete blood products prior to transfusion

IN MASSIVE TRANSFUSION SCENARIO (greater than 1 blood volume lost):
- Allowable blood loss: \((\text{Hct initial} - \text{Hct final})/\text{Hct initial} \times \text{EBV}\).
- Replace losses with crystalloid or colloid (your choice), but once replacement with crystalloid has reached 100 cc/kg (50cc/kg in critically ill) or blood loss approximately 1-1.5 blood volumes (0.5 to 1 BV in critically ill), anticipate a possible dilutional coagulopathy and get FFP thawing (takes 30 minutes).
- In iatrogenic blood letting (e.g. scoliosis repair) dilutional coagulopathy is due to factors at approximately 1-1.5 blood volumes lost and 1.5-2 blood volumes for plts.
- In neonates who are healthy, mix blood with colloid or crystalloid 1:1 (Hct-0.27) or if ill 2/3:1/3 (Hct-0.32). Consider mixing in same ratios with FFP if documented coagulopathy. As long as you are transfusing these reconstituted mixtures and the BP and CVP are maintained or the artline has minimal respiratory variations, you know that the minimal Hct possible in the neonate is that the blood you are transfusing. Easy or What?
- Advantages are that the calculations for your approach are made preop, rapidity of blood loss not a big deal (you only have to worry about where you are roughly with regards to blood volumes versus trying to match the blood loss...
recorded by the nurses) and you are in control: no guess work.

- **Mixing the blood** is made simple by drawing what you need from the bags via dispensing pins in a syringe and administering it through the "Hot Line". Note that packed cells, platelets, FFP and cryoprecipitate have to go through 170-260 microns filter.

- **If possible try not to use type 0 blood** in an emergency if it is not absolutely necessary because it is a product in high demand for 46% of the population which are group O. Conserve Rh- blood if possible; mainly use in potentially childbearing women or girls otherwise Rh+ blood should be okay even in a negative recipient because it will cause a mild delayed hemolytic reaction. This is especially true in the scenario of a massive transfusion in which there is a limited amount of Rh- blood available.

- **In the case of type AB patients undergoing massive transfusion**, one should default to type A blood because that will be the most available. Also, once massive transfusion has occurred, group AB recipients' plasma will become group A which should be plentiful in the blood bank.

- **Remember**, that not all alloantibodies cause clinically significant hemolytic reactions.

**MASSIVE TRANSFUSION COMPLICATIONS:**

- **Hypocalcemia:** from citrate toxicity when administering rapidly whole blood (yes, you do give it using donor-directed blood or autologous blood but it might come fractionated), FFP, PRBC or albumin. Calcium chloride 1 mg: 1cc blood solutions or calcium gluconate 1.5 mg: 1cc blood solutions.

- **During massive transfusion, consider starting dopamine** after 5 blood volumes lost and epinephrine after 10 blood volumes lost.
Hypotension is thought to be related to plasticizers in the blood bag.

- **Hypomagnesemia:** Citrate binds Mg, should be supplemented with magnesium sulfate 30 mg/kg IV slowly over a period of 30-40 minutes after 2 blood volumes lost.
- **Hyperkalemia:** highest levels in whole blood, irradiated blood and units near their expiration date. Often seen with hypovolemia/acidosis. Treatment includes calcium chloride, insulin/dextrose, hyperventilation, ventolin, kayexalate.
- **Hypothermia:** leads to platelet dysfunction, decreased drug metabolism/clearance, decreased CO, hypotension, arrhythmias, increased oxygen consumption (shivering) and leftward displacement of the oxyHgb dissociation curve
- **Dilutional coagulopathy**

**PLATELETS:**

- To increase platelet count by 50-70/mm³ (50-70 x 10⁶/liter) transfuse 0.2 units/kg.
- Acceptable PLT count for surgery is > 65,000/mm³
- Compatibility is the same as RBCs regarding ABO compatibility but it is not absolutely necessary.
- Should be CMV negative and irradiated for neonates
- Single donor units of PLTS is equivalent to 8 units. Use unconcentrated (has plasma with factors) if associated factor deficiency and use concentrated units (approximately 1/5th the volume) if concerned about fluid overload.
- In massive transfusions expect a significant decrease in platelets after 1.5 blood volumes lost. This depends on your starting platelet
count such that after 1 blood volume loss your count is 70% baseline, after 2 BV it is 40% and after 3 BV it is 20%. Therefore, you can anticipate when you will need platelets in an IATROGENIC BLOOD-LETTING VERSUS TRAUMA, in which case you may need platelets earlier.

- Remember, if you do not need your platelets right away when they are brought to you DO NOT put them in the freezer, but rather store them at room temperature.
- If transfusing more than 5 units of platelets at one time, will result in exposure to at least 5 more individuals platelets stored in many packs of 5 units for different donors).
<table>
<thead>
<tr>
<th>PLT (x10^9/L)</th>
<th>CLINICAL SETTING</th>
<th>SUGGEST</th>
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<tbody>
<tr>
<td>&lt;10</td>
<td>Immune thrombocytopenia</td>
<td>Transfuse plts only with serious bleeding</td>
</tr>
<tr>
<td>&lt;10</td>
<td>Non-immune thrombocytopenia</td>
<td>Transfuse 1 pool of plts</td>
</tr>
<tr>
<td>&lt;10</td>
<td>Non-immune thrombocytopenia &amp; HLA-alloimmunized</td>
<td>Transfuse 1 unit of HLA-matched apheresis</td>
</tr>
<tr>
<td>&lt;20</td>
<td>Non-immune thrombocytopenia &amp; fever &gt;38.5°C or coagulopathy</td>
<td>Transfuse 1 pool of plts</td>
</tr>
<tr>
<td>&lt;20</td>
<td>Procedures not associated with significant blood loss</td>
<td>Transfuse 1 pool of plts</td>
</tr>
<tr>
<td>20-50</td>
<td>Procedures not associated with significant blood loss</td>
<td>Transfuse 1 pool on hold, transfuse only if significant bleeding</td>
</tr>
<tr>
<td>&lt;50</td>
<td>Epidural anesthesia &amp; lumbar puncture</td>
<td>Transfuse 1 pool immediately before procedure</td>
</tr>
<tr>
<td>&lt;50</td>
<td>Procedures associated with blood loss or major surgery (&gt;500ml expected blood loss)</td>
<td>Transfuse 1 pool immediately before procedure</td>
</tr>
<tr>
<td>&lt;100</td>
<td>Pre-neurosurgery or head trauma</td>
<td>Transfuse 1 pool of plts</td>
</tr>
<tr>
<td>Any</td>
<td>Platelet dysfunction and marked bleeding (e.g. Post CPB, ASA, antiplatelet agents)</td>
<td>Transfuse 1 pool of plts</td>
</tr>
</tbody>
</table>

**FRESH FROZEN PLASMA**

**DOSE:** 10-15mL/kg: Small adult: 3 units, Large adult: 4 units

- Random donor plasma (250mL)
- Apheresis donors (500mL): equivalent to 2 units of random donor plasma
- Compatibility is the REVERSE OF PRBC: it takes 30 minutes to thaw and do not forget about citrate toxicity.
• Biological half life: factor VII (3-6hrs), factor
  VIII (8-12hrs), factors II and IX (2-3 days)
• Administer immediately before planned
  procedure.

