



**ROYAL COLLEGE**  
OF PHYSICIANS AND SURGEONS OF CANADA  
**COLLÈGE ROYAL**  
DES MÉDECINS ET CHIRURGIENS DU CANADA

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# NATIONAL CURRICULUM FOR CANADIAN ANESTHESIOLOGY RESIDENCY

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## NATIONAL CURRICULUM GUIDE FOR ANESTHESIOLOGY

Second Edition  
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National Curriculum Guide For Anesthesiology

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NOTE: As a convention in this document, plain text denotes skills and knowledge that apply to the specialty training at the graduate level of a non-subspecialized Anesthesiologist.

*Italicized items denote knowledge and skills that apply to specialty training of the subspecialty fellow.*

## PREAMBLE

The National Curriculum for Canadian Anesthesiology Residency describes the knowledge and skills that are expected of a physician entering practice as a specialist anesthesiologist in Canada or those intending to practice in Canada. It reflects the knowledge and competencies a resident should have following the completion of an accredited Canadian anesthesiology residency training program. It is written to be a resource for students, residents, teachers, and examiners to assist them in clarifying the expectations relevant to their roles in the educational process.

The document is structured by division into general areas of knowledge or skills. Each area is subsequently divided into specific topics, and finally into the specific expected competencies and knowledge items.

The Anesthesiology National Curriculum describes a dynamic field of knowledge and scope of practice. While effort is made to maintain this document and keep it current, it is important to realize that major new advances in the discipline of Anesthesiology may become expected knowledge and skills of the candidate sooner than the next revision.

## MEDICAL EXPERT

### 1 Airway Evaluation and Management

Upon completion of this training, the Anesthesiologist shall demonstrate competence and knowledge in the objectives related to airway evaluation and management listed below.

#### A) Airway Anatomy and Physiology

- 1.1 Demonstrate knowledge of the structure and function of upper and lower airways, including but not limited to:
  - 1.1.1 Nose, mouth, teeth, tongue
  - 1.1.2 Nasopharynx, oropharynx, pharynx
  - 1.1.3 Epiglottis, larynx, glottis, vocal cords, valleculae
  - 1.1.4 Cartilages
  - 1.1.5 Sensory and motor innervation
  - 1.1.6 Conducting and respiratory airways: trachea, bronchi, bronchioles, alveoli
- 1.2 Demonstrate knowledge of the physiology and pathophysiology of ventilation and respiration, including but not limited to:
  - 1.2.1 Control of breathing
  - 1.2.2 Central nervous system
  - 1.2.3 Diaphragm and accessory muscles

#### B) Basic Airway Management

- 1.3 Demonstrate knowledge and expertise in basic airway management for the patient with and without an upper airway obstruction
- 1.4 Acute Airway Obstruction
  - 1.4.1 Demonstrate knowledge of the etiologies and complications of airway obstruction, including but not limited to:
    - 1.4.1.1 Hypercarbia/acidosis
    - 1.4.1.2 Hypoxia
    - 1.4.1.3 Aspiration
    - 1.4.1.4 Foreign Body
    - 1.4.1.5 Upper airway infection (epiglottitis, submandibular, parapharyngeal and retropharyngeal abscess, etc.)
    - 1.4.1.6 Angioneurotic edema

1.5 Bag-Valve-Mask Ventilation

1.5.1 Demonstrate knowledge and expertise in patient ventilation using bag-valve-mask devices, including but not limited to:

- 1.5.1.1 Selection of appropriately-sized masks
- 1.5.1.2 Assembly, use, and trouble-shooting of self-inflating ventilation devices
- 1.5.1.3 Assembly, use, and trouble-shooting of non-self-inflating ventilation devices, including but not limited to the Ayre's T-piece
- 1.5.1.4 Two-person mask ventilation techniques
- 1.5.1.5 Role of positive end expiratory pressure (PEEP) valve
- 1.5.1.6 Role of APL valve
- 1.5.1.7 Role of reservoir bag

1.6 Basic Airway Adjuncts

1.6.1 Demonstrate knowledge and competence in the use of basic adjuncts to overcome acute airway obstruction including appropriate sizing and insertion techniques, including but not limited to:

- 1.6.1.1 Oropharyngeal airway
- 1.6.1.2 Nasopharyngeal airway
- 1.6.1.3 Supraglottic airway device; LMA, i-GEL, air-Q, etc.

1.7 Demonstrate proficiency in immediate recognition and management of the patient with an acutely obstructed airway, including but not limited to:

1.7.1 Basic Life Support (BLS) protocols:

- 1.7.1.1 Assessing patient responsiveness
- 1.7.1.2 Obtaining assistance
- 1.7.1.3 Patient positioning
- 1.7.1.4 Recovery position
- 1.7.1.5 Chin lift, head tilt, jaw thrust
- 1.7.1.6 Indications for and use of pharmacologic agents, including management of laryngospasm
- 1.7.1.7 Rescue breathing
- 1.7.1.8 Cardiopulmonary resuscitation

**C) Oxygen Delivery Systems**

- 1.8 Demonstrate an understanding of systems designed for delivery of oxygen to the patient, including but not limited to:
  - 1.8.1 Oxygen sources
  - 1.8.2 Wall oxygen systems and specifications
  - 1.8.3 High pressure oxygen supply
  - 1.8.4 Diameter Index Safety System (DISS)
  - 1.8.5 Pin Index Safety System (PISS)
  - 1.8.6 Quick-connect systems
  - 1.8.7 Flowmeters
  - 1.8.8 Cylinder sizes, pressures, capacities
  - 1.8.9 Regulators and flowmeters
  - 1.8.10 Nasal Cannula
  - 1.8.11 Flow rates and delivered oxygen
  - 1.8.12 Capnography
  - 1.8.13 Face masks
  - 1.8.14 Simple, Venturi and Non-rebreathing systems
  - 1.8.15 Management of preoxygenation

**D) Universal Precautions – (see Chapter 14 - Infectious Disease)**

- 1.9 Demonstrate knowledge and understanding of the role of universal precautions in patient care, including airway management using face shields, barrier masks including N95 mask and the Powered Air-Purifying Respirator (PAPR), gloves and fluid-impermeable gowns
  - 1.9.1 Demonstrate knowledge of the requirements for fluid, droplet and aerosol precautions

**E) Airway Evaluation**

- 1.10 Demonstrate advanced knowledge and competence in assessment of patient airways, particularly those features predisposing to difficulty in airway management
  - 1.10.1 Elicit a satisfactory patient history, including but not limited to:
    - 1.10.1.1 Review of old records
    - 1.10.1.2 History of prior encounters with anesthetics
    - 1.10.1.3 Dental/soft tissue damage



1.10.2 Perform a complete physical examination, including but not limited to:

- 1.10.2.1 Mallampati score
- 1.10.2.2 Thyromental distance
- 1.10.2.3 Upper lip bite test
- 1.10.2.4 Range of motion of neck
- 1.10.2.5 Neck circumference
- 1.10.2.6 Mandible size, mouth opening
- 1.10.2.7 Other predictors of airway difficulty
  - 1.10.2.7.1 Dentition, including large or prominent upper incisors
  - 1.10.2.7.2 Tongue
  - 1.10.2.7.3 Gender
  - 1.10.2.7.4 Age
  - 1.10.2.7.5 Body habitus/obesity
  - 1.10.2.7.6 Facial hair
  - 1.10.2.7.7 Medical conditions and surgical conditions which impact on airway management, including but not limited to: (also see section 7.1.4)
    - 1.10.2.7.7.1 Tumours
    - 1.10.2.7.7.2 Trauma
    - 1.10.2.7.7.3 Pregnancy
    - 1.10.2.7.7.4 Infection of the upper airway
    - 1.10.2.7.7.5 Metabolic and rheumatic diseases (diabetes, rheumatoid arthritis)
    - 1.10.2.7.7.6 Congenital anomalies
- 1.10.2.8 Investigations
  - 1.10.2.8.1 Demonstrate appropriate use and understanding of diagnostic testing and imaging where results may impact the planning of a patient's pre-operative and post-operative airway and ventilatory management, including but not limited to:
    - 1.10.2.8.1.1 Pulmonary function testing
    - 1.10.2.8.1.2 Blood gas testing
    - 1.10.2.8.1.3 Flow-volume loops
    - 1.10.2.8.1.4 Chest X-ray
    - 1.10.2.8.1.5 CT-scan of neck and upper/lower airway

## **F) Communicator Competencies**

- 1.11 Demonstrate appropriate communication skills required to facilitate the patient's airway evaluation and management
  - 1.11.1 Provide clear communication of pre-operative findings/concerns/plans to the patient
  - 1.11.2 Provide accurate written documentation of pre-operative assessment and patient discussion for colleagues
  - 1.11.3 Provide accurate written documentation of intra-operative airway findings
  - 1.11.4 Identify the patient with a difficult airway and be able to:
    - 1.11.4.1 Provide written information, where relevant, to the patient regarding their difficult airway and its management
    - 1.11.4.2 Communicate this finding with the patient and family, and other physicians including the family physician
    - 1.11.4.3 Discuss wearing a MedicAlert bracelet

## **G) Collaborator Competencies**

- 1.12 Optimize help provided by other OR staff through effective utilization of resources and delegation of roles in routine and difficult airway management

## **H) Airway Management Techniques**

- 1.13 Endotracheal intubation

Demonstrate competence in airway management using endotracheal intubation

- 1.13.1 Describe the indications for intubation
  - 1.13.1.1 Airway obstruction unrelieved by basic maneuvers
  - 1.13.1.2 Oxygenation and Ventilation
  - 1.13.1.3 Management of hypoxia, hypercarbia
  - 1.13.1.4 Ventilatory support
  - 1.13.1.5 Airway protection
  - 1.13.1.6 Trauma/burns
  - 1.13.1.7 Obtunded patient
  - 1.13.1.8 Tracheobronchial toilet/suctioning
  - 1.13.1.9 Anesthetics and surgery
    - 1.13.1.9.1 Cases in which muscle relaxants are required
    - 1.13.1.9.2 Surgery around head and neck
    - 1.13.1.9.3 Airway procedures

- 1.13.1.9.4 Bronchoscopy, biopsies, therapeutic procedures
- 1.13.1.10 Indications and contraindications for rapid sequence induction
- 1.13.2 Describe the routes of intubation
  - 1.13.2.1 Orotracheal intubation
  - 1.13.2.2 Nasotracheal intubation
    - 1.13.2.2.1 Surgical and anatomic indications
    - 1.13.2.2.2 Considerations
    - 1.13.2.2.3 Contraindications
    - 1.13.2.2.4 Blind nasal intubation
  - 1.13.2.3 Transtracheal airway management
    - 1.13.2.3.1 In situ via tracheotomy stoma
    - 1.13.2.3.2 Considerations of fresh tracheotomy versus mature stoma
  - 1.13.2.4 Urgent non-elective endobronchial intubation, for reasons related to lung protection and/or management
    - 1.13.2.4.1 Intrapulmonary bleeding
    - 1.13.2.4.2 Bronchopleural fistula
    - 1.13.2.4.3 Empyema
- 1.13.3 Manage Endotracheal intubation
  - 1.13.3.1 Demonstrate knowledge and expertise in managing normal and difficult airways with appropriate use of adjuncts where necessary:
    - 1.13.3.1.1 Preparation
      - 1.13.3.1.1.1 Equipment choice
      - 1.13.3.1.1.2 Appropriate laryngoscope blade size
      - 1.13.3.1.1.3 Appropriate endotracheal tube type and size
      - 1.13.3.1.1.4 Equipment check
      - 1.13.3.1.1.5 Monitors
      - 1.13.3.1.1.6 Suction
      - 1.13.3.1.1.7 Alternative airway devices available

1.13.3.1.2 Direct laryngoscopy

- 1.13.3.1.2.1 Curved blades
- 1.13.3.1.2.2 Straight blades
- 1.13.3.1.2.3 Levering blades
- 1.13.3.1.2.4 Other specialized blades

1.13.3.1.3 Indirect laryngoscopy techniques

- 1.13.3.1.3.1 Demonstrate knowledge and expertise in managing normal and difficult airways using alternatives to direct laryngoscopy, including but not limited to:
  - 1.13.3.1.3.1.1 Fibreoptic laryngoscopes, flexible and rigis
  - 1.13.3.1.3.1.2 Videolaryngoscopes
  - 1.13.3.1.3.1.3 Other specialized tool (e.g., Shikani, Bullard, etc.)

1.13.3.1.4 Adjuncts to facilitate endotracheal tube placement

- 1.13.3.1.4.1 Optimal patient positioning
- 1.13.3.1.4.2 Manoeuvres to facilitate visualization
  - 1.13.3.1.4.2.1 BURP (backward upward rightward position)
  - 1.13.3.1.4.2.2 OELM (optimal external laryngeal manipulation)
- 1.13.3.1.4.3 Gum elastic bougie
- 1.13.3.1.4.4 Malleable stylets
- 1.13.3.1.4.5 Lighted (e.g., Trachlight, Tubestat)

1.13.3.1.5 Confirmation of endotracheal tube placement and position in the trachea

- 1.13.3.1.5.1 Visualization
- 1.13.3.1.5.2 Auscultation
- 1.13.3.1.5.3 Capnography
- 1.13.3.1.5.4 Radiography

1.13.4 Manage awake intubation

1.13.5 Manage extubation

1.13.5.1 Demonstrate an understanding of the methods of and considerations for airway management at the extubation phase, including but not limited to:

1.13.5.1.1 Airway toilet, suctioning

1.13.5.1.2 Awake extubation criteria

1.13.5.1.3 Deep extubation technique and criteria

1.13.5.1.4 Post-extubation stridor

1.13.5.1.5 Extubation of the patient with a difficult airway (see below 1.16.6)

1.14 Supraglottic devices

1.14.1 Demonstrate competence in airway management using supraglottic devices, including but not limited to:

1.14.1.1 Indications and contraindications of different supraglottic devices

1.14.1.2 Elective use as alternative to endotracheal intubation

1.14.1.3 Laryngeal mask airway (LMA), Classic, Prooseal, etc.

1.14.1.4 Emerging alternatives, including i-Gel, air-Q, etc.

1.14.1.5 Use of specific types of supraglottic airways as a conduit for endotracheal intubation

1.14.1.6 Emergent use in difficult airway algorithms

1.14.1.7 Emergent use in COCI (Cannot Oxygenate, Cannot Intubate) situation

1.15 Complications of airway management

1.15.1 Demonstrate an understanding of and an ability to recognize and treat the complications of airway management, including but not limited to:

1.15.1.1 Errors and complications of endotracheal tube placement

1.15.1.1.1 Endobronchial intubation

1.15.1.1.2 Tube displacement related to patient positioning and neck flexion/extension

1.15.1.1.3 Esophageal intubation

1.15.1.1.4 Airway trauma

1.15.1.1.5 Dental trauma

1.15.1.1.6 Soft tissue trauma

- 1.15.1.1.7 Post-extubation stridor
- 1.15.1.1.8 Nasal trauma after nasal intubation
- 1.15.1.1.9 Aspiration
- 1.15.1.2 Prevention strategies
  - 1.15.1.2.1 Fasting guidelines
  - 1.15.1.2.2 Anti-reflux pre-treatment strategies
  - 1.15.1.2.3 Role of cricoid pressure
- 1.15.1.3 Current national recommendations and guidelines for managing complications of intubation, including but not limited to the role of:
  - 1.15.1.3.1 Bronchoscopy
  - 1.15.1.3.2 Lavage
  - 1.15.1.3.3 Antibiotics

## **I) The Difficult Airway**

- 1.16 Demonstrate competence for the recognition and management of predicted and unexpected difficult airways. The anesthesiologist must demonstrate knowledge of a range of safe options for securing difficult airways. In doing so, the anesthesiologist must also demonstrate appropriate communication, management and technical skills.
  - 1.16.1 General Considerations
    - 1.16.1.1 Demonstrate a sound working knowledge of the difficult airway algorithms and current accepted airway guidelines. The anesthesiologist must understand and be able to utilize the considerations and recommendations for difficult airway management, including but not limited to:
      - 1.16.1.1.1 Predicted versus unpredicted difficult airway
      - 1.16.1.1.2 Awake versus asleep strategy
      - 1.16.1.1.3 Fiberoptic versus videolaryngoscopic techniques
      - 1.16.1.1.4 Regional anesthesia
      - 1.16.1.1.5 Failed intubation strategy
      - 1.16.1.1.6 Intubations versus alternatives; other approaches and other devices
      - 1.16.1.1.7 Supraglottic devices
      - 1.16.1.1.8 Cannot oxygenate, cannot intubate strategy
      - 1.16.1.1.9 Calling for assistance

1.16.1.1.10 Special considerations in the pediatric, obstetric and other populations

1.16.2 Further classification of difficult airways into descriptive categories:

- 1.16.2.1 Difficult mask ventilation
- 1.16.2.2 Difficult laryngoscopy
- 1.16.2.3 Difficult supraglottic airway
- 1.16.2.4 Difficult intubation
- 1.16.2.5 Difficult front of neck access
- 1.16.2.6 Difficult ventilation due to airway misplacement, endotracheal tube obstruction, circuit malfunction, etc.

1.16.3 Predicted Difficult Airway

- 1.16.3.1 Demonstrate knowledge and proficiency in formulating an approach to the recognized difficult airway. The anesthesiologist must understand and be able to weigh alternative strategies
- 1.16.3.2 Patient preparation for awake intubation
  - 1.16.3.2.1 Psychological, communication of plan/concerns
  - 1.16.3.2.2 Pharmacological
  - 1.16.3.2.3 Anti-sialogogue
  - 1.16.3.2.4 Anxiolytic
  - 1.16.3.2.5 Strategies for uncooperative patients
  - 1.16.3.2.6 Airway topicalization techniques (e.g., aerosol, spray and pledget)
  - 1.16.3.2.7 Local anesthetic pharmacology
  - 1.16.3.2.8 Nerve block techniques
  - 1.16.3.2.9 Managing the passage of the endotracheal tube over an assistive device which may include but is not limited to the
    - 1.16.3.2.9.1 Fiberoptic bronchoscope
    - 1.16.3.2.9.2 Guidewire
    - 1.16.3.2.9.3 Bougie

1.16.4 Unpredicted Difficult Airway

- 1.16.4.1 Demonstrate an ability to deal with unanticipated difficult airways. The anesthesiologist must understand and be able to apply the guidelines provided in difficult airway

algorithms, including the role of supraglottic devices, surgical airways, and patient wake-up options

- 1.16.4.2 Describe the principles of anesthesia crisis resource management and the various types of human error when faced with an unanticipated difficult airway

#### 1.16.5 The Surgical Airway

- 1.16.5.1 Demonstrate a working knowledge of surgical options for emergency airway management. The anesthesiologist must demonstrate knowledge of the use of at least one cricothyrotomy kit or approach:

- 1.16.5.1.1 Mini-tracheostomy
- 1.16.5.1.2 Cricothyrotomy
- 1.16.5.1.3 Jet ventilation
- 1.16.5.1.4 Contraindications to surgical airway techniques

#### 1.16.6 Extubation of the Difficult Airway Patient

- 1.16.6.1 Demonstrate an understanding of the implications for airway management during the extubation of the difficult airway patient. The anesthesiologist must be able to demonstrate consideration of the following additional concerns:

- 1.16.6.1.1 The patient with a wired jaw
- 1.16.6.1.2 The patient with airway edema
- 1.16.6.1.3 Extubation over an introducer
- 1.16.6.1.4 Assessment for readiness for extubation



## 2 Ambulatory Anesthesiology

### A) Ambulatory Anesthesiology Settings

The resident must demonstrate knowledge and competence in applying the Guidelines to the Practice of Anesthesia of the Canadian Anesthesiologists' Society.

- 2.1 Demonstrate an understanding of the various settings and administrative structures required for ambulatory Anesthesiology, including but not limited to:
  - 2.1.1 Hospital based centers
  - 2.1.2 Hospital affiliated centers
  - 2.1.3 Freestanding centers (e.g., dental offices, cosmetic surgery clinics, endoscopy clinics)
  
- 2.2 Demonstrate knowledge with respect to guidelines or standards pertaining to the design and resources required for ambulatory Anesthesiology sites, including but not limited to:
  - 2.2.1 Anesthetics and life support equipment
  - 2.2.2 Monitors
  - 2.2.3 Drugs – in particular drugs required to manage emergencies including Malignant Hyperthermia
  - 2.2.4 Special equipment
    - 2.2.4.1 Difficult airway
    - 2.2.4.2 Regional anesthesia
  - 2.2.5 Site physical design
    - 2.2.5.1 Basic knowledge of O.R. design requirements and standards per Canadian Anesthesiologists Society (CAS)
    - 2.2.5.2 Managing gas supplied in tanks, adequacy of reserve supply, downstream pressure regulation & monitoring
    - 2.2.5.3 O.R. ventilation and waste gas scavenging as per CAS recommendations
    - 2.2.5.4 Equipment maintenance and servicing
    - 2.2.5.5 Awareness that provincial guidelines specify requirements for number and qualifications of ancillary staff
    - 2.2.5.6 Provincial Colleges of Physicians and Surgeons role in accrediting non-hospital facilities
    - 2.2.5.7 Abortion guidelines for non-hospital facilities

**B) Pre-operative assessment of patients**

- 2.3 Demonstrate an understanding of the factors related to appropriate patient selection and appropriateness of surgical procedures for ambulatory surgery, including but not limited to:
  - 2.3.1 Obtain a thorough and pertinent medical history
  - 2.3.2 Perform a thorough physical examination
  - 2.3.3 Obtain appropriate and pertinent tests and consultations, including but not limited to:
    - 2.3.3.1 Laboratory tests
    - 2.3.3.2 Imaging studies
    - 2.3.3.3 Electrocardiograms
    - 2.3.3.4 Specialist consultations
  - 2.3.4 Select with judgement the preoperative tests needed
    - 2.3.4.1 Promote CAS Choosing Wisely Canada when appropriate
  - 2.3.5 Identify and evaluate any pre-existing comorbid conditions
    - 2.3.5.1 Provisions for pre-operative screening through record review, interview & examination and directed consultations to reduce late cancellations as well as morbidity & mortality
    - 2.3.5.2 American Society of Anesthesiologists (ASA) Status and appropriateness for ambulatory care
    - 2.3.5.3 Body Mass Index (BMI) stratification
    - 2.3.5.4 Screening and diagnosis of Obstructive Sleep Apnea (OSA)
  - 2.3.6 Select eligible patients for ambulatory anesthesia based on:
    - 2.3.6.1 Type of surgery
    - 2.3.6.2 Duration of surgery
    - 2.3.6.3 Patient comorbidities
    - 2.3.6.4 Potential for fluid shifts, hemodynamic changes and blood/blood product transfusions
    - 2.3.6.5 Potential severity of perioperative complications
    - 2.3.6.6 Post-operative care
  - 2.3.7 Special considerations for pediatric patients
    - 2.3.7.1 Former premature patients
    - 2.3.7.2 Comorbid conditions including obstructive sleep apnea

- 2.3.7.3 Patients with upper respiratory tract infections
- 2.3.7.4 Airway challenges
- 2.3.7.5 Other criteria or need for hospital admission

### **C) Pre-operative patient preparation**

- 2.4 Demonstrate knowledge with respect to preparing patients for ambulatory surgery with respect to:
  - 2.4.1 NPO status
    - 2.4.1.1 Ensure appropriate NPO status based on timing of surgery
    - 2.4.1.2 Provide a rationale for NPO policies
    - 2.4.1.3 Establish an appropriate NPO policy for ambulatory site
  - 2.4.2 Pre-existing medication management-order or withhold chronically administered medications as appropriate
    - 2.4.2.1 Including considerations for Hormone Replacement Therapy (HRT)/Birth Control Pill (BCP)
  - 2.4.3 Pre-operative medications – order anxiolytics, sedatives, analgesics in the peri-operative period as appropriate for an ambulatory setting
  - 2.4.4 Preparation for discharge planning – provision of clear instructions to patients and families

### **D) Anesthetic techniques**

- 2.5 Demonstrate an approach to anesthetic techniques appropriate for ambulatory surgery, including but not limited to:
  - 2.5.1 General Anesthesia
    - 2.5.1.1 Describe drugs and techniques appropriate for use in an ambulatory care setting
  - 2.5.2 Regional Anesthesia
    - 2.5.2.1 Demonstrate knowledge of regional anesthetic techniques appropriate for ambulatory surgery and the benefits and drawbacks of such techniques
  - 2.5.3 Monitored Anesthesia Care
    - 2.5.3.1 Demonstrate an understanding of the use of monitored anesthesia care in the ambulatory setting

**E) Anesthesia care for surgical procedures**

- 2.6 Demonstrate knowledge with respect to procedures appropriate for ambulatory surgery
  - 2.6.1 Provide safe and competent anesthesia care for adult and pediatric patients for surgical procedures for:
    - 2.6.1.1 Dental surgery
    - 2.6.1.2 Diagnostic imaging and procedures
    - 2.6.1.3 General surgery
    - 2.6.1.4 Gynecology
    - 2.6.1.5 Ophthalmology
    - 2.6.1.6 Orthopedic surgery
    - 2.6.1.7 Otolaryngology
    - 2.6.1.8 Plastic surgery
    - 2.6.1.9 Urologic surgery
    - 2.6.1.10 Vascular surgery

**F) Postoperative care**

- 2.7 Demonstrate an understanding of the requirements for postoperative care in an ambulatory setting, including but not limited to:
  - 2.7.1 Post Anesthesia Care Unit (PACU)
    - 2.7.1.1 Describe and arrange appropriate monitoring of the patient following completion of surgery
    - 2.7.1.2 Identify and manage post-operative complications
    - 2.7.1.3 Describe discharge criteria to Post Recovery Care
    - 2.7.1.4 Provide appropriate post-operative pain management
    - 2.7.1.5 Provide appropriate post-operative nausea and vomiting management
  - 2.7.2 Post Recovery Care
    - 2.7.2.1 Describe process for post-operative teaching and instructions
    - 2.7.2.2 Assure post-operative follow-up plans
    - 2.7.2.3 Describe discharge criteria for discharge home

2.7.3 Unplanned admission

- 2.7.3.1 Describe process for unplanned admission to hospital for patients failing to meet discharge criteria or for patients with post-operative complications requiring hospital admission

**G) Emergency Situations**

- 2.8 Demonstrate an ability to recognize and treat potential emergency situations in the ambulatory setting, including disposition of the patient

- 2.8.1 Evacuation plans/procedures (particularly in free standing facilities) including fire safety

**H) Quality Control/Assurance**

- 2.9 Demonstrate an ability to identify parameters requiring monitoring for Quality Control/Assurance:

- 2.9.1 Peri-operative complications
- 2.9.2 Unplanned hospital admissions
- 2.9.3 Post-operative nausea and vomiting
- 2.9.4 Post-operative pain control
- 2.9.5 Peri-operative morbidity and mortality

### 3 Autonomic Nervous System

#### A) Functional Anatomy and Physiology of the Autonomic Nervous System

- 3.1 Demonstrate an understanding of the anatomy and physiology of the autonomic system including relevant pathophysiology and pharmacology and describe the:
  - 3.1.1 Functional anatomy and physiology of the sympathetic nervous system
  - 3.1.2 Functional anatomy and physiology of the parasympathetic nervous system
  - 3.1.3 Functional anatomy and physiology of the enteric nervous system
  - 3.1.4 Adrenergic and cholinergic receptors and the physiologic effects of their receptor agonists and antagonists
  - 3.1.5 Signal transduction, up-regulation and down-regulation of adrenergic receptors

#### B) Function of the Autonomic Nervous System

- 3.2 Demonstrate an understanding of the function of the autonomic system
  - 3.2.1 Describe the responses of effector organs by stimulation of sympathetic and parasympathetic nerves
    - 3.2.1.1 Heart
    - 3.2.1.2 Blood vessels
    - 3.2.1.3 Bronchial tree
    - 3.2.1.4 Gastrointestinal tract
    - 3.2.1.5 Eye
    - 3.2.1.6 Pancreas
    - 3.2.1.7 Sweat glands
  - 3.2.2 Explain the function of the autonomic nervous system in visceral pain
    - 3.2.2.1 Explain the physiology of celiac ganglion block
  - 3.2.3 Explain the effect of stellate ganglion block on upper limb blood circulation and sympathetic lumbar ganglion block on lower limb blood circulation
  - 3.2.4 Explain Marey's law
  - 3.2.5 Explain the Bainbridge reflex
  - 3.2.6 Explain the Valsalva manoeuvre