CRYOPRECIPITATE

DOSE: 1 unit per 10kg of body weight, Small adult: 8
  units, Large adult: 12 units

• Contains Factor VIII, fibrinogen (150mg in
  each unit), and von Willebrand's factor
• Compatibility is the REVERSE OF PRBCs. ABO
  compatibility is preferred but not entirely
  necessary.
• Half life of fibrinogen is 7d.

INDICATIONS:
• Treatment of bleeding in patients with
  fibrinogen <0.8-1.0g/L
• Clinical status suggestive of low fibrinogen and
  unable to wait for result because of patient's
  condition
• Treatment of bleeding in a patient with von
  Willebrand's disease or hemophilia A (if DDAVP
  or factors unavailable).
TRANSFUSION REACTIONS

- Febrile non-hemolytic transfusion reaction: soluble factors-cytokines in the plasma of the component transfused or recipient antibodies, reactive to antigens expressed on cells in the component, usually WBC
- Acute hemolytic transfusion reaction: ex. ABO incompatibility, other blood group alloantibodies
- Delayed hemolytic transfusion reaction: formation of antibodies to transfused red cell alloantigens or from RBC antigen exposure during pregnancy
- Viral transmission
- Bacterial contamination
- Immunosupression
- Alloimmunization
- TRALI (transfusion related acute lung injury): bilateral interstitial and alveolar infiltrates without increased pulmonary pressures. Usually acute onset with symptoms up to 6hrs after start of transfusion. Symptoms include: dyspnea, hypoxemia, fever and hypotension.
- TACO (transfusion related circulatory overload): from impaired cardiac function or rapid rate of transfusion
- Allergic Reaction
<table>
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<tbody>
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<tr>
<td>1 in 100</td>
<td>Minor allergic rxn (urticaria)</td>
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<tr>
<td>1 in 300</td>
<td>Febrile non-hemolytic transfusion rxn per unit of RBC</td>
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<td>1 in 700</td>
<td>Transfusion-associated circulatory overload per transfusion episode</td>
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<tr>
<td>1 in 5000</td>
<td>Transfusion-related acute lung injury (TRALI)</td>
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<tr>
<td>1 in 7000</td>
<td>Delayed hemolytic transfusion reaction</td>
</tr>
<tr>
<td>1 in 10,000</td>
<td>Symptomatic bacterial sepsis per pool of 5 donor units of pltS</td>
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<tr>
<td>1 in 40,000</td>
<td>Death from bacterial sepsis per pool of 5 donor units of pltS</td>
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<tr>
<td>1 in 40,000</td>
<td>ABO-incompatible transfusion per RBC transfusion episode</td>
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<tr>
<td>1 in 40,000</td>
<td>Serious allergic reaction per unit of component</td>
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<tr>
<td>1 in 82,000</td>
<td>Transmission of hepatitis B virus per unit of component</td>
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<tr>
<td>1 in 100,000</td>
<td>Symptomatic bacterial sepsis per unit of RBC</td>
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<tr>
<td>&lt;1 in 1,000,000</td>
<td>Transmission of West Nile Virus</td>
</tr>
<tr>
<td>1 in 3,000,000</td>
<td>Transmission of HTLB per unit of component</td>
</tr>
<tr>
<td>1 in 3,100,000</td>
<td>Transmission of HCV per unit of component</td>
</tr>
<tr>
<td>1 in 4,700,000</td>
<td>Transmission of HIV per unit of component</td>
</tr>
</tbody>
</table>
PATIENTS AT RISK REQUIRING IRRADIATED PRODUCTS:
- Patients with congenital immunodeficiency states
- Intrauterine transfusions
- Neonatal exchange transfusions
- Pre-term infants
- Patients with hematological malignancies, including lymphoma
- Patients undergoing bone marrow transplants or stem cell transplants
- Solid organ transplant recipients
- Patients with solid tumors undergoing aggressive myeloablative chemo
- Recipients of directed transfusions from family members
- Patients treated with purine analogs

BLOOD CONSERVATION

GENERAL
- Good surgical technique
- Minimize blood sampling and loss
- Ensure anemic patients are prescribed iron:
  - Elemental iron: 150-200mg/d in adults, 6mg/kg/d divided into 3 doses in children
- Stop using anti-plt and anti-coagulants before major surgery
  - ASA: stop 7 days pre-op (48hrs min)
  - Plavix: stop 7 days pre-op (5 d min)
  - NSAIDS: stop 5 half-lives pre-op
  - Warfarin: stop 4 days pre-op

ACUTE NORMOVOLEMIC HEMODILUTION (ANH)
- Whole blood withdrawn when anesthesia is initiated and is replaced with crystalloid/colloid to maintain normovolemia
• Stored at room temp in OR on a continuous rocker
• Re-transfused after bleeding ceases or if Hgb low
• Medical literature is controversial about the safety and efficacy of ANH

CELL SAVER
• Patient’s blood is collected intraoperatively in a way that it can be re-infused
• **Contraindications**: malignant cells, bacterially contaminated fluid, ascetic fluid, amniotic fluid
• **Complications**: air embolism, thrombocytopenia, bacterial contamination, tumour dissemination, hemoglobinemia

PREOPERATIVE AUTOLOGOUS BLOOD DONATION
• **Eligible**: pts with 10% chance of blood exposure during elective surgery
• Should be collected between 21-34d pre-op
• **Contraindications**: recent MI or unstable coronary syndrome, stenotic valvular disease, anemia, bacterial infection
• Not without risk: iatrogenic anemia, surgery cancelled, bacterial contamination, technical error etc.

ERYTHROPOIETIN
• Stimulates erythropoiesis
• **Eligible**: pts with Hgb <130g/L and probability of requiring a blood transfusion of 10% or greater
• **Dose**: 600U/kg sc qweek for 4 doses starting 28d pre-op or 300U/kg sc qd x 15d starting 10d pre-op
• **Contraindications**: uncontrolled HTN; cardiac, peripheral vascular or cerebrovascular disease; hypersensitivity to mammalian-derived cell
products, albumin or other components of the product

ANTIFIBRINOLYTICS
- To prevent/treat increased fibrinolysis during surgery, esp. cardiac surgery
- Dose Cardiac Surgery:
  - Aprotinin: 1mU bolus, then 0.25mU/hr for duration of surgery, and 1mU added to pump prime
  - Transexamic acid: 50-100mg/kg +/- 2-4mg/kg/hr for duration of surgery
- Dose variable for non cardiac surgery
- Adverse effects:
  - Aprotinin: hypersensitivity reaction, renal dysfunction
  - Transexamic acid: GI upset

Reference


Online transfusion course:
www.sunnybrook.nextmovelearning.com
**PAIN MANAGEMENT**

**POST OP PAIN ASSESSMENT**

CHEOPS PAIN SCALE:
Choose the one behavior from each of the 5 categories that you feel applies best to the present state of the patient. Add up the score and record the total.

**Modified CHEOPS**

Children's Hosp. Of Eastern Ontario Pain Scale  
Best =0  Worst=2

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cry</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>No Cry</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Moaning / Crying</strong></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Scream</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Facial Expression</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Smiling</strong></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Composed</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Grimace</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Verbal:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Positive</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>None or other complaint</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Pain complaint</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Torso</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neutral</strong></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Shifting/tense/upright</strong></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Pain Complaint</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Legs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neutral</strong></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Kick,Squirm,Drawn-up</strong></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Restrained</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
SEDATION SCALE:
S = Sleep, Easy to Arouse
1 = Awake and Alert
2 = Slightly drowsy, Easily Aroused
3 = Frequently drowsy, Arousable, Drifts off to sleep during conversation
4 = Somnolent, Minimal or no response to physical stimulation

THE VISUAL ANALOG SCALE (VAS)/ NUMERICAL RATING SCALE (NRS)

The VAS measures the strength of a child’s pain experience. It is generally used with children from 5-17 years old.