- 3.2.7 Explain the Bezold-Jarisch reflex
- 3.2.8 Explain the baroreceptor reflex
- 3.2.9 Explain the oculo-cardiac reflex
- 3.2.10 Explain Horner's syndrome

**C) Pharmacology of the Autonomic Nervous System**

- 3.3 Demonstrate an understanding of the pharmacology of the autonomic system
  - 3.3.1 Describe the synthesis, storage, release, inactivation and metabolism of norepinephrine and epinephrine
  - 3.3.2 Describe the synthesis, storage, release, and inactivation of acetylcholine
  - 3.3.3 Name the more frequently used alpha and beta-agonists, both direct and indirect and explain their clinical effect
  - 3.3.4 Explain the effects of alpha and beta-blockers
  - 3.3.5 Explain the effects of cholinomimetics and anti-cholinergics drugs
  - 3.3.6 Explain the effects of calcium channel blockers on the blood vessels
  - 3.3.7 Explain the effects of alpha 2 agonists in regard to pain
  - 3.3.8 Explain the effects of antihypertensive drugs on the autonomic nervous system, including drugs affecting the renin-angiotensin system
  - 3.3.9 Explain the effects of antidepressant drugs on the autonomic nervous system, including Monoamine Oxidase Inhibitors (MAOIs) and tricyclic antidepressants
  - 3.3.10 Explain the relation between antiemetic drugs and the autonomic nervous system
  - 3.3.11 Explain the relation between tocolytic drugs and the autonomic nervous system
  - 3.3.12 Describe the effects of anticholinergic and adrenergic drugs on a transplanted heart
  - 3.3.13 Describe the effects of epinephrine injection in the presence of volatile anesthetics
  - 3.3.14 Describe the effects of beta-blockers in the context of acute cocaine intoxication

**D) Autonomic Dysfunction**

- 3.4 Demonstrate an understanding of the pathophysiology of the autonomic nervous system with respect to the following conditions, including their diagnosis, assessment, management and their interactions with anesthesia:
  - 3.4.1 Pheochromocytoma
  - 3.4.2 Autonomic dysreflexia
  - 3.4.3 Diabetic autonomic neuropathy
  - 3.4.4 Effects of aging
- 3.5 Demonstrate an understanding of the pathophysiology of the surgical stress syndrome



## 4 Cardiovascular Physiology and Anesthesia

### A) General Objectives

- 4.1 Upon completion of this training, the Anesthesiologist shall demonstrate knowledge and proficiency in all the objectives listed below

### B) Cardiac anatomy and physiology

- 4.2 Demonstrate knowledge with respect to the following:

4.2.1 Basic Science

4.2.1.1 Coronary anatomy and physiology

- 4.2.1.1.1 Describe the normal coronary anatomy and common variants, including being able to describe the vascular supply of the major cardiac chambers and cardiac conduction systems
- 4.2.1.1.2 Describe the normal structure of coronary arteries and the determinants of arteriolar tone
- 4.2.1.1.3 Describe the determinants of coronary artery blood flow, myocardial oxygen supply and myocardial oxygen demand, including differences between the right and left ventricles
- 4.2.1.1.4 Describe the pathogenesis of myocardial ischemia, including the pathology of atherosclerotic heart disease, dynamic stenosis, collateral circulation and coronary steal
- 4.2.1.1.5 Describe the pathogenesis of perioperative ischemia and infarction, including similarities and differences from Myocardial Infarction (MI) in the ambulatory (non-surgical) setting

4.2.1.2 Cardiac physiology

- 4.2.1.2.1 Describe the phases of the cardiac cycle and relate these to the electrocardiogram
- 4.2.1.2.2 Discuss the determinants of cardiac output (heart rate and stroke volume), including those variables which influence stroke volume (preload, afterload, contractility)
- 4.2.1.2.3 Describe commonly used indices of systolic function, such as  $dp/dt$ , Ejection Fraction (EF), and End Systolic Pressure Volume Relationship (ESPVR); pressure volume loops
- 4.2.1.2.4 Describe the determinants of normal diastolic function and understand its importance in the normal function

- of the heart, as well as describe conditions associated with abnormal diastolic function
  - 4.2.1.2.5 Describe the differences between the function of the left and right ventricle, and the interaction between the two
  - 4.2.1.2.6 Describe the normal anatomy, structure and function of the four heart valves
  - 4.2.1.2.7 Describe the pericardium anatomy and understand the physiologic consequences of diseases of the pericardium
  - 4.2.1.3 Electrophysiology
    - 4.2.1.3.1 Describe the normal anatomy of the cardiac conduction system
    - 4.2.1.3.2 Describe the phases of cellular action potentials, including the major associated ion currents
    - 4.2.1.3.3 Describe the automaticity of the cardiac conduction system, understanding the differences between the SA node, AV node, Bundle of His and Purkinje fibres
    - 4.2.1.3.4 Describe excitation-contraction coupling, and how electrical activation of the myocyte leads to contraction and relaxation
  - 4.2.1.4 Neurohumoral regulation of the heart
    - 4.2.1.4.1 Describe the sympathetic and parasympathetic innervation of the heart including neurotransmitters and receptors
    - 4.2.1.4.2 Describe the interaction of the sympathetic nervous system (SNS) and parasympathetic nervous system (PSNS) with cardiac variables, including heart rate, contractility, relaxation as well as venous and arteriolar tone
    - 4.2.1.4.3 Describe the major hormonal systems which regulate cardiac function, including the renin-angiotensin system, natriuretic peptides, vasopressin and catecholamines
    - 4.2.1.4.4 Describe major cardiac reflex systems, such as the:
      - 4.2.1.4.4.1 Baroreceptor reflex
      - 4.2.1.4.4.2 Chemoreceptor reflex
      - 4.2.1.4.4.3 Bainbridge reflex
      - 4.2.1.4.4.4 Bezold-Jarisch reflex
      - 4.2.1.4.4.5 Vagal manoeuvres
-

4.2.1.4.4.6 Cushing's reflex

4.2.1.5 Vascular anatomy and physiology

- 4.2.1.5.1 Describe the anatomy of the pulmonary vasculature
- 4.2.1.5.2 Describe the regulation of pulmonary artery tone, including autonomic and humoral mechanisms
- 4.2.1.5.3 Describe the impact of pulmonary vascular resistance on the function of the right ventricle
- 4.2.1.5.4 Describe the anatomy of the aorta, including major branches
- 4.2.1.5.5 Describe the vascular supply of the major organs and the four limbs
- 4.2.1.5.6 Describe the autonomic and humoral control of vascular smooth muscle, and how these systems regulate arterial and venous tone

4.2.1.6 Embryology

- 4.2.1.6.1 Demonstrate a basic understanding of cardiac embryology
- 4.2.1.6.2 Demonstrate awareness of how this relates to major congenital cardiac diseases, such as:
  - 4.2.1.6.2.1 Patent ductus arteriosus
  - 4.2.1.6.2.2 Coarctation of the aorta
  - 4.2.1.6.2.3 Major abnormalities of the great vessels, such as transposition
  - 4.2.1.6.2.4 Major valvular abnormalities, such as Ebstein's anomaly, pulmonary atresia, and Tetralogy of Fallot
  - 4.2.1.6.2.5 Hypoplastic heart syndromes
  - 4.2.1.6.2.6 Atrial Septal Defect (ASD)
  - 4.2.1.6.2.7 Ventricular Septal Defect (VSD)
- 4.2.1.6.3 Describe normal fetal circulation and understand the differences between adult and fetal circulation

- 4.2.1.7 Demonstrate an ability to apply the aforementioned basic sciences principles in clinical management with respect to the assessment, monitoring, and perioperative management of patients with and without cardiac diseases

## C) Cardiovascular system and anesthesia

### 4.3 Clinical assessment

#### 4.3.1 Demonstrate the ability to:

- 4.3.1.1 Take a focused cardiac history
- 4.3.1.2 Complete a focused physical examination of the cardiovascular system
- 4.3.1.3 Interpret relevant laboratory data
- 4.3.1.4 Interpret 12-lead ECG
- 4.3.1.5 Interpret the summary reports of advanced cardiac investigations such as:
  - 4.3.1.5.1 Vascular studies such as the ankle-brachial index and carotid Doppler studies
  - 4.3.1.5.2 Holter monitors
  - 4.3.1.5.3 Myocardial stress tests
  - 4.3.1.5.4 Myocardial perfusion studies
  - 4.3.1.5.5 Left – and – right-sided cardiac catheterization studies
  - 4.3.1.5.6 Echocardiography exams
- 4.3.1.6 Seek the appropriate cardiac investigations to perform the perioperative assessment
- 4.3.1.7 Summarize all data to determine the patient cardiac risk and relevant anesthetic considerations

### 4.4 Pathophysiology

- 4.4.1 Demonstrate a thorough understanding of the pre-existing cardiac disease in planning for non-cardiac as well as cardiac surgery for patients with cardiac disease. The anesthesiologist must demonstrate an ability to manage patients with:
  - 4.4.1.1 Medically optimized pre-existing cardiac disease
  - 4.4.1.2 Thoracic Aortic Disease (atheroma, aneurysms, dissections)
  - 4.4.1.3 Coronary Artery Disease
    - 4.4.1.3.1 Acute myocardial ischemia
    - 4.4.1.3.2 Myocardial infarction
    - 4.4.1.3.3 Complications of myocardial infarction such as dysrhythmia, VSD, Congestive Heart Failure (CHF), Mitral Regurgitation (MR), Left Ventricular aneurysm, pseudoaneurysm
    - 4.4.1.3.4 Recent thrombolytic and anti-platelet therapy

- 4.4.1.3.5 Recent Percutaneous Coronary Intervention (PCI) and coronary stent placement
- 4.4.1.4 Valvular heart disease
  - 4.4.1.4.1 Aortic Stenosis (AS)
  - 4.4.1.4.2 Aortic Regurgitation (AR)
  - 4.4.1.4.3 Mitral Stenosis (MS)
  - 4.4.1.4.4 Mitral Regurgitation (MR)
  - 4.4.1.4.5 Pulmonary Stenosis (PS)
  - 4.4.1.4.6 Tricuspid Regurgitation (TR)
- 4.4.1.5 Cardiac tamponade
- 4.4.1.6 Constrictive pericarditis
- 4.4.1.7 Cardiomyopathies
  - 4.4.1.7.1 Dilated
  - 4.4.1.7.2 Restrictive
  - 4.4.1.7.3 Obstructive (Hypertrophic Obstructive Cardiomyopathy (HOCM) with or without Systolic Anterior Motion (SAM), Dynamic left ventricular obstruction in the elderly)
  - 4.4.1.7.4 Tako-tsubo or stress-related
- 4.4.1.8 Cardiogenic shock
  - 4.4.1.8.1 Right sided congestive heart failure (CHF)
  - 4.4.1.8.2 Left sided CHF from diastolic and/or systolic dysfunction
- 4.4.1.9 Pulmonary Hypertension
  - 4.4.1.9.1 Aberrant conduction and acute and chronic dysrhythmia (including atrial fibrillation, supra-ventricular tachycardia, Wolf Parkinson White (WPW))
  - 4.4.1.9.2 Pacemaker and Automatic Implantable Cardioverter Defibrillator (AICD)
  - 4.4.1.9.3 Cardiac transplant
  - 4.4.1.9.4 Adult Congenital Heart Disease
  - 4.4.1.9.5 Endocarditis

4.5 Pharmacology

- 4.5.1 Demonstrate knowledge with respect to mechanism of action, pharmacokinetics and pharmacodynamics, indications, contraindications, side effects, complications, dosage, antidote, interactions, and anesthetic implications of:
  - 4.5.1.1 Sympathomimetics, alpha and beta $\beta$ - adrenergic antagonists
  - 4.5.1.2 Phosphodiesterase inhibitors
  - 4.5.1.3 Calcium sensitizing agents (levosimendan)
  - 4.5.1.4 Peripheral vasodilators, including the nitrates;
  - 4.5.1.5 Calcium-channel blockers
  - 4.5.1.6 Diuretics
  - 4.5.1.7 Other anti-hypertensive agents
  - 4.5.1.8 Other anti-dysrhythmic drugs, including digitalis
  - 4.5.1.9 Prostaglandins
  - 4.5.1.10 Nitric Oxide
  - 4.5.1.11 Anti-fibrinolytic agents
  - 4.5.1.12 Anti-platelet agents
  - 4.5.1.13 Thrombolytics
  - 4.5.1.14 Heparin and non-heparin anticoagulants
  - 4.5.1.15 Protamine
  - 4.5.1.16 Drugs for pulmonary hypertension
- 4.5.2 Demonstrate understanding of the use of epidurals and spinal cord stimulation in myocardial ischemia
- 4.5.3 Demonstrate knowledge and understanding of the effects on the cardiovascular system of all the major agents use in anesthesiology
- 4.5.4 Demonstrate knowledge of the current indications for and recommendations of pharmacologic agents to minimize or prevent perioperative ischemic complications (e.g., ASA,  $\beta$ -blockers, statins, etc.)