The child is asked to “rate their pain from 0-10, with …….. of 0 (no pain) and 10 (worst paint imaginable).
# PREMATURE INFANT PAIN PROFILE (PIPP)

<table>
<thead>
<tr>
<th>Corrected Gestation</th>
<th>Baseline Behavioral State</th>
<th>Heart Rate</th>
<th>Brow Bridge</th>
<th>Nose/Oral</th>
<th>Eye Squeeze</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>26-36 weeks</td>
<td>active/awake</td>
<td>0-4 bpm increase</td>
<td>None</td>
<td>Minimum</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>32-35 weeks</td>
<td>quiet/awake</td>
<td>5-14 bpm increase</td>
<td>0-2% decrease</td>
<td>Moderate</td>
<td>Minimum</td>
<td>3</td>
</tr>
<tr>
<td>26-31 weeks</td>
<td>quiet/awake</td>
<td>15-24 bpm increase</td>
<td>3-4% decrease</td>
<td>Moderate</td>
<td>Minimum</td>
<td>4</td>
</tr>
<tr>
<td>&lt;26 weeks</td>
<td>quiet/awake</td>
<td>&lt;25 bpm increase</td>
<td>5-7% decrease</td>
<td>Maximum</td>
<td>Maximum</td>
<td>5</td>
</tr>
</tbody>
</table>

**Pipp Score Interpretation:**
- 0-6: No/Painful
- 6-12: Moderate Pain
- >12: Severe Pain

If max. # observed: score 0.1 x max. score to a denominator of 2.
<table>
<thead>
<tr>
<th>Date</th>
<th>Pain Score (0-10)</th>
<th>Respiratory Rate</th>
<th>Narcotic (mg)</th>
<th>PMMA</th>
<th>Sedation Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

**PAIN ASSESSMENT FLOW SHEET**
<table>
<thead>
<tr>
<th>Scale Legend for Pain Assessment Flow Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1:</td>
</tr>
<tr>
<td>Example 2:</td>
</tr>
<tr>
<td>Example 3:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 4:</td>
</tr>
<tr>
<td>Example 5:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 6:</td>
</tr>
<tr>
<td>Example 7:</td>
</tr>
</tbody>
</table>

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REGIONAL ANESTHESIA IN CHILDREN

Most regional anesthesia procedures are performed under GA unless the patient is mature enough to understand and is able to sit still with sedation and assistance.

Spinal Analgesia:
CSF IN CHILDREN:
- The volume is doubled compared to adults
- 50% of the total volume is in the subarachnoid space as compared to 25% in adults
- The hydrostatic pressure is lower in the dorsal recumbent position compared to adults

EQUIPMENT:
22-25 G 1-1/4 inch spinal needle

TECHNIQUE:
- A full aseptic technique is required.
- Spinal cord ends @ L1 at 1 yr and @ L3 in newborn. The 3-4 or 4-5 lumbar interspace should be chosen, never higher.
- Sitting position may help improve CSF hydrostatic pressure and flow
- Be careful with positioning; keep neck extended to avoid A/W obstruction.
- Some suggest leaving needle in for 5 sec to prevent backflow.
- Place monitors on the lower limbs so neonate is undisturbed during the surgical procedure.

DRUGS:
Neonates and Infants:
Tetracaine 20 mg powder diluted in 2 mls 10% dextrose and drawn up in a TB syringe will yield a solution where 0.1 ml = 1 mg
Use dose of 1.0 mg/kg +/- 5 mcg Epinephrine or Epi rinse
Bupivacaine 0.5% in a dose of 0.1 ml/kg

**Usual doses of local anesthetics for spinal anesthesia in children**

<table>
<thead>
<tr>
<th>Local Anesthetic</th>
<th>0-5 kg</th>
<th>5-15 kg</th>
<th>&gt;15 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain tetracaine (1%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose (mg/kg)</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Volume (mL/kg)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Duration (min)</td>
<td>75</td>
<td>80</td>
<td>85</td>
</tr>
<tr>
<td>Tetracaine (1%) with epi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose (mg/kg)</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Volume (mL/kg)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Duration (min)</td>
<td>120</td>
<td>120</td>
<td>125</td>
</tr>
<tr>
<td>Bupivacaine (0.5%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose (mg/kg)</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Volume (mL/kg)</td>
<td>0.1</td>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td>Duration (min)</td>
<td>65-75</td>
<td>70-80</td>
<td>75-85</td>
</tr>
</tbody>
</table>


**INTRATHECAL MORPHINE**
- 5-20mcg/kg
- Dose dependent on staff anesthetist

**COMPLICATIONS:**
- Most common is a failed block
- Autonomic nervous system not well developed in infants and young children, little vagal activity, therefore minimal hemodynamic compromise.
- Avoid lifting legs for cautery pad post injection, especially if hyperbaric solution, to avoid a “total spinal”.
- Rare: meningitis, neurologic sequelae, PDPH
Caudal Analgesia:

TECHNIQUE:
- sterile
- 22-25G needle
- Knee to chest lateral position
- Landmarks: the cornu of the sacral hiatus
- Pierce the sacrococcygeal membrane at 45-75 degree angle to the skin, redirect rostrally at 20-30 degree angle to the skin and advance 2-3mm into the sacral canal
- Give a test dose

ARMITAGE FORMULA
- 0.5mL/kg for T12-L1 block
- 1mL/kg for T8-T10 block
- 1.25mL/kg for T4-T6 block

Maximum of 20mL

BUPIVACAINE PLAIN 0.25% WITH OR WITHOUT EPINEPHRINE
- Circumcision or Hypospadia:
  - Required level of block is L5 to S5
  - Use 0.5 ml/kg or 1 ml/yr
- Herniorraphy or Orchidopexy:
  - Required level of block is T9 to S5
  - Use 1.0-1.5 ml/kg + slight Trendelenburg
- Maximum dose of Bupivacaine is 20 mls. If further volume is required to get a higher block, dilute with 0.9% saline.
- The caudal block cannot be recommended for higher blocks, as toxic doses of local anesthetics are required, unless a catheter is threaded by this route.

Please discuss the dosages with attending staff.

ROPIVACAINE
- In healthy human adult volunteers, intravenous ropivacaine causes fewer central nervous system and cardiovascular toxicity symptoms and appears 25% less toxic than bupivacaine at the maximum tolerance dose.
- Pharmacokinetic profile after a single lumbar and caudal epidural injection in children over 3 months is similar to adult except for time to peak effect. The time to peak venous plasma concentration was longer in children, median 60-90 minutes, versus 25 minutes in adults.
- The clearance is slower in infants less than 1 year old.
- Typically, we use same volume of 0.2% ropivacaine as 0.25% bupivacaine +/- Epinephrine.
- Ropivacaine is believed to have some epidural vessel vaso-constrictive properties.

**CAUDAL MORPHINE**
- Dose: 30-50mcg/kg
- Cardiac surgery: 75-150mcg/kg
- In-patients only

**CONTRAINDICATION**
- Local and systemic sepsis
- Coagulopathy
- Increased ICP
- Meningomyelocele
- Active neurological disease
- Uncorrected hypotension
- Abnormality of sacrum

**COMPLICATIONS**
- Intrathecal/subdural injection
- IV/IO/SC injection
- Incomplete block
- Infection
- Urinary retention
- Neurological injury
- Soft tissue injury

**Epidural Analgesia**

Epidural analgesia can provide excellent postoperative analgesia for children undergoing thoracic, abdominal and lower extremity surgery. The proposal to use this technique should be discussed with the parents. In addition 5E needs to be notified prior to insertion to ensure appropriate nursing staff is available.