4.6 Monitoring (see also Chapter 15 – Monitoring and Equipment)

- 4.6.1 Demonstrate knowledge and ability to interpret all information from cardiovascular monitors, including their limitations, in determining diagnosis and guiding perioperative management:
  - 4.6.1.1 ECG
  - 4.6.1.2 Pulse oxymetry

- 4.6.1.3 Non-invasive and invasive blood pressure monitoring
- 4.6.1.4 Central venous pressure monitoring
- 4.6.1.5 Pulmonary Artery (PA) pressure monitoring
- 4.6.1.6 Non-invasive and invasive cardiac output monitoring
- 4.6.1.7 Transthoracic and transesophageal echocardiographic monitoring (see Chapter 25 – POCUS)
- 4.6.2 Demonstrate an understanding and ability to interpret information from thromboelastogram monitoring
- 4.6.3 Demonstrate an understanding and ability to interpret blood gas analysis
- 4.7 Other
  - 4.7.1 Demonstrate knowledge of various methods of blood conservation in cardiac and non-cardiac surgery including cell savers
  - 4.7.2 Demonstrate an understanding of the pathophysiology and management of heparin-induced thrombocytopenia HIT and new/novel anticoagulants (e.g., recombinant Hirudin, Argatroban, bivalirudin)
  - 4.7.3 Demonstrate an understanding of the pathophysiology of heparin resistance

#### **D) Anesthesia for cardiac surgery**

- 4.8 Perioperative management of patients undergoing cardiac surgery
  - 4.8.1 Demonstrate knowledge of special issues related to Cardiac Surgery and Anesthesiology
  - 4.8.2 Demonstrate knowledge of the indications for elective and emergent coronary artery bypass graft (CABG) surgery
  - 4.8.3 Demonstrate knowledge of the indications, contraindications and risks for intra-aortic balloon pump (IABP)
  - 4.8.4 Demonstrate knowledge of the pathophysiology and management of complications after cardiac surgery such as bleeding, graft occlusion, early and late arrhythmia, stroke, tamponade and neuro-cognitive dysfunction
  - 4.8.5 Demonstrate knowledge of the management of temporary pacemaker utilization post cardiac surgery
  - 4.8.6 Demonstrate knowledge of antifibrinolytics and their role in blood conservation
  - 4.8.7 Demonstrate knowledge of Cardiopulmonary Bypass CPB and its physiologic effects and complications

- 4.8.8 Demonstrate knowledge of the perioperative management of procedures in the cath lab (e.g., Atrial fibrillation ablation, Patent foramen ovale (PFO) closure)
- 4.8.9 Demonstrate knowledge of resource utilization and cost effectiveness techniques in cardiac anesthesiology, surgery and Cardiovascular (CV) intensive care

## **E) Anesthesia for Vascular Surgery**

- 4.9 Demonstrate an understanding of the anatomy and physiology relevant to the management of patients presenting for vascular surgery, including but not limited to:
  - 4.9.1 Anatomy, Physiology and Pathophysiology
    - 4.9.1.1 Demonstrate knowledge of the basic sciences as applicable to Anesthesiology, including vascular anatomy, and pertinent physiology
    - 4.9.1.2 Anatomy and physiology of spinal blood supply
    - 4.9.1.3 Physiologic consequences of aortic cross clamping including impact of level of clamping
    - 4.9.1.4 Pathophysiology of atherosclerotic disease
    - 4.9.1.5 Pathophysiology of the major diseases of the aorta:
      - 4.9.1.5.1 Aortic aneurysm
      - 4.9.1.5.2 Aortic dissection
      - 4.9.1.5.3 Aortic occlusive disease
      - 4.9.1.5.4 Embolic disease and ischemic limb
      - 4.9.1.5.5 Connective tissue disease
      - 4.9.1.5.6 Aortitis
      - 4.9.1.5.7 Aortic injury after blunt trauma
  - 4.9.2 The anesthesiologist must demonstrate an ability to apply the aforementioned knowledge in clinical management with respect to the assessment, monitoring and perioperative management of patient undergoing a vascular surgery
- 4.10 Clinical Assessment
  - 4.10.1 Demonstrate a comprehensive preoperative assessment and optimization of coexisting diseases prior to provision of anesthetic care
  - 4.10.2 Intervene appropriately to minimize perioperative risk



4.11 Clinical Management of Vascular Surgery

- 4.11.1 Demonstrate an expert understanding of the following considerations:
  - 4.11.1.1 Implications of clamping at various levels of the aorta
  - 4.11.1.2 Management of the hemodynamic effects of aortic cross clamping
- 4.11.2 Demonstrate an understanding of monitoring standards for vascular surgery, including but not limited to:
  - 4.11.2.1 Monitoring brain function, especially during carotid endarterectomy
  - 4.11.2.2 Monitoring spinal cord especially during thoracic aortic surgery
  - 4.11.2.3 Indications, contraindications and limitations of invasive monitoring
  - 4.11.2.4 Monitoring Activated Clotting Time (ACT)
- 4.11.3 Manage the anesthetic care for surgeries involving the descending aorta:
  - 4.11.3.1 Thoracic aneurysm repair
  - 4.11.3.2 Abdominal aneurysm repair
  - 4.11.3.3 Aortic dissection surgery
  - 4.11.3.4 Ruptured aortic aneurysm surgery
- 4.11.4 Manage the anesthetic care for:
  - 4.11.4.1 Peripheral vascular surgery
  - 4.11.4.2 Carotid endarterectomy and carotid stenting
    - 4.11.4.2.1 Highlight the advantages and disadvantages of regional versus general anesthesia
  - 4.11.4.3 Amputation
- 4.11.5 Provide expert care in the context of vascular surgery in relation to:
  - 4.11.5.1 Renal protection and supra-celiac clamps
  - 4.11.5.2 Spinal cord protection during thoracic aortic surgery

- 4.11.6 Provide expert post-operative management of adult patients following aortic, peripheral vascular and carotid procedures
- 4.11.7 Demonstrate competence in all technical procedures commonly employed in vascular anesthetic procedures, including
  - 4.11.7.1 Airway management
  - 4.11.7.2 Cardiovascular resuscitation
  - 4.11.7.3 Invasive monitoring
  - 4.11.7.4 Regional anesthetic techniques
  - 4.11.7.5 Analgesic techniques
- 4.11.8 Manage massive transfusions and its inherent complications
- 4.11.9 Demonstrate knowledge in the use of spinal drainage for thoracic aneurysm repair
- 4.11.10 Demonstrate understanding of the principles of perioperative anesthetic management for surgery of the ascending aorta and aortic arch
- 4.11.11 Pain Management
  - 4.11.11.1 Demonstrate knowledge and proficiency in providing pain management for patients following abdominal and peripheral vascular procedures
    - 4.11.11.1.1 Epidural and spinal analgesia including understanding of risks in the context of antiplatelet agents usage, intraoperative heparinization and other alterations in coagulation status

## 5 Complications of Anesthesia

- 5.1 Upon completion of this training, the Anesthesiologist shall demonstrate the ability to:
  - 5.1.1 Assess a patient's potential for complications based on comorbidities and planned procedures
  - 5.1.2 Obtain informed consent including discussion of the risks
  - 5.1.3 Prevent potential complications
  - 5.1.4 Manage complications
  - 5.1.5 Arrange appropriate patient disposition
  - 5.1.6 Document complications appropriately
  - 5.1.7 Disclose relevant information to the patient
  - 5.1.8 Arrange appropriate debriefing and quality assurance measures

### A) Identification and Management of Complications of Anesthesia

- 5.2 Demonstrate comprehensive knowledge and understanding of the most frequent or severe complications related to Anesthesia including, etiologies, risks factors, prevention, diagnosis, management and follow-up, including but not limited to:
  - 5.2.1 Awareness
  - 5.2.2 Allergy and anaphylaxis (see Chapter 13 – Immunology and Rheumatology section 13.4)
  - 5.2.3 Bacteremia
  - 5.2.4 Hyper-/hypotension
  - 5.2.5 Tachy-/bradycardia and arrhythmias
  - 5.2.6 Hyper-/hypocarbica
  - 5.2.7 Hypoxemia
  - 5.2.8 Hyper-/hypothermia
  - 5.2.9 Raised airway pressure
  - 5.2.10 Laryngospasm
  - 5.2.11 Bronchospasm
  - 5.2.12 Aspiration/Aspiration Pneumonia
  - 5.2.13 Dental injury
  - 5.2.14 Corneal abrasion
  - 5.2.15 Perioperative visual loss
  - 5.2.16 Post-operative nausea and vomiting
  - 5.2.17 Nerve injury

- 5.2.18 Delirium
- 5.2.19 Post-operative cognitive dysfunction
- 5.2.20 Cardiac arrest
- 5.2.21 Intraoperative fires/burns

**B) Identification and Management of Complications of Regional Anesthesia** - See Chapter 28 - Regional Anesthesia section 28.5

**C) Identification and Management of Complications related to Anesthetic Drugs**

- 5.3 Demonstrate comprehensive knowledge and understanding of the pathophysiology and management of complications related to anesthetic agents or other drugs used during anesthesia including but not limited to: (also see Chapter 23 – Pharmacology and Chapter 35 – Volatile Agents)
  - 5.3.1 Allergic reactions (see Chapter 13 – Immunology and Rheumatology section 13.4)
  - 5.3.2 Anaphylaxis and Anaphylactoid reactions
  - 5.3.3 Overdose
  - 5.3.4 Extravasation of drugs
  - 5.3.5 Drugs interactions
- 5.4 Demonstrate comprehensive knowledge and understanding of the specific complications related to anesthetic agents including, pathophysiology, risks factors, prevention, diagnosis, management and follow-up, including but not limited to the following:
  - 5.4.1 Malignant Hyperthermia
  - 5.4.2 Halothane Hepatitis
  - 5.4.3 Succinylcholine myalgias

**D) Identification and Management of Complications related to Fluid Management**

- 5.5 Demonstrate comprehensive knowledge and understanding of the pathophysiology and management of complications related to fluid and blood product administration
  - 5.5.1 Fluid (see Chapter 6 - Critical Care section 6.3)
  - 5.5.2 Blood products (see Chapter 11 - Hematology section 11.31)

**E) Identification and Management of Complications related to Monitoring**

- 5.6 Demonstrate comprehensive knowledge and understanding of the specific complications related to invasive and non-invasive monitoring used during perioperative care including, pathophysiology, risks factors, prevention, diagnosis, management and follow-up. (see also Chapter 15 – Monitoring and Equipment)

**F) Identification and Management of Complications related to Patient Positioning**

- 5.7 Demonstrate comprehensive knowledge and understanding of the specific complications related to patient positioning including, pathophysiology, risks factors, prevention, diagnosis, management and follow-up, including but not limited to:
- 5.7.1 Pressure point injury
  - 5.7.2 Nerve injury (pressure, stretching)
  - 5.7.3 Eyes injury (abrasion, pressure)
  - 5.7.4 Venous air embolism
  - 5.7.5 Inadequate organ perfusion (stroke, compartment syndrome)
  - 5.7.6 Specific injury related to prone positioning
    - 5.7.6.1 Loss of airway in the prone position
    - 5.7.6.2 Cardiac arrest in the prone position
  - 5.7.7 Specific injury related to beach chair positioning
  - 5.7.8 Specific injury related to lateral positioning
  - 5.7.9 Specific injury related to gynecologic positioning
  - 5.7.10 Specific injury related to prolonged surgery
- 5.8 Demonstrate comprehensive knowledge and understanding of the risk related to change of positioning during surgery
- 5.9 Understanding the risks of extreme head position, including perioperative stroke

**G) Identification and Management of Complications related to the Type of surgery**

- 5.10 Demonstrate comprehensive knowledge and understanding of the specific complications related to the type of surgery including, pathophysiology, risks factors, prevention, diagnosis, management and follow-up

**H) Identification and Management of Complications related to Mechanical Ventilation – (see Chapter 6 - Critical Care section 6.2)**

- 5.11 Demonstrate comprehensive knowledge and understanding of the specific complications related to mechanical ventilation including, pathophysiology, risks factors, prevention, diagnosis, management and follow-up

**I) Identification of Occupational Hazards for Anesthesiologists and other OR personnel**

- 5.12 Demonstrate an understanding of the potential risks to themselves and others when dealing with high risk patients in various situations in the operating room and potential prevention strategies, including but not limited to:
- 5.12.1 Needle stick
  - 5.12.2 Infections – needle, airborne, contact
  - 5.12.3 Toxic substance in the environment (e.g., volatile agents)
  - 5.12.4 Laser
  - 5.12.5 Fire safety
- 5.13 Violent patient – Assault (physical, verbal)
- 5.14 Demonstrate an understanding of the potential risks encounter during practice and potential prevention strategies, including but not limited to:
- 5.14.1 Physical injury related to patient lifting
  - 5.14.2 Noise pollution
  - 5.14.3 Post Traumatic Stress Disorder (PTSD) after adverse events
  - 5.14.4 Fatigue
  - 5.14.5 Substance abuse
  - 5.14.6 Suicide and other mental illness

## 6 Critical Care

Upon completion of this training, the Anesthesiologist must demonstrate an understanding of all the facets of critical care medicine including principles of management of the critically ill patient, acute resuscitation, trauma management and crisis resource management.

### A) Airway management (see Chapter 1 – Airway Evaluation and Management)

- 6.1 Demonstrate an in depth understanding of airway management in the critically ill patient

### B) Mechanical ventilation

- 6.2 Demonstrate an understanding of the physiology of mechanical ventilation and its use in critical care, its indications, contraindications and side effects:
  - 6.2.1 Indications for and contraindications of non-invasive and invasive positive pressure ventilation
  - 6.2.2 Hemodynamic effects of positive pressure ventilation: Heart-lung interaction
  - 6.2.3 Modes of ventilation
    - 6.2.3.1 Continuous mandatory ventilation (CMV)
    - 6.2.3.2 Assist-Control Ventilation (ACV)
    - 6.2.3.3 Synchronized intermittent mandatory ventilation (SIMV)
    - 6.2.3.4 Pressure support ventilation
    - 6.2.3.5 Pressure control ventilation
    - 6.2.3.6 Pressure control inverse ration ventilation (PCIRV)
    - 6.2.3.7 Airway pressure release ventilation (APRV)
    - 6.2.3.8 Proportional Assist Ventilation (PAV)
    - 6.2.3.9 Non-invasive positive pressure ventilation
      - 6.2.3.9.1 Continuous Positive Airway Pressure (CPAP)
      - 6.2.3.9.2 Bilevel Positive Airway Pressure (BiPAP)
    - 6.2.3.10 High frequency Percussive ventilation
      - 6.2.3.10.1 High frequency oscillation
  - 6.2.4 Ventilator induced lung injury and it's prevention
  - 6.2.5 Adult Respiratory Distress Syndrome (ARDS) net protocol
  - 6.2.6 Managing patient-ventilator dyssynchrony
  - 6.2.7 Weaning from mechanical ventilation

- 6.2.8 Monitoring ventilatory therapy
  - 6.2.8.1 Arterial and venous blood gases
  - 6.2.8.2 Pulse oximetry
  - 6.2.8.3 Ventilator graphics (pressure, flow)
- 6.2.9 Sedation and paralysis for mechanical ventilation
  - 6.2.9.1 Pharmacology of common sedative and analgesic agents
  - 6.2.9.2 Indications for neuromuscular blockade and pharmacology of neuromuscular blocking agents
  - 6.2.9.3 Complications of prolonged mechanical ventilation and neuromuscular blockade
    - 6.2.9.3.1 Myopathy of critical illness