**EQUIPMENT:**

- Two sizes of catheters are available:
  - 20G catheter passing through a 18G needle (up to 10kg)
  - 19G catheter passing through a 17G needle (>10kg)
- The epidural kits also contain a loss of resistance syringe, a filter and a catheter connector.
- You will also need a pink 18G needle, an ampoule of 0.9% saline, 0.2% ropivacaine and a 10 mls syringe.

**TECHNIQUE:**

- Aseptic technique with gloves.
- The back should be prepared using a chlorhexidine based prep solution.
- Infiltrate with local anesthetic if awake
- Tip of the Touhy needle inserted midline and the supraspinous ligament should be identified.
- The distance between skin and the epidural space in infants may be as little as 5 mm.
- Once in the supraspinous ligament remove the stylet and connect the saline filled loss of resistance syringe.
• Resistance to injection of saline is much greater resulting in a more accurate endpoint, and LOR to saline is mandatory.
• Whatever technique is employed the pressure on the loss of resistance syringe must be continuous whilst advancing the needle.
• The catheter should be threaded in the usual manner with at least 4 cm being left in the epidural space.
• Children, especially infants, are very mobile following surgery; this results in repeated extension and flexion of the lumbar spine, the consequence being extrusion of short lengths catheters.
• Furthermore, because the distance between the skin and epidural space is smaller, catheters left in only a very short distance appear to leak around the skin insertion site.
• The use of epidural analgesia in neonates has been facilitated by the discovery that a catheter can be reliably threaded to the thoracic region from a caudal approach in neonates. It tends to be quite reliable in infants less than 5 kg. Placement can be verified by using a Tsui technique.

CATHETER FIXATION:
• The catheter is brought caudally gently curved so that it lies in a cephalad direction and steristrips and a transparent occlusive dressing, i.e. tegaderm, is applied. White paper tape is applied around the transparent dressing and over the catheter up the back to the shoulder.
• This white paper tape is then gently rubbed with an alcohol wipe to stick better to the skin.
• Discuss test dose and local anesthetic dose for bolus and continuous infusion with staff.
EPIDURAL ON WARD:

The epidural infusions on the wards will have pre-prepared syringes: 0.1% ropivacaine with 1:400,000 epinephrine and 2 mcg/ml of Fentanyl.

The maximum infusion rate:
- 0.4 ml/kg/hr for children
- 0.2 ml/kg/hr for neonates

This should be lowered as tolerated during the first several days of infusion.

Patients will be monitored for 4 hours after removing the epidural catheter if the continuous infusion included epidural Fentanyl.

Absolutely no other narcotics while receiving epidural narcotics unless ordered by anesthesia.

Anti-emetic orders, and any other medications, are written on the Epidural Medication Order Sheet.
PATIENT CONTROLLED ANALGESIA (PCA)

PCA is available to children over 6 (exceptionally 5) years of age.

Ensure patient has received an IV loading dose prior to initiating IV PCA.

Morphine is used as the drug of choice to provide post-operative pain relief, which should be diluted as Morphine sulphate 1 mg/ml. Currently there is no Dilaudid PCA available from the pharmacy.

Some centers use nurse or parent controlled analgesia however this is not being used at CHEO at this time. Education about PCA is key. Instruct that the children should press the button whenever they start to feel pain and to not wait until they have severe pain. The parents should understand that only the child should decide when to push the button for a dose of medication. This gives the child a sense of control.
**IV PCA GUIDELINES:**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Basal Rate (mcg/kg/hr)</th>
<th>Bolus Rate (mg/kg)</th>
<th>Lockout Interval (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td>(10-30 mcg/kg/hr)</td>
<td>0.01-0.03</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td>usually start with 20</td>
<td>(10-30 mcg/kg)</td>
<td>usually 6-8</td>
</tr>
<tr>
<td></td>
<td>mcg/kg/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fentanyl</td>
<td>(0.5 mcg/kg/hr)</td>
<td>0.0005-0.001</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.5-1.0 mcg/kg)</td>
<td></td>
</tr>
<tr>
<td>Dilaudid</td>
<td>(1-4 mcg/kg/hr)</td>
<td>0.004mg/Kg</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4mcg/kg)</td>
<td></td>
</tr>
</tbody>
</table>

NB  No background infusion unless OK’d by staff anesthesiologist.
POST OP PAIN MANAGEMENT PROTOCOL FOR COVERAGE OF EPIDURALS AND PCA'S ON THE WARD

- The billing and order sheets for PCA and epidurals are filled by the person who initiated the PCA or the epidural.
- The person who is coming off-call should do Pain Rounds prior to Resident morning Rounds before 7:30 am and thus be ready for AM hand over.
- Any issues, problems and specific treatment plans should be discussed by the team on AM rounds with the attending anesthesiologist. A second round in the evening will be done by the resident on call.
- The resident on call deals with "troubleshooting" PCA's and epidural-related calls during the day.
- Any new PCA's and epidurals started in the OR during the day should be properly handed over to the resident on call.
- A progress note sheet dedicated to the PCA or epidural is at the bedside on a clipboard, together with nursing notes and pain scores. A short progress note is written during each visit.
- When it is appropriate to discontinue PCA therapy, the resident will write an order to that effect on the chart.
- The resident will also ensure that all forms have been completed, and that correct copies have been placed on the chart and in the anesthesia lounge.
- Please record all visits to patients on the pain sheets and in the chart.
- Please do not order IM medication orders.
BILLING PROCEDURES:

When filling out PCA sheets please make sure:

- There is a PCA order sheet and a PCA consultation/follow up sheet stamped with addressograph information.

- There is an ANESTHESIA BILL (stamped with addressograph information)- 2 bills if the patient is going to be in the ICU.

- The name of the STAFF ANESTHETIST is on the PCA consultation/follow up sheet.

- The name of the STAFF SURGEON or STAFF PEDIATRICIAN (if it’s a medical patient) is on the PCA consultation/follow up sheet.

- There is a DIAGNOSIS/SURGICAL PROCEDURE recorded on the PCA consultation/follow up sheet- there has to be a reason for why the Anesthesia department is being consulted to provide pain management.

- If the patient spends time in the ICU you need to record the fact that you made visits there. For spinal fusion patients, record the ADMIT AND DISCHARGE DATES FROM THE ICU on the PCA consultation/follow up sheet.

- Residents please note that you are expected to make a MINIMUM of TWO VISITS/DAY. The DATE and TIME of each visit MUST be recorded on the PCA consultation/follow up sheet.
• It’s nice if you write the name of the staff person and referring surgeon on the actual bill, but don’t get carried away with recording information because the space on the bill is needed for recording visits and times. Since bills can get lost or forgotten, it is more important to have the information on the PCA consultation/follow up sheet.

• As a courtesy to your colleagues, it is also helpful to have the ward (and room number, if you know it) recorded on the PCA consultation/follow up sheet so that the residents can find the patients easily when they make their follow up visits.

When filling out consults please make sure:

• An ANESTHESIA BILL is stamped up at the same time you fill out the consult.

• The name of the STAFF ANESTHETIST is recorded on the consultation- this is usually the staff person with whom you discuss the consult.