### **C) Management of fluid, electrolyte and acid-base disorders**

- 6.3 Demonstrate an understanding of fluid and electrolyte disturbances encountered in critical care and their management
  - 6.3.1 Normal distribution of total body water and electrolytes
  - 6.3.2 Options for fluid replacement
    - 6.3.2.1 Crystalloids
    - 6.3.2.2 Synthetic colloids
    - 6.3.2.3 Albumin
    - 6.3.2.4 Blood Products
  - 6.3.3 Diagnosis and Management of electrolyte abnormalities (acute and chronic)
    - 6.3.3.1 Hypo/Hyponatremia
    - 6.3.3.2 Hypo/Hyperkalemia
    - 6.3.3.3 Hypo/Hypercalcemia
    - 6.3.3.4 Hypo/Hypermagnesemia
    - 6.3.3.5 Hypo/Hyperphosphatemia
  - 6.3.4 Diagnosis, Classification and Management of acid-base disorders
    - 6.3.4.1 Respiratory acidosis
    - 6.3.4.2 Respiratory alkalosis
    - 6.3.4.3 Metabolic acidosis
    - 6.3.4.4 Metabolic alkalosis



6.3.4.5 Mixte disorders

**D) Nutrition**

6.4 Demonstrate an understanding of the nutritional needs of the critically ill patient and an approach to management thereof:

6.4.1 Options for nutritional replacement

6.4.1.1 Enteral feeding

6.4.1.2 Total Parenteral Nutrition (TPN)

6.4.2 Estimation of resting energy expenditure – the Harris – Benedict equation

**E) Transfusion therapy** (see Chapter 11 – Hematology)

6.5 Demonstrate an understanding of transfusion therapy as it applies to the critically ill patient

**F) Pathophysiology and Management of shock**

6.6 Demonstrate an understanding of the pathophysiology of various forms of shock and the management thereof:

6.6.1 Hypovolemic shock

6.6.2 Septic shock

6.6.2.1 Systemic inflammatory response syndrome (SIRS)

6.6.3 Cardiogenic shock

6.6.4 Obstructive shock

6.6.4.1 Pulmonary embolism

6.6.4.2 Pericardial tamponade

6.6.4.3 Tension pneumothorax

6.6.4.4 Air embolism

6.6.4.5 Amniotic fluid embolism

6.6.5 Distributive shock

6.6.5.1 Spinal shock

6.6.5.2 Anaphylactic shock

- 6.6.6 Fluid therapy
- 6.6.7 Pharmacology of and critical indications for vasopressors and inotropic therapy

### **G) Management of Hypertension**

- 6.7 Demonstrate an understanding of the causes and management of hypertension in the critically ill patient, including but not limited to:
  - 6.7.1 Establish a differential diagnosis of the hypertension including but not limited to malignant hypertension, renal failure, thyroid storm, pheochromocytoma, neuroleptic malignant syndrome, brain herniation, etc.
  - 6.7.2 Demonstrate knowledge of the pharmacology and appropriate use of antihypertensive agents
  - 6.7.3 Diagnose and manage an hypertensive crisis

### **H) Respiratory Failure**

- 6.8 Demonstrate an understanding of the pathophysiology and an approach to the management of critically ill patients in respiratory failure, including differential diagnosis of respiratory failure, including but not limited to:
  - 6.8.1 Acute Respiratory Distress Syndrome (ARDS)
  - 6.8.2 Hospital acquired pneumonia
  - 6.8.3 Chronic obstructive pulmonary disease
  - 6.8.4 Ventilator associated pneumonia
  - 6.8.5 Severe community acquired pneumonia
  - 6.8.6 Severe acute asthma (e.g., status asthmaticus)
- 6.9 Demonstrate knowledge of the pathophysiology, diagnose and manage pulmonary hypertension
- 6.10 Demonstrate technical knowledge and management for
  - 6.10.1 Thoracentesis
  - 6.10.2 Chest tube insertion

### **I) Acute Coronary Syndromes (ACS)**

- 6.11 Demonstrate an understanding of the pathophysiology, diagnosis and management of acute coronary syndromes, including but not limited to:
  - 6.11.1 Pharmacologic management of ACS
  - 6.11.2 Percutaneous coronary angioplasty and stenting
  - 6.11.3 Coronary artery bypass grafting

- 6.11.4 Management of cardiac failure (left and right cardiac failure)
  - 6.11.4.1 Pharmacology
  - 6.11.4.2 Supportive care
  - 6.11.4.3 Intra-aortic balloon pump
  - 6.11.4.4 LVAD and RVAD (left and right ventricular assist devices) – awareness of their usage
- 6.11.5 Complications of myocardial infarction
  - 6.11.5.1 Acute mitral regurgitation
  - 6.11.5.2 Ventricular septal defect
  - 6.11.5.3 Ventricular free wall rupture
  - 6.11.5.4 Ventricular aneurysm

**J) Management of arrhythmias and cardiac arrest**

- 6.12 Demonstrate an in depth knowledge of the Advanced Cardiac Life Support (ACLS) protocols and an approach to the management of arrhythmias and cardiac arrest, including but not limited to:
  - 6.12.1 ACLS guidelines for the management of:
    - 6.12.1.1 Ventricular tachycardia (VT), (including polymorphic VT), and ventricular fibrillation
    - 6.12.1.2 Asystole
    - 6.12.1.3 Atrial flutter and fibrillation
    - 6.12.1.4 Other supraventricular tachycardias
    - 6.12.1.5 Symptomatic bradycardia
    - 6.12.1.6 AV block
    - 6.12.1.7 Wolff-Parkinson-White syndrome
    - 6.12.1.8 Pulseless electrical activity
  - 6.12.2 Principles of safe cardioversion and defibrillation
  - 6.12.3 Transthoracic and transvenous pacing
  - 6.12.4 Management of the pacemaker dependent patient)
  - 6.12.5 Management of a patient with an automatic implantable cardiac defibrillator (AICD)
  - 6.12.6 Management of a patient with a cardiac resynchronization therapy device (CRT); CRT-P (biventricular pacemaker) and CRT-D (CRT-P with cardioverter-defibrillator)
  - 6.12.7 Pharmacology of antiarrhythmic therapy

**K) Infectious diseases** - See Chapter 14 - Infectious Disease

- 6.13 Demonstrate an approach to the diagnosis and management of infectious diseases in the critically ill patient
  - 6.13.1 Antibiotic therapy and timing
  - 6.13.2 Tapering and tailoring of antibiotic therapy

**L) Neurocritical care**

- 6.14 Demonstrate knowledge of issues encountered with neurocritical care unit patients, including but not limited to:
  - 6.14.1 Management of severe head trauma and raised intracranial pressure (ICP)
  - 6.14.2 Management of cerebrovascular accident due to ischemic or hemorrhagic stroke
    - 6.14.2.1 Intracranial hemorrhage
    - 6.14.2.2 Subarachnoid hemorrhage
  - 6.14.3 Management of status epilepticus
  - 6.14.4 Differential diagnosis and management of decreased level of consciousness and coma
  - 6.14.5 Management of agitation and delirium
  - 6.14.6 Diagnosis and management of Guillain–Barre syndrome
  - 6.14.7 Management of spinal shock

**M) Pulmonary embolism and thromboembolic disease**

- 6.15 Diagnosis of deep vein thrombosis and pulmonary embolism
- 6.16 Principles of prophylactic and therapeutic anticoagulant therapy
- 6.17 Diagnosis and management of massive pulmonary embolism

**N) Acute and Chronic Renal Failure** - See Chapter 30 - Renal/ Urologic

- 6.18 Demonstrate knowledge of the pathophysiology and the management of the critically ill patient with renal failure, including but not limited to:
  - 6.18.1 Management of the critically ill patient with chronic renal failure
  - 6.18.2 Differential diagnosis and management of acute renal failure
  - 6.18.3 Management of rhabdomyolysis
  - 6.18.4 Management of hyperkalemia

- 6.18.5 Management of hepatorenal syndrome
- 6.18.6 Principles of hemodialysis, continuous renal replacement therapy and sustained low efficiency dialysis: acute vs. chronic
- 6.18.7 Hemodialysis, use in poisoning/ingestions

**O) Management of Acute and Chronic Hepatic Failure - See Chapter 12 - Hepatobiliary**

- 6.19 Demonstrate knowledge of the pathophysiology and the management of the critically ill patient with hepatic failure, including but not limited to:
  - 6.19.1 Differential diagnosis and management of acute and fulminant hepatic failure
  - 6.19.2 Indications for urgent liver transplantation
  - 6.19.3 Management of complications of hepatic failure
    - 6.19.3.1 Cerebral edema
    - 6.19.3.2 Hepatic encephalopathy
    - 6.19.3.3 Coagulopathy
    - 6.19.3.4 Ascites
    - 6.19.3.5 Spontaneous bacterial peritonitis
    - 6.19.3.6 Hepatorenal and hepatopulmonary syndromes

**P) Gastrointestinal Emergencies**

- 6.20 Demonstrate knowledge of the pathophysiology and the management of the critically ill patient presenting with gastrointestinal emergencies, including but not limited to:
  - 6.20.1 Differential diagnosis and management of upper and lower gastrointestinal bleeding
  - 6.20.2 Differential diagnosis and management of peritonitis
  - 6.20.3 Prevention and management of aspiration
  - 6.20.4 Disorders of bowel mobility
  - 6.20.5 Prevention of stress ulceration and complications of treatment
  - 6.20.6 Management of acute pancreatitis
  - 6.20.7 Intestinal ischemia
  - 6.20.8 Acute megacolon
  - 6.20.9 Abdominal compartment syndrome

**Q) Endocrine Emergencies**

- 6.21 Demonstrate knowledge of the pathophysiology and the management of the critically ill patient presenting with endocrine emergencies, including but not limited to:
  - 6.21.1 Diabetes mellitus
  - 6.21.2 Diabetic ketoacidosis
  - 6.21.3 Hyperosmolar nonketotic coma
  - 6.21.4 Hyperthyroidism and Thyroid storm
  - 6.21.5 Hypothyroidism and myxedema coma
  - 6.21.6 Hypercalcemia
  - 6.21.7 Adrenal insufficiency
  - 6.21.8 Diabetes insipidus
  - 6.21.9 Syndrome of inappropriate antidiuretic hormone (SIADH)

**R) Management of Poisoning and Drug-Related Complications**

- 6.22 Demonstrate knowledge of the physiological consequences and the management of patients after poisonings, drug overdoses and exposure to agents used in bioterrorism, including but not limited to:
  - 6.22.1 Salicylates
  - 6.22.2 Methanol/ethylene glycol/isopropyl alcohol
  - 6.22.3 Sedative agents
    - 6.22.3.1 Barbiturates
    - 6.22.3.2 Benzodiazepines
  - 6.22.4 Antipsychotic agents
    - 6.22.4.1 Phenothiazines
    - 6.22.4.2 Lithium
  - 6.22.5 Antidepressants
    - 6.22.5.1 Monoamine oxidase inhibitors
    - 6.22.5.2 Tricyclic antidepressants
  - 6.22.6 Acetaminophen
  - 6.22.7 Narcotics
  - 6.22.8 Beta blockers
  - 6.22.9 Calcium channel blockers

- 6.22.10 Digitalis
- 6.22.11 Carbon monoxide
- 6.22.12 Organophosphate poisoning (insecticides, medications, nerve agents)
- 6.22.13 Cyanide

### **S) Drug Related Syndromes**

- 6.23 Diagnose and manage idiosyncratic drug reactions, including but not limited to:
  - 6.23.1 Serotonin syndrome
  - 6.23.2 Malignant hyperthermia (MH)
  - 6.23.3 Neuroleptic malignant syndrome

### **T) Critical care of the trauma patient**

- 6.24 Demonstrate in depth knowledge of the management of the trauma patient, including but not limited to:
  - 6.24.1 Principles of Advanced Trauma Life Support (ATLS)
  - 6.24.2 Management of hypovolemia
  - 6.24.3 Management of hypothermia
  - 6.24.4 Management of coagulopathy
  - 6.24.5 Management of abdominal compartment syndrome
  - 6.24.6 Evaluation and management of various forms of trauma:
    - 6.24.6.1 Blunt trauma
    - 6.24.6.2 Penetrating trauma
    - 6.24.6.3 Crush injury
    - 6.24.6.4 Long bone trauma
    - 6.24.6.5 Thoracic trauma
    - 6.24.6.6 Abdominal trauma
  - 6.24.7 Evaluation and management of neurologic trauma
    - 6.24.7.1 Head injury and raised intracranial pressure
    - 6.24.7.2 Spinal cord injury and spinal shock
    - 6.24.7.3 Determination of brain death
      - 6.24.7.3.1 Management of the brain dead organ donor

- 6.24.8 Evaluation and management of burns
- 6.24.9 Airway management of the trauma patient

**U) Obstetrical Critical Care - See Chapter 18 – Obstetrical Anesthesia**

- 6.25 Demonstrate knowledge of obstetrical conditions requiring critical care management, including but not limited to:
  - 6.25.1 Pre-eclampsia/eclampsia
  - 6.25.2 HELLP syndrome
  - 6.25.3 Respiratory critical care of the pregnant patient
    - 6.25.3.1 Pneumonia
    - 6.25.3.2 ARDS
    - 6.25.3.3 Asthma
    - 6.25.3.4 Respiratory failure
  - 6.25.4 Postpartum hemorrhage
    - 6.25.4.1 Abruptio placenta
  - 6.25.5 Amniotic fluid embolism
  - 6.25.6 Disseminated intravascular coagulation
    - 6.25.6.1 Uterine rupture
  - 6.25.7 Management of cardiac arrest in pregnancy
  - 6.25.8 Thromboembolic disease in pregnancy
  - 6.25.9 Postpartum care of the parturient with cardiovascular disease
    - 6.25.9.1 Acute coronary syndrome
    - 6.25.9.2 Valvular heart disease
    - 6.25.9.3 Postpartum cardiomyopathy
  - 6.25.10 Management of trauma during pregnancy

**V) Postoperative Care**

- 6.26 Demonstrate knowledge of the management of patients requiring critical care admission after major surgical procedures, including but not limited to:
  - 6.26.1 Cardiac surgery
  - 6.26.2 Thoracic surgery



6.26.3 Vascular surgery

6.26.3.1 Abdominal aortic aneurysm surgery

6.26.3.2 Revascularization of the lower limb surgery

6.26.3.3 Carotid endarterectomy

6.26.4 Solid organ transplant

6.26.5 Major abdominal surgery

6.26.5.1 Hepatic resection

6.26.5.2 Pancreatectomy

6.26.5.3 Esophagectomy

6.26.5.4 Bowel resection

6.27 Demonstrate appropriate fluid and electrolyte management after major surgery

**W) Ethical principles of Critical Care management**

6.28 Demonstrate knowledge of ethical concerns related to management of critically ill patients, including but not limited to:

6.28.1 Patient confidentiality and privacy legislation

6.28.2 Patient autonomy

6.28.3 Principles of informed consent and decision making

6.28.3.1 Blood products consent and refusal

6.28.4 Next of kin designation

6.28.5 End of life decision making

6.28.6 Organ procurement for transplantation

6.28.7 Management and review of adverse events

6.28.8 Communication with families in crisis

6.28.9 Cultural aspects of Critical Care

**X) Principles of crisis management and team leadership**

6.29 Demonstrate knowledge of crisis resource management and team leadership in critical situations, including but not limited to:

- 6.29.1 Leadership
- 6.29.2 Resource assessment and allocation
- 6.29.3 Situational awareness
- 6.29.4 Communication and collaboration during a crisis

## 7 Ear, Nose and Throat Surgery

Upon completion of this training, the competent Anesthesiologist shall demonstrate advanced knowledge and clinical proficiency in all the objectives listed below

### A) General ENT Considerations:

- 7.1 Demonstrate knowledge of the general considerations for providing anesthetics for ENT procedures and communicate closely with the surgeon and operating room personnel regarding perioperative airway management concerns, including but not limited to:

- 7.1.1 Preoperative Patient Concerns

- 7.1.1.1 Co-morbid conditions (e.g., smoking, COPD, alcohol, cancer)

- 7.1.1.2 Spectrum of patients, Pediatric to elderly

- 7.1.2 Airway Anatomy – See chapter 1 - Airway

- 7.1.3 Shared and Remote Airway Considerations

- 7.1.3.1 Implications of limited physical and visual access during anesthetic

- 7.1.3.2 Specialized endotracheal tubes to facilitate surgical access

- 7.1.3.3 Vigilance against airway disconnections and kinking during surgical maneuvers

- 7.1.3.4 Occult bleeding into the airway during surgery

- 7.1.3.5 Throat packs

- 7.1.4 Difficult Airway

- 7.1.4.1 Implications of presenting disease process

- 7.1.4.1.1 Tumours and mass effects

- 7.1.4.1.2 Post-surgical or irradiation scarring

- 7.1.4.1.3 Congenital deformities

- 7.1.4.1.4 Foreign bodies

- 7.1.4.1.5 Trauma including maxilla-facial trauma

- 7.1.4.1.6 Trismus

- 7.1.4.1.7 Infections, abscesses

- 7.1.4.2 Considerations for appropriate endotracheal tube type, size and placement

- 7.1.4.2.1 Microlaryngoscopy tubes

- 7.1.4.2.2 Laser tubes

- 7.1.4.2.3 Nasal versus oral intubation
- 7.1.4.2.4 Oral and nasal RAE tubes
- 7.1.4.2.5 Neural Integrity Monitor EMG tubes (NIM tubes)
- 7.1.4.3 Control of ventilation and oxygenation
  - 7.1.4.3.1 Awake airway control
  - 7.1.4.3.2 Intravenous versus inhalation induction
  - 7.1.4.3.3 Other options – surgery under local anesthetic including awake tracheostomy
- 7.1.4.4 Emergence and extubation strategies
  - 7.1.4.4.1 Re-examination of airway for bleeding/clots
  - 7.1.4.4.2 Deep extubation versus awake extubation
  - 7.1.4.4.3 Consideration of throat packs, nasal packing
  - 7.1.4.4.4 Consideration of airway exchange catheters in appropriate cases
  - 7.1.4.4.5 Consideration of postoperative intubation

## **B) Endoscopy and Airway Infections**

- 7.2 Demonstrate knowledge of the anesthetic concerns and goals for endoscopy, with proficient evaluation and management of the patient. The anesthesiologist must also be able to manage patients presenting with acute infections that threaten airway patency, including epiglottitis and abscesses
  - 7.2.1 Considerations of presenting complaints
    - 7.2.1.1 Hoarseness, stridor, hemoptysis, croup
    - 7.2.1.2 Foreign body aspiration
    - 7.2.1.3 Airway trauma
    - 7.2.1.4 Papillomatosis
    - 7.2.1.5 Tumours
    - 7.2.1.6 Stenosis
    - 7.2.1.7 Vocal cord problems
  - 7.2.2 Procedural considerations
    - 7.2.2.1 Biopsies, bleeding, obstruction
    - 7.2.2.2 Lasers
    - 7.2.2.3 Positioning

- 7.2.2.4 Intubation and ventilation challenges
  - 7.2.2.4.1 Awake intubation, inhalation versus intravenous inductions, spontaneous vs. controlled ventilation
- 7.2.2.5 Jet ventilation
- 7.2.2.6 Rigid versus flexible endoscope

### **C) Nasal Cavity Search**

- 7.3 Demonstrate knowledge of the considerations for nasal cavity surgery, and demonstrate expertise in managing these cases
  - 7.3.1 Considerations of presenting complaints
    - 7.3.1.1 Nasal obstruction, polyps, infections
    - 7.3.1.2 Associated problems, e.g., Asthma, allergies, cystic fibrosis
    - 7.3.1.3 Epistaxis – trauma, coagulopathy, hemodynamic stability
  - 7.3.2 Procedural considerations
    - 7.3.2.1 Use of vasoconstrictors
      - 7.3.2.1.1 Cocaine, alternatives to cocaine e.g., phenylephrine, oxymetazoline
    - 7.3.2.2 Throat packs
    - 7.3.2.3 Occult blood loss
    - 7.3.2.4 Patient immobility vs. Short case lengths
    - 7.3.2.5 Post-op nasal packing, bleeding, positioning
    - 7.3.2.6 Major complications of sinus surgery including eye and brain damage

### **D) Laser Surgery of the Upper Airway**

- 7.4 Demonstrate advanced knowledge and practical skills in managing laser surgery cases
  - 7.4.1 Basic laser science
    - 7.4.1.1 Types of surgical lasers and indications
      - 7.4.1.1.1 Short wavelength lasers
      - 7.4.1.1.2 Infrared lasers
  - 7.4.2 Ventilation and oxygenation techniques
    - 7.4.2.1 Apneic technique, Jet ventilation, Spontaneous ventilation,

- Controlled ventilation with ETT
- 7.4.2.2 Low FiO<sub>2</sub>
- 7.4.3 Safety considerations
  - 7.4.3.1 Protection of patient and personnel
    - 7.4.3.1.1 Eye protection
    - 7.4.3.1.2 Skin protection
    - 7.4.3.1.3 Inhalation protection
  - 7.4.3.2 Airway fires
    - 7.4.3.2.1 Prevention strategies
      - 7.4.3.2.1.1 Surgeon techniques
      - 7.4.3.2.1.2 Gas mix
      - 7.4.3.2.1.3 ETT modifications
  - 7.4.3.3 Fire management protocol

## **E) Tonsillectomy and Adenoidectomy**

- 7.5 Demonstrate knowledge of the concerns for and management of tonsil and adenoid surgery, particularly in the pediatric patient
  - 7.5.1 Indications and pre-operative evaluation
    - 7.5.1.1 Chronic/recurrent upper respiratory tract infection
    - 7.5.1.2 Pediatric obstructive sleep apnea
      - 7.5.1.2.1 Adeno-tonsillar hypertrophy
    - 7.5.1.3 Bleeding dyscrasias
    - 7.5.1.4 Loose teeth
  - 7.5.2 Indications to postpone surgery
  - 7.5.3 Procedural considerations
    - 7.5.3.1 Induction and maintenance technique
    - 7.5.3.2 ETT, NTT, LMA
    - 7.5.3.3 Deep extubation vs. awake extubation
    - 7.5.3.4 Airway toilet
    - 7.5.3.5 Risk of negative pressure pulmonary edema

- 7.5.3.6 Re-operation for bleeding after adenotonsillectomy
  - 7.5.3.6.1 Chronology of bleeding
  - 7.5.3.6.2 Coagulopathy
  - 7.5.3.6.3 Full stomach
  - 7.5.3.6.4 Airway difficulty
  - 7.5.3.6.5 Hemodynamic stability, blood loss
- 7.5.3.7 Postoperative pain management
  - 7.5.3.7.1 Pros and Cons of NSAIDs
- 7.5.3.8 Postoperative nausea and vomiting and use of antiemetic agents
- 7.5.3.9 Guidelines for postoperative discharge vs. observation

## **F) Major Head and Neck Cancer Surgery**

- 7.6 Demonstrate knowledge of the anesthetic considerations of major head and neck surgery, with appropriate expertise to manage these cases
  - 7.6.1 Patient condition/comorbidities/optimization
    - 7.6.1.1 Smoking, COPD, alcohol
    - 7.6.1.2 Elderly, malnutrition
    - 7.6.1.3 Cardiovascular disease
    - 7.6.1.4 Prior irradiation, chemotherapy
  - 7.6.2 Airway patency or compromise
    - 7.6.2.1 Tumour mass effects
    - 7.6.2.2 Indirect nasopharyngoscopy
    - 7.6.2.3 Stridor, hoarseness, airway bleeding
    - 7.6.2.4 Edema, inflammation, fibrosis
  - 7.6.3 Intra-operative management
    - 7.6.3.1 Consideration for awake tracheotomy
    - 7.6.3.2 Monitoring
      - 7.6.3.2.1 Invasive monitoring
      - 7.6.3.2.2 Post-operative monitoring
      - 7.6.3.2.3 Nerve identification by surgeon
      - 7.6.3.2.4 Avoidance of muscle relaxation

- 7.6.3.3 Case length
  - 7.6.3.3.1 Temperature control
  - 7.6.3.3.2 Blood loss considerations
- 7.6.3.4 Hemodynamic instability
  - 7.6.3.4.1 Surgical stimulation of carotid sinus, stellate ganglion
- 7.6.3.5 Free flap considerations
  - 7.6.3.5.1 Avoidance of vasoconstrictors
  - 7.6.3.5.2 Fluid management
  - 7.6.3.5.3 Temperature control

## **G) Tracheostomy**

- 7.7 Demonstrate knowledge of the pathological processes necessitating tracheostomy, and provide expert anesthetic management of the patient with or undergoing tracheostomy
  - 7.7.1 Indications for:
    - 7.7.1.1 Emergent tracheostomy for airway obstruction
      - 7.7.1.1.1 Epiglottitis
      - 7.7.1.1.2 Upper airway tumours
    - 7.7.1.2 Elective tracheostomy
      - 7.7.1.2.1 For pulmonary toilet
        - 7.7.1.2.1.1 Prolonged orotracheal intubation
      - 7.7.1.2.2 During major head and neck cancer surgery
      - 7.7.1.2.3 Chronic ventilatory failure
  - 7.7.2 Anesthetic options for emergency tracheostomy
    - 7.7.2.1 Awake tracheostomy under local anesthetic
    - 7.7.2.2 General anesthetic
      - 7.7.2.2.1 Awake fiberoptic intubation
    - 7.7.2.3 Management of loss of tracheostomy with fresh stoma



7.7.3 Trans-tracheal intubation

7.7.3.1 Patient with pre-existing tracheal stoma

**H) Surgery for Obstructive Sleep Apnea**

7.8 Demonstrate knowledge of the pathophysiological changes resulting from obstructive sleep apnea and their implications for perioperative anesthetic management for all types of surgical procedures. The anesthesiologist must be able to provide expert clinical care for the patient with sleep apnea presenting for corrective surgery, with recognition of the following considerations:

7.8.1 Diagnosis of obstructive sleep apnea

7.8.1.1 Presumptive indicators in patient history and physical exam – such as the STOP BANG questionnaire

7.8.1.2 Definitive indicators and severity classification from formal sleep studies

7.8.2 Physiological derangements

7.8.2.1 Cardiopulmonary

7.8.2.1.1 Ischemic changes, arrhythmias, pulmonary and systemic hypertension

7.8.2.2 Behavioural

7.8.2.2.1 Somnolence, cognition

7.8.2.3 Sensitivity to respiratory depressants

7.8.3 Management of the obstructive sleep apnea patient

7.8.3.1 Intraoperative

7.8.3.1.1 Intubation, extubation, and airway management considerations

7.8.3.2 Post-operative considerations

7.8.3.2.1 Monitoring

7.8.3.2.2 Ongoing need for non-invasive ventilation

## **I) Ear Surgery**

- 7.9 Demonstrate knowledge of the considerations for various surgeries on the external and internal ear structures and demonstrate expertise in the care of patients presenting for ear surgery

7.9.1 Anesthetic considerations

7.9.1.1 Variety of procedures

7.9.1.1.1 Myringotomy

7.9.1.1.2 Myringoplasty, tympanoplasty

7.9.1.1.3 Mastoidectomy

7.9.1.2 Identification/preservation of facial nerve

7.9.1.2.1 Monitoring

7.9.1.3 Considerations for nitrous oxide and muscle relaxants

7.9.1.4 Positioning

7.9.1.5 Post-operative nausea and vomiting

## **J) Others**

- 7.10 Demonstrate knowledge of the considerations for surgeries performed by ENT surgeons or maxilla-facial surgeons and demonstrate expertise in the care of patients presenting for these surgeries, including but not limited to:

7.10.1 Thyroid surgery

7.10.2 Facial osteotomy

## 8 Endocrinology

### A) Pancreatic disorders: diabetes mellitus

- 8.1 Demonstrate knowledge with respect to the types of Diabetes Mellitus, the treatment regimens and anticipated complications. The anesthesiologist must demonstrate an approach to:
  - 8.1.1 The evaluation of the diabetic patient, including the associated complications, and an approach to a treatment plan to obtain adequate metabolic control in the perioperative period
  - 8.1.2 Demonstrate an ability to establish a perioperative preparation protocol in relation to the type and severity of diabetes mellitus and the anticipated surgical procedures
    - 8.1.2.1 Demonstrate knowledge on the various class of pharmacologic agents used by diabetic patients and their management during the perioperative period including risk of adverse effects
  - 8.1.3 Describe the implications of tight perioperative glucose level control on patient outcome
- 8.2 Acute problems: Demonstrate knowledge regarding the pathophysiology and management of acute emergencies related to DM including ketoacidosis and hyperosmolar coma

### B) Thyroid Dysfunction: Hypo and Hyperthyroidism

- 8.3 Demonstrate knowledge regarding the pathophysiology and clinical manifestations of hyper and hypo-thyroidism and the effects on anesthetic management. The anesthesiologist must demonstrate an approach to evaluation and management of the patient with thyroid dysfunction including effects of therapy
- 8.4 Acute problems: Describe the pathophysiology of thyroid storm and myxedema coma, their clinical manifestations and the treatment modalities
  - 8.4.1 Knowledge of the anesthetic considerations and management of acute thyroid dysfunction