• The name of the STAFF SURGEON or STAFF PEDIATRICIAN is recorded on the consultation.

• You will have to ask or look at the chart as most consults are filled out by residents, especially on the medical wards. Medical wards are run by teams- Red Team, Blue Team, Purple Team- do NOT put the team name on the consult.
- This is not acceptable for medicolegal purposes - we need the name of the responsible, referring STAFF PHYSICIAN.

- You MUST SIGN and DATE your consults. Ideally, you bring the entire consult to the staff person, discuss the consult, they countersign it and then the yellow copy goes to the chart and the white copy, along with the bill, goes to the staff anesthetist. Please PRINT YOUR NAME legibly under your signature so we know who filled out the consult.

- If the consult is filled out for a TRAUMA CODE or you perform a PROCEDURE (e.g. iv insertion, sedation for a chest tube), you need to record the TIME you arrived/started and the TIME you finished - similar to what is done for an anesthetic. Having this information saves hours of work as it is always more difficult to get the information after the fact.
ANESTHESIA EMERGENCY BOX
It contains some resuscitative drugs and some basic airway equipment. It is located in the hallway of the anesthesia offices beside the lounge.

Please replace anything you remove from it before you place it back on the shelf.

ANAPHYLAXIS

Triad of Hypotension, Wheezing, Hives is diagnostic

SIGNS OF ACUTE ANAPHYLAXIS

1. Cutaneous – Hives
   Angioedema, Erythema, Peri-orbital / facial edema

2. Respiratory
   Increased Paw, decreased SpO2, perioral/intraoral edema, stridor, retractions, cyanosis, tachypnea, wheezing, decreased pulmonary compliance, pulmonary edema, laryngeal edema

3. Cardiovascular
   Decreased BP, increased HR, arrhythmias, diaphoresis, cardiac arrest

ETIOLOGIC AGENTS

1. Barbiturates
   STP, Methohexital
2. Muscle Relaxants
   Succinylcholine, Pancuronium, Atracurium, Gallamine
3. Antibiotics
   Penicillin, Cephalosporins, Vancomycin
4. Local Anesthetics
The preservative Methylparaben, metabolites related to paraaminobenzoic acid
5. Latex
6. Iodinated contrast material
7. Protamine
Blood and blood products

MANAGEMENT OF ANAPHYLAXIS UNDER GENERAL ANESTHESIA

Stop administration of antigen if known
Call for HELP!!!
Maintain airway with 100% O₂
Discontinue ALL anesthetic agents if hypotension
Start intravascular volume expansion minimum initial 20ml/kg NS, repeat as necessary

Treat Hypotension:
- **Epinephrine** drug of choice
- Mild-Moderate decrease BP - 0.1 µg/kg to 1µg/kg bolus
- Severe decrease BP/Cardiovascular Collapse - 3-15 µg/kg bolus
- Infusion 1 to 15 µg/kg/min as needed to maintain BP

Give Antihistamines:
- Diphenhydramine *(Benadryl)* 1-2 mg/kg IV
- **Ranitidine** *(Zantac)* 0.5 mg/kg IV

Give Steroids:
- **Hydrocortisone** *(Solu-Cortef)* 5-10 mg/kg
- OR Methylprednisolone *(Solu-Medrol)* 15-20 mg/kg IV

Give Bicarbonate
- 0.5 - 1mEq/kg IV as needed for persistent acidosis

Reassess vital signs frequently
Plan for ICU, monitoring, airway evaluation prior to extubation, lab tests- ABG, lytes, Cr, Ca, Mg, PO$_4$, +/- RAST test at later date. Remove all latex products

**BRONCHOSPASM**

**DEFINITION**
Reversible narrowing of medium and small airways due to smooth muscle contraction

**ETIOLOGY**
Asthma, COPD/BPD with a reactive component, airway irritation, medication

**TYPICAL SITUATIONS**
- Patients with known asthma, chronic lung disease or recent URTI
- Mechanical irritation of the airway, i.e. placement of oral airway, intubation or endobronchial intubation.
- Chemical irritation of the airway, i.e., pungent anesthetic gases, soda lime dust, smoke inhalation
- Administration of drugs that can precipitate bronchospasm, i.e. histamine releasers anticholinesterases, β-antagonists
- Aspiration of gastric contents
- Pulmonary embolism

**DIFFERENTIAL DIAGNOSIS**
- Aspiration of gastric contents
- Kinked or obstructed ETT
- Pneumothorax
- Pulmonary Edema
- Pulmonary Embolism
- Endobronchial intubation
- Anaphylaxis/anaphylactoid reactions
- Air trapping
PREVENTION:
- Avoid anesthesia and elective surgery in high risk patients: acute URTI, poorly controlled asthma or COPD
- Ensure optimization with bronchodilators and/or steroids prior to anesthesia and have patients continue their medications until the time of surgery
- When proceeding consider regional anesthesia, avoid using drugs that may exacerbate the condition.
- Remember ketamine is a bronchodilator
- Ensure patient has reached an appropriate depth of anesthesia before manipulating the airway
- Consider adding lidocaine IV 1.5mg/kg 1-3 minutes prior to intubation and/or extubation
- Avoid desflurane, consider using sevoflurane or halothane preferentially because they are less pungent

MANIFESTATIONS
- Increased PIP
- Audible wheeze, especially during expiration (Note: wheeze will disappear if bronchospasm becomes severe and there is little to no air movement)
- Decreased pulmonary compliance
- Decrease O2 Saturation
- Decreased tidal volume
- Hypercarbia: Note: EtCO2 may be decreased or absent if bronchospasm is severe and there is little or no gas flow, or if cause is endobronchial intubation

MANAGEMENT
ENSURE ADEQUATE OXYGENATION
AND VENTILATION:
• Increase FiO2 to 100% if O2 Sat is compromised
• Ventilate patient by hand: Feel the pulmonary compliance, may reduce peak airway pressure
• **CALL FOR HELP in any difficulty** maintaining saturation / ensuring ventilation

**VERIFY DIAGNOSIS OF BRONCHOSPASM**
• Auscultate the chest
• Check position, placement and patency of ETT
• Pass a suction catheter down ETT
• If in doubt about ETT, consider replacing it

**FOR MILD TO SEVERE BRONCHOSPASM**
• Remove any airway irritant, if possible
• Increase anesthetic depth with a volatile agent if patient will tolerate.
• Administer β-agonist via metered-dose inhaler into the circuit:
• Note: May need large dose when given via ETT
  Salbutamol 4-8 puffs

**FOR MODERATE TO SEVERE BRONCHOSPASM**
• As per mild bronchospasm then:
• Continue with salbutamol up to 12 puffs unless there is severe tachycardia
• Consider nebulized β-agonist via ETT
• Initiate IV Therapy:
  o Epinephrine IV 0.1mcg/kg bolus
  o Corticosteroids: Methylprednisolone IV 1mg/kg q6h
  o Consider H1 and H2 antagonists if histamine release or anaphylaxis suspected:
    Ranitidine !V 1mg/kg a12h and Diphenhydramine 1V 1-2 mg/kg q6h
  o Consider repeat Epinephrine boluses or infusion
• Stop the surgical procedure as soon as possible
If still can’t ventilate:
  o Arrange for ICU ventilator, or transfer patient to ICU setting for ongoing management

EMERGENCY THERAPY FOR MALIGNANT HYPERTHERMIA

MANIFESTATIONS
  • unexplained tachycardia
  • increased ETCO2
  • increased heat in soda lime container
  • muscle rigidity
  • hyperthermia (late manifestation)
  • cyanosis
  • metabolic acidosis
  • hyperkalemia
  • elevated CK
  • myoglobinuria

ACUTE PHASE TREATMENT:

1. Get Help, get Dantrolene
   Immediately discontinue all volatile inhalation anesthetics and succinylcholine. Hyperventilate with 100% oxygen at high gas flows: at least 10 L/min. The circle system and CO₂ absorbent need not be changed.