### C) Parathyroid Dysfunction: Hypo and Hyperparathyroidism

- 8.5 Demonstrate knowledge with respect to:
  - 8.5.1 The evaluation of parathyroid gland function with respect to calcium metabolism and the treatment modalities used to ensure normocalcemia
  - 8.5.2 The anesthetic considerations of patients with parathyroid dysfunction

- 8.6 Describe the pathophysiology of hypo and hyper-calcemic states, their clinical manifestations and the treatment of these conditions

**D) Adrenal Dysfunction**

- 8.7 Demonstrate knowledge of the physiology of the adrenal cortex and medulla and the implications of acute and chronic adrenal dysfunction in the perioperative period as manifested by:
- 8.7.1 Pheochromocytoma: pathophysiology, clinical manifestations, preoperative preparation and perioperative management
  - 8.7.2 Cushing syndrome: Etiology, pathophysiology, clinical manifestations and perioperative management
  - 8.7.3 Adrenal insufficiency: Etiology of primary and secondary Addison's disease. Preoperative evaluation and management of patients with suppression of the pituitary axis due to long term steroid use
  - 8.7.4 Acute adrenal crisis: Diagnosis and Management
- 8.8 Manage the patient currently or recently receiving corticosteroid therapy presenting for anesthesia and surgery

**E) Posterior Pituitary Dysfunction: Syndrome of Inappropriate Anti-diuretic Hormone SIADH and Diabetes Insipidus**

- 8.9 Demonstrate knowledge of the normal pituitary function and evaluation of the patient with Posterior pituitary dysfunction including the pathophysiology, differential diagnosis, treatment, and anesthetic considerations of SIADH and diabetes insipidus

**F) Anterior Pituitary Dysfunction: Panhypopituitarism and Acromegaly**

- 8.10 Demonstrate knowledge of the pathophysiology, clinical manifestations and treatment of acute and chronic panhypopituitarism. The anesthesiologist must demonstrate an understanding of the pathophysiology, clinical presentation and treatment of the acromegalic patient and must describe the anesthetic considerations for patients with acromegaly

**G) Carcinoid Syndrome**

- 8.11 List the clinical manifestations of carcinoid syndrome and the anesthetic considerations arising from them
- 8.12 Demonstrate knowledge of the perioperative management of carcinoid syndrome

## 9 Ethics

**A) Upon completion of this training, the anesthesiologist must demonstrate an understanding of ethical principles as they apply to clinical practice:**

- 9.1 Describe the most frequently used ethical principles
  - 9.1.1 Beneficence, non-maleficence, respect for persons, autonomy, justice
- 9.2 Consent
  - 9.2.1 Ethical basis for getting consent (respect for persons/respect for autonomy, patient's right to define own good and goals of care)
    - 9.2.1.1 Obtaining informed consent – persuasion vs. coercion
  - 9.2.2 Determination of goals of care
  - 9.2.3 Capacity
    - 9.2.3.1 Assessment of capacity
    - 9.2.3.2 Lack of capacity (infants and children, demented, intoxicated, unconscious)
    - 9.2.3.3 Age of consent (consider local legislation) (mature minors)
    - 9.2.3.4 Advanced directives
  - 9.2.4 Substitute Decision Makers (SDMs)
    - 9.2.4.1 Regulations and principles for SDMs (dependent upon local jurisdiction)
  - 9.2.5 Consent for special circumstances
    - 9.2.5.1 Blood transfusion
    - 9.2.5.2 Jehovah's Witnesses – children, pregnancy, coercion by others
  - 9.2.6 Consent for Anesthesia, including appropriate documentation
  - 9.2.7 Refusal of care, including appropriate documentation
  - 9.2.8 Demands of inappropriate care

9.3 Privacy and Confidentiality

9.3.1 Difference between privacy and confidentiality

9.3.2 Awareness of risk of breach of confidentiality

9.3.2.1 Social media

9.3.2.2 Discussions with family

9.3.2.3 Conversation – OR, corridor

9.3.2.4 VIP patients

9.3.3 Situations where confidentiality is legitimately breached: duty to report / statutory reporting

9.3.3.1 Patients (not common in anesthesia)

9.3.3.2 Colleagues

9.3.3.3 Substance abuse

9.3.3.4 Sexual misconduct

9.3.3.5 Incompetence / unsafe practice

9.4 End of life

9.4.1 Do Not Resuscitate orders

9.4.1.1 Management of Do Not Resuscitate orders within the perioperative period

9.4.2 Withholding or Withdrawing care

9.4.2.1 Ineffective care – who decides, what is ineffective, goals of care

9.4.2.2 Futility – definition and management

9.4.2.2.1 Who decides what is futile?

9.4.2.2.2 When it applies? What are the associated risks?

9.4.3 Medical Assistance in Dying

9.5 Organ Donation

9.5.1 Brain Death – definition and determination

9.5.2 Donation after Cardiac Death

9.5.3 Donation after medical assistance in dying

9.6 Professional Behaviours

- 9.6.1 General professionalism
- 9.6.2 Conflict management (e.g., anesthesia-surgery)
- 9.6.3 Truth-telling – disclosure of error, giving bad news)
- 9.6.4 Recognizing and respecting diversity
  - 9.6.4.1 Gender, religious, cultural, ethnic, sexual, age, disability (mental and physical)

9.7 Teaching in Anesthesia

- 9.7.1 Tension between needs of patient and needs of learner
  - 9.7.1.1 Procedures for teaching, not for patient care
- 9.7.2 Disclosure to patient (who is doing what)
- 9.7.3 Teaching under anesthesia
- 9.7.4 Teaching using the newly dead

9.8 Resource Allocation

- 9.8.1 Individual patient vs. societal/hospital resources
- 9.8.2 The “last bed” or “last OR” slot –
  - 9.8.2.1 Criteria for allocation

9.9 Research in Anesthesia

- 9.9.1 Ethical conduct of research (research integrity); Research Ethics Boards
- 9.9.2 Timing of consent for research
- 9.9.3 Right to withdraw (but cannot withdraw under general anesthesia)
- 9.9.4 Clinical trials in the unconscious (trauma)
- 9.9.5 Publication ethics

9.10 Relations with industry

- 9.10.1 Conflict of interest and bias

9.11 Conscientious Objection

9.12 Risk

- 9.12.1 The patient who is a risk (infectious disease violence)
- 9.12.2 The doctor who is a risk (blood-borne pathogens)

## 10 Geriatrics

Upon completion of this training, the Anesthesiologist must demonstrate knowledge of the physiologic, pharmacologic and pathologic changes accompanying the aging process. The anesthesiologist must demonstrate knowledge of the impact that these changes have on the safe anesthetic management of the elderly patient.

### Goals & Objectives

#### A) Physiology and Pathophysiology of the Geriatric Patient

10.1 Demonstrate knowledge of the issues related to the geriatric population compared to non-geriatric adults, including but not limited to:

- Anatomic changes
- Physiologic changes
- Anesthetic considerations
  - 10.1.1 Central Nervous System
  - 10.1.2 Autonomic Nervous System
  - 10.1.3 Cardiovascular System
  - 10.1.4 Respiratory System
  - 10.1.5 Gastrointestinal System
  - 10.1.6 Renal System
  - 10.1.7 Hepatic System
  - 10.1.8 Musculoskeletal
  - 10.1.9 Thermoregulation
  - 10.1.10 Hematologic System

#### B) Preoperative Management

10.2 Evaluate and prepare the geriatric patient for anesthesia

10.2.1 Comorbidities and the Geriatric Patient

- 10.2.1.1 Elicit an appropriate history and perform a physical examination of the elderly patient to identify existing comorbid conditions
- 10.2.1.2 Obtain appropriate investigations and consultations in order to optimize elderly patients prior to surgery
- 10.2.1.3 Demonstrate knowledge of pre-existing comorbidities, the concept of frailty and its assessment, and the impact they have in the safe anesthesia management of the elderly patient
- 10.2.1.4 Demonstrate respect for the process of informed consent,



substitute decision makers and advance directives

10.2.2 Preoperative Testing

- 10.2.2.1 Demonstrate appropriate rationale, selection and use of ancillary testing based on planned surgical procedure, patient health status and perioperative guidelines
- 10.2.2.2 Demonstrate appropriate knowledge in interpretation of diagnostic tests

**C) Pharmacology and the Geriatric Patient**

10.3 Pharmacokinetics

- 10.3.1 Demonstrate knowledge of differences in pharmacokinetics in the elderly patient based upon differences in:
  - 10.3.1.1 Absorption
  - 10.3.1.2 Distribution
  - 10.3.1.3 Metabolism
  - 10.3.1.4 Excretion

10.4 Pharmacodynamics

- 10.4.1 Describe changes in the pharmacodynamics, rationale for selection and appropriate use of agents routinely used in anesthesia practice, including but not limited to:
  - 10.4.1.1 Intravenous induction agents
  - 10.4.1.2 Muscle relaxants
  - 10.4.1.3 Opioids
  - 10.4.1.4 Benzodiazepines
  - 10.4.1.5 Inhaled anesthetics
  - 10.4.1.6 Local anesthetics

**D) Anesthesia and the Geriatric Patient**

- 10.5 Provide perioperative care for geriatric patients by being able to discuss evidence related to choice of anesthetic technique and post-operative outcome in this patient population
  - 10.5.1 General Anesthesia in the Geriatric Patient
    - 10.5.1.1 Discuss the physiologic effects of general anesthesia in the elderly patient
    - 10.5.1.2 Discuss indications, contraindications and risks associated with the use of general anesthesia specific to the elderly

- 10.5.1.3 Provide safe, competent general anesthesia for all major and minor surgical procedures in elderly patients

- 10.5.2 Regional Anesthesia in the Geriatric Patient - See Chapter 27 - Regional

- 10.5.2.1 Describe the alterations in anatomy, physiology, pharmacology and complications specific to the geriatric patient for the following techniques:

- 10.5.2.1.1 Epidural Anesthesia
- 10.5.2.1.2 Spinal Anesthesia
- 10.5.2.1.3 Head and neck blocks
- 10.5.2.1.4 Upper extremity blocks
- 10.5.2.1.5 Lower extremity blocks

**E) Special Postoperative Considerations in the Geriatric Patient**

- 10.6 Describe the risk factors, complications, treatment, and management of the following postoperative conditions in geriatric patients:
  - 10.6.1 Post-operative cognitive dysfunction (POCD)
  - 10.6.2 Delirium
  - 10.6.3 Pain

**F) Post-Operative Recovery and the Geriatric Patient**

- 10.7 Anticipate and manage postoperative recovery of geriatric patients
  - 10.7.1 Discuss age-related impediments to recovery of preoperative function and independence
  - 10.7.2 Advocate on behalf of patients with respect to postoperative recovery of function and independence

## 11 Hematology

Upon completion of this training, the competent anesthesiologist must demonstrate knowledge of the following:

### **A) Physiology of oxygen transport:**

- 11.1 Physiology of oxygen delivery and oxygen consumption
- 11.2 Physiologic adaptive responses to (euvolemic) anemia
- 11.3 Impaired oxygen delivery
- 11.4 Clinical and laboratory indicators of shock
- 11.5 Understand the concepts of  $\text{VO}_2$  for tissue metabolic processes,  $\text{DO}_2$ , oxygen, extraction ratio,  $\text{DO}_2$  crit (critical threshold of oxygen delivery)
- 11.6 Be able to calculate arterial oxygen content

### **B) Physiology of Normal Hemostasis**

- 11.7 Role of vascular endothelium
- 11.8 Platelets (adhesion, activation, aggregation, and various factors involved with platelet function)
- 11.9 Coagulation factors
- 11.10 Physiologic mechanisms to limit the coagulation: Antithrombin, Tissue Factor Pathway Inhibitor, Protein C and Protein S, and the fibrinolytic system
- 11.11 Alterations seen in the normal postoperative period (and the effect on postoperative DVT), normal pregnancy, the newborn, trauma, sepsis, shock and cancer
- 11.12 Minimum acceptable levels for laboratory testing to allow for normal surgical hemostasis, provision of spinal and epidural anesthesia (platelet count, factor levels, INR, fibrinogen level, anti-factor Xa levels, viscoelastic testing)

### **C) Hematological Monitoring**

- 11.13 Basic hematology monitoring
- 11.14 Laboratory to assess the coagulation system
- 11.15 Laboratory monitoring of the various pharmacological agents used
- 11.16 Thromboelastogram monitoring

**D) Pharmacology: Anticoagulants/Antifibrinolytics / Antiplatelet agents**

- 11.17 Demonstrate knowledge of the perioperative management of the following categories of medications in regard to pharmacodynamics (mechanism of action), pharmacokinetics (dose, clinical duration of action, etc.), and clinical pharmacology (indications contraindications, side effects, complications):
  - 11.17.1 Vitamin K antagonists (Coumadin)
  - 11.17.2 Heparin (both unfractionated and low molecular weight)
    - 11.17.2.1 Agents used as alternatives to patients who have a history of heparin induced thrombocytopenia
  - 11.17.3 Direct oral anticoagulants – DOAC (e.g., factor Xa inhibitor, direct thrombin inhibitors)
  - 11.17.4 Platelet inhibitors including ASA and NSAIDS
  - 11.17.5 ADP inhibitors (e.g., Clopidogrel, Ticlid)
  - 11.17.6 Glycoprotein IIb/IIIa direct receptor antagonist (e.g., Abciximab)
  - 11.17.7 Phosphodiesterase inhibitors (e.g. dipyridamole)
  - 11.17.8 Anti-fibrinolytic agents (e.g., aminocaproic acid, tranexamic acid, aprotinin)
- 11.18 Describe the impact on relevant laboratory monitoring for each categories of medication described above
- 11.19 Describe the perioperative use of the following agents including their mechanism, pharmacokinetics and clinical pharmacology:
  - 11.19.1 Protamine
  - 11.19.2 Vitamin K
  - 11.19.3 Desmopressin (DDAVP)
  - 11.19.4 Recombinant activated Factor VII (rFVIIa)
  - 11.19.5 Idarucizumab
- 11.20 Demonstrate knowledge of the situations where bridging the anticoagulation during the perioperative period is indicated
- 11.21 Demonstrate knowledge of the guidelines on anticoagulation and regional and neuraxial anesthesia
- 11.22 Demonstrate knowledge and appropriate application of the guidelines for perioperative thromboprophylaxis