2. Administer dantrolene sodium 2.5 mg/kg bolus rapidly
   Continue bolus administration as needed until signs of MH (e.g. tachycardia, rigidity, increased endtidal CO₂ and temperature elevation) are controlled. Occasionally, a total dose greater than 10 mg/kg may be needed. Each vial of dantrolene contains 20 mg of dantrolene and 3 grams mannitol. Each vial should be mixed with 60 mL of sterile water for injection USP without a bacteriostatic agent.
3. Administer bicarbonate
To correct metabolic acidosis as guided by blood gas analysis. In the absence of blood gas analysis 1-2 mEq/kg should be administered.

4. Simultaneous with the above
Actively cool the hyperthermic patient. Use IV cold saline (NOT Ringer's lactate) 15 mL/kg q 15 min X3
Lavage stomach, bladder, rectum and open cavities with cold saline as appropriate
Surface cool with ice and hypothermia blanket
Monitor closely since over vigorous treatment may lead to the hypothermia.

5. Dysrhythmias
Will usually respond to treatment of acidosis and hyperkalemia. If they persist or are life threatening, standard anti-arrhythmic agents may be used with the exception of calcium channel blockers (may cause hyperkalemia and CV collapse)
May use procainamide or lidocaine

6. Determine and monitor
End-tidal CO₂, arterial, central or femoral venous blood gases, serum potassium and other electrolytes, urine output, PT/PIT and calcium for baseline values. Repeat as clinically indicated

7. Hyperkalemia
Is common and should be treated with hyperventilation, bicarbonate, intravenous glucose and insulin (10 units regular insulin in 50 mL 50% glucose titrated to potassium level or 0.15 u/kg regular insulin in 1 mL/kg 50% glucose)

Life-threatening hyperkalemia may also be treated with calcium administration (e.g. 2-5 mg/kg or CaCl₂)
Check blood glucose every two hours if insulin has been given.

8. **Ensure urine output**
   Of greater than 2 mL/kg/hr by hydration and/or administration of mannitol or furosemide. Consider central venous or PA monitoring because of fluid shifts & hemodynamic instability that may occur.

9. **Sudden unexpected cardiac arrest in children**
   Children less than about 10 year of age who experience sudden cardiac arrest after succinylcholine in the absence of hypoxemia and anesthetic overdose should be treated for acute hyperkalemia first. In this situation calcium chloride should be administered along with other means to reduce serum potassium. They should be presumed to have sub-clinical muscular dystrophy and a neurologist should be consulted.

**POST ACUTE PHASE**

- Observe the patient in an ICU setting for at least 24 hours since recrudescence of MH may occur.
- Administer dantrolene 1mg/kg or more q 4-6 hours for 24-48 post episode.
- Follow ABG, CK, potassium, urine and serum myoglobin, clotting studies and core body temperature until such time as they return to normal values (e.g. q6 hours). Central temperature (e.g. Rectal, esophageal) should be continuously monitored until stable.
- Counsel the patient and family regarding MH and further precautions. Refer the patient to MHAUS.
- Fill out an Adverse Metabolic Reaction to Anesthesia (AMRA) report available through
MHAUS. A letter to the patient’s primary care doctor is advised.

CAUTION: This protocol may not apply to every patient and may require alteration according to specific patient needs.

References:

TRAUMA TEAM ACTIVATION

A Trauma Code will be called by the Emergency Department Physician or Nurse in Charge (in collaboration with the physician) when a patient meets the Trauma Team Activation Guidelines:

1. Is en route from scene as per notification from Ambulance Dispatch (Pager will read 1111 - ETA)
2. Presents to the ED without notice (walk-ins) (Pager will read 1111 - 00)
3. Is expected in transfer from a referring hospital (Pager will read 1111 - ETA)

The Emergency Department Physician or Nurse in Charge will activate the trauma team by calling switchboard and saying “Trauma Code One Emergency...” and then the time in minutes. The page will go out to the appropriate pagers as 1111 - ETA in minutes. For example, if the patient is already in the ED, the page would read 1111 - 00 or if the patient was expected in a ½ hour, the page would read 1111 - 30.

The TTL on call will respond to the Trauma Code page by promptly calling the ED to acknowledge receipt of the page and to learn critical details about the trauma patient. He/she may also be available for immediate consultation via telephone for the CHEO ED Physician or referring hospital physician. The TTL will then proceed directly to the ED (1111 - 00) to arrive in no less than 30 minutes or within 5 minutes of the patient’s arrival.

All Residents/Fellows (Surgery, Anesthesia, ICU) and Respiratory Therapists who receive the page should
proceed immediately to the ED (1111-00) or within 5 minutes of patient arrival (1111-ETA).

The Staff person on call for the various services who receives the Trauma Code page may or may not proceed directly to the ED. They may await contact from their resident prior to deciding if their presence is required.

Radiology Technicians who receive the page will be prepared to proceed immediately to the ED once notified of patient age and films required by the TTL or ED Physician.
**ANTIBIOTIC DOSING**

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>DOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
<td>50mg/kg IV q6hrs</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>25mg/kg IV q8hrs (max 1gm)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>7.5-10mg/kg IV q8hrs</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>10mg/kg IV q6-8hrs</td>
</tr>
<tr>
<td>Flagyl</td>
<td>15mg/kg IV loading 7.5mg IV q6-8hrs</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>2.5mg/kg IV - Preterm &lt;1000g q 24hrs</td>
</tr>
<tr>
<td></td>
<td>&gt;1000g q12hrs</td>
</tr>
<tr>
<td></td>
<td>-Term /postnatal age &gt;7d q12hrs</td>
</tr>
<tr>
<td></td>
<td>-Children q 8hrs</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>10mg/kg IV q6hrs over 60min</td>
</tr>
</tbody>
</table>

*These doses were confirmed with the CHEO pharmacy and assuming the kidney function is normal.*
<table>
<thead>
<tr>
<th>Dose</th>
<th>Maximum frequency 8 hourly (Max 4 mg)</th>
<th>Maximum frequency 8 hourly</th>
<th>Maximum frequency 8 hourly</th>
<th>Maximum frequency 8 hourly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ondansetron</strong></td>
<td>0.1 mg/kg IV</td>
<td>0.5 - 1 mg/kg IV</td>
<td>1 mg/kg PR, not in children &lt;10 kg</td>
<td>Max 4 mg</td>
</tr>
<tr>
<td><strong>Gravol</strong></td>
<td>0.15 mg/kg IV</td>
<td>0.1 - 0.25 mcg/kg/hr</td>
<td>0.1 - 0.25 mcg/kg/hr</td>
<td></td>
</tr>
<tr>
<td><strong>Dexamethasone</strong></td>
<td>0.1 - 0.25 mcg/kg/hr</td>
<td>0.1 - 0.25 mcg/kg/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Naloxone infusion</strong></td>
<td>0.1 - 0.25 mcg/kg/hr</td>
<td>0.1 - 0.25 mcg/kg/hr</td>
<td>Used by heme often for oncology and sickle cell pts</td>
<td></td>
</tr>
</tbody>
</table>
ANTI-PRURITIC
Consider switching opioid
Exclude other causes (i.e. Drug allergy)

- Use anti-pruritic:
  - Diphenhydramine 0.5mg/kg PO/IV q6hrs
  - Nalbuphine 10-20mcg/kg IV q 6hrs
  - Hydroxyzine 0.5-1mg/kg PO q 6hrs
    - Adults: 25-75 mg/kg PO q 6hrs
  - Naloxone infusion 0.1-0.25mcg/kg/hr IV
    (usually only on hematology ward, however check with nurse in charge)

CONSTIPATION
- Docusate: Child 10-40mg PO daily
  - Adult 50-200mg PO daily
- Dulcolax: Child 5mg PO/PR daily
  - Adult 10mg PO/PR daily
# MUSCLE RELAXANTS

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succinylcholine</td>
<td>1-2 mg/kg</td>
</tr>
<tr>
<td>Cis-Atracurium</td>
<td>0.08-0.1 mg/kg</td>
</tr>
<tr>
<td>Pancuronium</td>
<td>0.1 mg/kg</td>
</tr>
<tr>
<td>Rocuronium</td>
<td>0.5-1 mg/kg</td>
</tr>
<tr>
<td>Mivacurium</td>
<td>0.25 mg/kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preparation</th>
<th>20 mg/ml</th>
<th>10 mg/ml</th>
<th>2 mg/ml</th>
<th>10 mg/ml</th>
</tr>
</thead>
</table>

**MUSCLE RELAXANT REVERSAL AGENTS**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>0.02 mg/kg IV</td>
</tr>
<tr>
<td>Glycopyrrolate</td>
<td>0.01 mg/kg</td>
</tr>
<tr>
<td>Neostigmine</td>
<td>0.07 mg/kg</td>
</tr>
<tr>
<td>Edrophonium</td>
<td>0.5-1 mg/kg</td>
</tr>
</tbody>
</table>

**NEBULIZED AGENTS**

**RACEMIC EPINEPHRINE**

- 0.5 cc diluted in 2 cc NS
- Monitor during administration. Stop if HR > 200/min or if dysrhythmias are seen.

**LIDOCAINE SPRAY**

- 10% solution
- metered dose = 10 mg lidocaine per puff max.
  dose = 3 mg/kg

**SALBUTAMOL**
- respir. Solution = 0.5% = 5 mg/ml to be diluted to 2-3 mls total volume with 0.9% saline
- **Dose:** 6 mo. - 1 year: 2.5 mg; 1 -7 yrs: 5.0 mg; over 7 yrs: 5.0 mg
- All doses 4-6 hourly as required. May be needed continuously in ICU setting.

**NSAID’S**

- **IBUPROFEN**
  - Dose: 4-10 mg/kg/dose q 6-8 hrs PO prn, max. 1.2 g/day
  - Adults (>60kg): 400-600mg PO q6hrs

- **INDOMETHACIN**
  - Dose: 1-3 mg/kg/day PO divided TID, **NOT** to exceed 200 mg/day PO/PR
  - Adults (>60kg): 25-50 mg PO BID-TID

- **KETOROLAC**
  - Dose: 0.5 mg/kg/dose IM/IV as a single dose
  - Adults and children > 16 yrs and > 50 kg, 30 mg/dose IV as a single dose
  - If given as multiple dose treatment, use 0.5 mg/kg/dose IV q6h to a max 120 mg/day IV

- **NAPROXEN**
  - Dose: 10-20 mg/kg/day divided BID, max 1 g/day
  - Adults (>60kg): initially 500 mg, then 250 mg PO q6-8h, max of 1250 mg/day

- **CELEBREX**
- Dose: 2-4mg/kg PO q12hr
- Adults (>60kg): 100-200mg PO q12hr
Figure 10-1 A. Various palliative procedures that can be used in patients who have congenital heart disease with a decreased pulmonary blood flow. B. Pulmonary artery banding procedure to reduce the pulmonary blood flow.
<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE</th>
<th>ROUTE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codeine</td>
<td>0.5-1.5 mg/kg q6h prn (max 60mg)</td>
<td>Oral/IM, NEVER IV!!!!</td>
<td>Severe hypotension, 30% inefficient metabolism</td>
</tr>
<tr>
<td>Morphine</td>
<td>IR: 0.15-1.5 mg/kg q3-4h</td>
<td>PO/PR</td>
<td>Excreted renally</td>
</tr>
<tr>
<td></td>
<td>SR: 10-15mg q8-12hrs (20-35kg), 15-30mg</td>
<td>IV/SC bolus</td>
<td>Histamine release</td>
</tr>
<tr>
<td></td>
<td>Q8-12hrs for 35-50kg</td>
<td>IV continuous infusion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.05-0.2 mg/kg q3-4h</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.01-0.06 mg/kg/hr, prem 0.005mg/kg/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fentanyl</td>
<td>1-3 mcg/kg up to 10 mcg/kg</td>
<td>IV</td>
<td>Up to 100 mcg/kg in cardiac surgery</td>
</tr>
<tr>
<td></td>
<td>0.5-2mcg/kg/hr</td>
<td>IV infusion</td>
<td></td>
</tr>
<tr>
<td>Sufentanil</td>
<td>LD=0.2-0.5 mcg/kg</td>
<td>IV</td>
<td>In cardiac surgery run @</td>
</tr>
<tr>
<td></td>
<td>0.2-0.3 mcg/kg/hr</td>
<td>Continuous infusion</td>
<td>1-2 mcg/kg/hr</td>
</tr>
<tr>
<td>Remifentanil</td>
<td>0.5-1.0 mcg/kg</td>
<td>Bolus IV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.05-0.1 mcg/kg/min</td>
<td>Continuous infusion</td>
<td></td>
</tr>
<tr>
<td>DRUG</td>
<td>DOSE</td>
<td>ROUTE</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------</td>
<td>--------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Oxycodone</td>
<td>0.1mg/kg q 4hrs, if &gt;50kg 5-10mg q 3-4hrs</td>
<td>PO</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dilaudid</td>
<td>0.02mg/kg Q 2-4 hrs 6mcg/kg/hr 0.04-0.08mg/kg q 3-4hr</td>
<td>IV Continuous infusion IV PO</td>
<td></td>
</tr>
</tbody>
</table>
CARDIAC DRUGS

INFUSIONS-RULE OF “3”
For many drugs, such as inotropes, which are given as infusions in mcg/kg/min, the rule of “3” may be used to prepare appropriate dilutions:

- Add 3 times the patient weight (in kg) as mg of the drug to make 50 mls with diluent. The infusion rate in ml/hr = mcg/kg/min of the drug.

i.e. for a 20 kg child add:

- \((3 \times 20)\) mg = 60 mg of Dopamine (= 1.5 mls) to 48.5 ml of diluent.
- Thus a rate of 5 ml/hr = 5 mcg/kg/min
- Multiples of 3 may be used to allow slower or faster rates of infusion.

i.e. for Epinephrine use 0.3 mg/kg to give a solution where

- 1 cc/hr = 0.1 mcg/kg/min

OR

DOPAMINE/ DOBUTAMINE: patient weight (kg) \(\times 15\) = mg/50 ml diluent. 1 ml/h = 5 mcg/kg/min.

EPINEPHRINE/ NOREPINEPHRINE/ PHENYLEPHRINE/ISOPROTERENOL: patient weight (kg) \(\times 0.3\) = mg/50 ml diluent. 1 ml/h = 0.1 mcg/kg/min.

NITROGLYCERIN/ NITROPRUSSIDE: patient weight (kg) \(\times 3\) = mg/50 ml D5W. 1 ml/h = 1 mcg/kg/min.

VASOPRESSIN: 0.5 u/ 50 ml N.S = 0.01 u/ml. 0.1 ml/kg/h = 1 milliunit/kg/min.

PGE1: patient weight (kg) \(\times 60\) = mcg/20 ml diluent. 1 ml/h = 0.05 mcg/kg/min.
### ANTIARRHYTHMIC AGENTS:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Bolus Dose</th>
<th>Infusion Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenosine</td>
<td>100, 150, 200 mcg/kg (rapid infusion)</td>
<td></td>
</tr>
<tr>
<td>Amiodarone</td>
<td>5 mg/kg (over 30-60 min)</td>
<td>5-10 mcg/kg/min</td>
</tr>
<tr>
<td>Bretylium</td>
<td>5 mg/kg (over 1 min)</td>
<td>20-30 mcg/kg/min</td>
</tr>
<tr>
<td>Digoxin</td>
<td>20-30 mcg/kg (1/2, 1/4, 1/4 every 8 h)</td>
<td>7-10 mcg/kg/day PO (in 2 doses)</td>
</tr>
<tr>
<td>Diltiazem</td>
<td>0.25 mg/kg, max 20 mg (over 2 min)</td>
<td>0.1-0.3 mg/kg/h</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>1 mg/kg (up to 3 mg/kg)</td>
<td>20-50 mcg/kg/min</td>
</tr>
<tr>
<td>MgSO4</td>
<td>25-50 mg/kg up to 1 gr (over 30 min)</td>
<td></td>
</tr>
<tr>
<td>Procainamide</td>
<td>10-15 mg/kg (over 30 min)</td>
<td>40-50 mcg/kg/min</td>
</tr>
<tr>
<td>Verapamil</td>
<td>0.05-0.3 mg/kg, max 10 mg (over 5 min)</td>
<td></td>
</tr>
<tr>
<td>Cardioversion</td>
<td>1 J/kg (VT, SVT)</td>
<td>2 J/kg (VF) then 4 J/kg</td>
</tr>
</tbody>
</table>

### BETA BLOCKER AGENTS:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Bolus Dose</th>
<th>Infusion Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esmolol</td>
<td>100-500 mcg/kg</td>
<td>50-300 mcg/kg/min</td>
</tr>
<tr>
<td>Labetalol</td>
<td>0.1-0.4 mg/kg</td>
<td>0.25-1 mg/kg/h</td>
</tr>
<tr>
<td>Propranolol</td>
<td>0.05-0.1 mg/kg</td>
<td></td>
</tr>
</tbody>
</table>

### INOTROPIC AGENTS:

<table>
<thead>
<tr>
<th>Agent</th>
<th>Bolus Dose</th>
<th>Infusion Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amrinone</td>
<td>5 mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Dobutamine</td>
<td>2-20 mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Dopamine</td>
<td>2-10 mcg/kg/min</td>
<td></td>
</tr>
<tr>
<td>Epinephrine</td>
<td>1-10 mcg/kg</td>
<td>0.05-1 mcg/kg/min</td>
</tr>
<tr>
<td>Milrinone</td>
<td>50-100 mcg/kg</td>
<td>0.25-0.75 mcg/kg/min</td>
</tr>
</tbody>
</table>
### VASOACTIVE AGENTS:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Bolus Dose</th>
<th>Infusion Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ephedrine</td>
<td>0.2 - 0.3 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Hydralazine</td>
<td></td>
<td>1 - 5 mcg/kg/min</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>1- 2 mcg/kg</td>
<td>0.2 - 10 mcg/kg/min</td>
</tr>
<tr>
<td>Nitroprusside</td>
<td>1-2 mcg/kg</td>
<td>0.2 - 5- mcg/kg/min</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td></td>
<td>0.02- 0.2 mcg/kg/min</td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td>10 - 40 ppm</td>
</tr>
<tr>
<td>Phenylephrine</td>
<td>1- 2 mcg/kg</td>
<td>0.1 - 0.5 mcg/kg/min</td>
</tr>
<tr>
<td>Phentolamine</td>
<td>0.2 mg/kg</td>
<td>0.2- 2 mcg/kg/min</td>
</tr>
<tr>
<td>PGE1</td>
<td></td>
<td>0.01 - 0.2 mcg/kg/min</td>
</tr>
<tr>
<td>Sildenafil</td>
<td>0.25 - 1 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Vasopressin</td>
<td>0.4 u/kg</td>
<td>0.0003 - 0.002 u/kg/min</td>
</tr>
</tbody>
</table>

### OTHER AGENTS:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Bolus Dose</th>
<th>Infusion Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>0.02 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Aprotinin</td>
<td>3.9 mg /kg (over 30 min) + (4 mg/kg to the pump prime)</td>
<td>1 mg/kg/h until in ICU for 1 h 14 mg = 100,000 KIU</td>
</tr>
<tr>
<td>Ca chloride</td>
<td>10- 20 mg/kg (max 1 mg)</td>
<td></td>
</tr>
<tr>
<td>Ca gluconate</td>
<td>30 - 60 mg/kg (max 1 gm)</td>
<td></td>
</tr>
<tr>
<td>DDAVP</td>
<td>0.3 mcg/kg (max 20 mcg)</td>
<td></td>
</tr>
<tr>
<td>Dexamethasone</td>
<td>0.2 - 0.5 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Ethacrylic Acid</td>
<td>0.5mg/kg</td>
<td></td>
</tr>
<tr>
<td>Glucagon</td>
<td>50- 100 mcg/kg</td>
<td>0.3-3 mcg/kg/min</td>
</tr>
<tr>
<td>Drug</td>
<td>Dose (children)</td>
<td>Dose (infants)</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Glucose 10%</td>
<td>1 ml/kg (100 mg/kg)</td>
<td>1-5 mg/kg/min</td>
</tr>
<tr>
<td>Heparin</td>
<td>300-400 u/kg</td>
<td></td>
</tr>
<tr>
<td>Hydrocortisone</td>
<td>1-5 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Insulin</td>
<td>0.1-0.3 u/kg</td>
<td>0.1 u/kg/h</td>
</tr>
<tr>
<td>Isoproterenol</td>
<td></td>
<td>0.05-0.15 mcg/kg/min</td>
</tr>
<tr>
<td>KCL</td>
<td>0.2-1 mEq/kg (max 5 mEq/h)</td>
<td>(over 30-60 min)</td>
</tr>
<tr>
<td>Lasix</td>
<td>0.5-1 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Mannitol</td>
<td>0.25-1 g/kg</td>
<td>0.05-0.15 gm/kg/h</td>
</tr>
<tr>
<td>NaHCO3</td>
<td>0.5-2 mEq/kg</td>
<td></td>
</tr>
<tr>
<td>PGE-1</td>
<td></td>
<td>0.05-0.1 mcg/kg/min</td>
</tr>
<tr>
<td>Protamine</td>
<td>1 mg/100 u heparin</td>
<td></td>
</tr>
<tr>
<td>Solu-Medrol</td>
<td>5-25 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Transexamic acid</td>
<td>1-10 mg/kg</td>
<td>1-10 mg/kg/h</td>
</tr>
<tr>
<td>Vit K</td>
<td>0.5-2 mg (infants)</td>
<td>5-10 mcg/kg (children)</td>
</tr>
</tbody>
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