## E) Disorders of Oxygen Transport in the blood

- 11.23 Demonstrate knowledge of the pathophysiology, clinical presentation, laboratory investigation, and perioperative management of patients with the following conditions:

### 11.23.1 Hemoglobinopathies

#### Acquired

- 11.23.1.1 Methemoglobin, including precipitation by some pharmacologic agents (nitric oxide, nitroglycerine, nitroprusside)
  - 11.23.1.1.1 Pharmacology of methylene blue
- 11.23.1.2 Carboxyhemoglobin
- 11.23.1.3 Immune-mediated (e.g., drug-induced, hypersplenism)

#### Genetic

- 11.23.1.4 Sickle cell disease, including prevention, end organ complications, pain management and acute crisis management
- 11.23.1.5 Congenital spherocytosis
- 11.23.1.6 G6PD deficiency
- 11.23.1.7 Thalassemia

### 11.23.2 Anemias

- 11.23.2.1 Acute blood loss: predict increased risk of acute blood loss, clinical signs of acute blood loss, perioperative management, strategies to minimize blood loss
- 11.23.2.2 Management of the patient who refuses transfusions of blood products
- 11.23.2.3 Chronic blood loss
  - 11.23.2.3.1 Anemia secondary to deficiency of iron, B12, folic acid
  - 11.23.2.3.2 Anemia of chronic disease (renal failure, liver failure)
- 11.23.2.4 Hemolytic anemias
- 11.23.2.5 Aplastic anemia
- 11.23.2.6 Mechanical etiologies (e.g., Mechanical heart valve)

11.23.3 Polycythemia

11.23.3.1 Primary polycythemias

11.23.3.2 Secondary to hypoxemia

**F) Disorders of Coagulation**

11.24 The anesthesiologist will demonstrate knowledge of the pathophysiology, clinical presentation, laboratory investigation, and perioperative management of patients with the following conditions:

11.24.1 Congenital “bleeders”

11.24.1.1 Hemophilia A

11.24.1.2 Hemophilia B

11.24.1.3 Von Willebrand’s disease

11.24.2 Congenital “clotters”

11.24.2.1 Protein C deficiency

11.24.2.2 Protein S deficiency

11.24.2.3 Antithrombin deficiency

11.24.2.4 Factor V Leiden

11.24.2.5 Homocysteinuria

11.24.3 Acquired “bleeders”

11.24.3.1 Effects of anticoagulant drugs or antiplatelet drugs

11.24.3.2 Dilutional thrombocytopenia or dilution of procoagulants

11.24.3.3 Disseminated Intravascular Coagulation

11.24.3.4 Liver disease

11.24.3.5 Massive blood transfusion

11.24.3.6 Hypothermia

11.24.3.7 Thrombocytopenia

11.24.3.7.1 Idiopathic thrombocytopenic purpura

11.24.3.8 Effects of extracorporeal circulation (cell saver techniques, ECMO)

11.24.3.9 Sepsis

11.24.4 Acquired “clotters”

11.24.4.1 Heparin-induced thrombocytopenia

11.24.4.2 Thrombotic Thrombocytopenic Purpura

11.24.4.3 Antiphospholipid Antibody Syndrome

11.24.5 Hematologic Emergencies

11.24.5.1 New diagnosis of acute leukemia (blast crisis) especially acute promyelocytic leukemia

11.24.5.2 Hyperviscosity syndrome

11.24.5.3 Acute thrombosis

11.24.5.4 Acquired hemophilia

## **G) Blood Products**

11.25 Regarding the following blood products:

- Red Blood Cells
- Frozen Plasma (FP)
- Prothrombin Complex Concentration and factor concentrates (unactivated and activated)
- Platelets
- Cryoprecipitate

The competent anesthesiologist will demonstrate knowledge of the following:

11.25.1 Indications/contraindications

11.25.2 Physiology

11.25.3 Risks

11.25.4 Benefits

11.25.5 Diagnosis and management of common or life-threatening complications and strategies to mitigate them, including but not limited to:

11.25.5.1 Febrile reactions

11.25.5.2 Allergic reactions

11.25.5.3 Volume overload

11.25.5.4 Transfusion-related acute lung injury (TRALI)

11.25.5.5 Acute and delayed haemolytic reactions

11.25.5.6 Sepsis

11.25.5.7 Coagulopathy

11.25.5.8 Electrolyte disturbances

11.25.5.9 Hypothermia

- 11.25.5.10 Transfusion-associated graft vs. host disease (TA-GVHD)
  - 11.25.5.11 Immune-related effects
  - 11.25.5.12 Transfusion-transmitted diseases (hepatitis B and C, HIV etc.)
  - 11.25.5.13 Effect of age of stored RBC's
  - 11.25.5.14 Effect on 2-3 DPG
- 11.26 In association with the administration of blood products, the anesthesiologist will demonstrate proficiency in the following:
- 11.26.1 Obtaining informed consent
  - 11.26.2 Identification and verification of both the patient and the blood product
  - 11.26.3 Preparation and administration of the blood product (including the safe use of diluents, filters and filter size, blood administration sets, iv cannula size, and blood warmers including rapid infusion devices)
  - 11.26.4 Clear documentation

#### **H) Blood banking**

- 11.27 Demonstrate a working knowledge of blood bank procedures
- 11.27.1 Clerical procedures
  - 11.27.2 Serologic procedures
    - 11.27.2.1 Uncrossmatched (emergency release) RBC's
    - 11.27.2.2 Type-specific uncrossmatched RBC's
    - 11.27.2.3 Computer assisted and serological crossmatches
    - 11.27.2.4 Type and screen
    - 11.27.2.5 Frozen plasma
    - 11.27.2.6 Platelets
    - 11.27.2.7 Cryoprecipitate
    - 11.27.2.8 Antibody investigation

#### **I) Reduction of use of Homologous Blood Products:**

- 11.28 Demonstrate a working knowledge of:
- 11.28.1 Methods used to reduce blood loss
    - 11.28.1.1 Patient position
    - 11.28.1.2 Controlled hypotension (including the physiology, indications, contraindications, and technique, including the



- pharmacologic agent(s) used
- 11.28.1.3 Regional anesthesia
- 11.28.1.4 Preoperative hemoglobin optimization
- 11.28.1.5 Pharmacologic agents (e.g., antifibrinolytic agents, role of recombinant activated Factor VII (rFVIIa))
- 11.28.2 Alternatives to blood products and their risks and benefits
- 11.28.3 Use of crystalloids
- 11.28.4 Use of colloids
  - 11.28.4.1 Physiologic effects of colloids in comparison to crystalloids
  - 11.28.4.2 Understand the crystalloid/colloid evidence
  - 11.28.4.3 Compare starch vs. albumen
- 11.28.5 Management of the patient (preoperative discussion, intraoperative and postoperative management) who refuses blood products for religious or other reasons
- 11.28.6 Calculate “allowable blood loss”
- 11.28.7 Demonstrate a working knowledge of:
  - 11.28.7.1 Preoperative autologous donation (PAD)
  - 11.28.7.2 Directed donation
  - 11.28.7.3 Haemoglobin-based oxygen carriers, and perfluorocarbon emulsions
  - 11.28.7.4 Erythropoietin therapy
  - 11.28.7.5 Acute normovolemic hemodilution
  - 11.28.7.6 Perioperative RBC salvage and autotransfusion (including indications, contraindications, complications and technique)

## 12 Hepatobiliary

Upon completion of this training, the competent Anesthesiologist must demonstrate knowledge of the anatomy and physiology of the hepatic system

### A) Anatomy and physiology of the liver and biliary tract

- 12.1 Functional anatomy
- 12.2 Blood supply/control of hepatic blood flow
- 12.3 Physiologic functions of the liver
  - 12.3.1 Glucose homeostasis
  - 12.3.2 Fat metabolism
  - 12.3.3 Protein synthesis: drug binding/coagulation/ester linkages hydrolysis
  - 12.3.4 Drug and hormone metabolism
  - 12.3.5 Bilirubin formation and excretion
- 12.4 Effect of anesthesia on hepatic function
  - 12.4.1 Perioperative interpretation of hepatic function tests
- 12.5 Effect of anesthesia on hepatic function

### B) Hepatic Pharmacology

- 12.6 Demonstrate knowledge of the pharmacology relevant to the hepatic system
  - 12.6.1 Pharmacokinetics and pharmacodynamics
  - 12.6.2 Describe the mechanisms of hepatic drug elimination
  - 12.6.3 Knowledge of altered response to drugs in cirrhotic patient
  - 12.6.4 Knowledge of possible hepatotoxic drugs

### C) Pathophysiology

- 12.7 Demonstrate knowledge of:
  - 12.7.1 Postoperative hepatic dysfunction:
    - 12.7.1.1 Differential diagnosis
    - 12.7.1.2 Approach to determine etiology

- 12.7.2 Pre-, intra-, and post-hepatic dysfunction
- 12.7.3 Halothane hepatitis
- 12.7.4 Viral Hepatitis
- 12.7.5 Other forms of hepatitis and the implications thereof:
  - 12.7.5.1 Alcoholic
  - 12.7.5.2 Other drugs/toxins
  - 12.7.5.3 Infection – non – viral hepatitis
  - 12.7.5.4 Autoimmune
- 12.7.6 Liver failure/ End stage liver disease
  - 12.7.6.1 Etiologies
  - 12.7.6.2 Child's classification and Model for End Stage Liver Disease (MELD) score for preoperative risk stratification
  - 12.7.6.3 End Stage Liver Disease physiology and multi-organ dysfunction
- 12.7.7 Other disease
  - 12.7.7.1 Porphyrias
- 12.7.8 Anesthetic management
  - 12.7.8.1 Anesthetic management for acute or chronic alcoholism
  - 12.7.8.2 Anesthetic management for patient with acute or chronic liver failure
  - 12.7.8.3 Anesthetic management for a patient with a previous liver transplant

#### **D) Anesthesia for Hepatobiliary Procedures**

- 12.8 Demonstrate knowledge and understanding of anesthesia as it applies to the hepatic system. The anesthesiologist must demonstrate knowledge of the pathology that can alter normal hepatobiliary physiology and the non-physiologic insults to which patients might be subjected to during hepatobiliary procedures
- 12.9 Demonstrate competence in providing anesthetic care for patients presenting for:
  - 12.9.1 Cholecystectomy: open and laparoscopic
  - 12.9.2 Endoscopic biliary tract procedures
  - 12.9.3 Pancreatic resection
  - 12.9.4 Whipples' procedure

- 12.9.5 Liver resections
- 12.9.6 Liver donation
- 12.9.7 Transjugular Intrahepatic Portosystemic Shunt (T.I.P.S.) procedure
- 12.9.8 Hepatic trauma

## 13 Immunology and Rheumatology

### A) Physiology

- 13.1 Demonstrate knowledge of the basic physiology of the immune system, including but not limited to:
  - 13.1.1 Cellular immunity
  - 13.1.2 Transplant rejection
  - 13.1.3 Autoimmune diseases
  - 13.1.4 Humoral immunity
  - 13.1.5 The complement system
  - 13.1.6 Types I-IV of hypersensitivity reactions

### B) Immunological Diseases

- 13.2 The anesthesiologist shall, in collaboration with the appropriate consultant manage the patient with the following disorders presenting for surgical or obstetric management:
  - 13.2.1 Hereditary angioedema
  - 13.2.2 Congenital and acquired immunodeficiency states
  - 13.2.3 HIV/ AIDS
  - 13.2.4 Selective IgA deficiency and anaphylaxis associated with blood transfusions
  - 13.2.5 Cold autoimmune diseases: (e.g., cryoglobulinemia, cold Hemagglutinin disease, paroxysmal cold hemoglobinuria)
  - 13.2.6 Amyloidosis

### C) Autoimmune disease

- 13.3 The anesthesiologist shall, in collaboration with the appropriate consultant manage the patient with the following autoimmune disorders presenting for surgical or obstetric management. The anesthesiologist shall be well-versed on the anesthetic considerations of the individual autoimmune diseases
  - 13.3.1 Organ-specific autoimmune diseases
    - 13.3.1.1 Type 1 diabetes mellitus
    - 13.3.1.2 Myasthenia gravis
    - 13.3.1.3 Grave's disease
    - 13.3.1.4 Addison's disease
    - 13.3.1.5 Autoimmune haemolytic anemia

13.3.2 Systemic autoimmune diseases

- 13.3.2.1 Rheumatoid arthritis
- 13.3.2.2 Rheumatic fever
- 13.3.2.3 Ulcerative colitis and Crohn's Disease
- 13.3.2.4 Ankylosing spondylitis
- 13.3.2.5 Systemic lupus erythematosus
- 13.3.2.6 Scleroderma
- 13.3.2.7 IgA deficiency
- 13.3.2.8 Sarcoidosis

**D) Pre-existing Allergies**

13.4 The anesthesiologist shall demonstrate an understanding of the pathophysiology, clinical manifestations, appropriate investigation and management of the following:

- 13.4.1 Neuromuscular blocking agent allergy
- 13.4.2 Protamine allergy
- 13.4.3 Latex allergy
- 13.4.4 Metabisulfite allergy
- 13.4.5 Volatile agent allergic hepatitis
- 13.4.6 Transfusion reaction
- 13.4.7 Antibiotic allergy
- 13.4.8 Intravenous contrast media allergy
- 13.4.9 Food allergies associated with drug or medical substance allergies
  - 13.4.9.1 Eggs/ propofol
  - 13.4.9.2 Banana/ kiwi /latex
  - 13.4.9.3 Fish/ protamine
  - 13.4.9.4 Shellfish/ iodine prep
- 13.4.10 Drug reactions
  - 13.4.10.1 Anaphylaxis
  - 13.4.10.2 Drug-induced release of histamine (anaphylactoid reaction)
  - 13.4.10.3 Activation of the complement system

**E) Transplantation: (See Chapter 34 - Transplantation )**

**F) Systemic Inflammatory Response Syndrome (SIRS)**

- 13.5 Demonstrate knowledge of the SIRS and its role in multi-organ failure in the critically-ill patient and assess such patients presenting for surgery

**G) Rheumatology/Connective Tissue Disorders**

- 13.6 Demonstrate knowledge of the pathophysiology, clinical presentation, natural history, treatment modalities, systemic implications and anesthetic considerations of the connective tissue disorders including:
- 13.6.1 Epidermolysis bullosa
  - 13.6.2 Scleroderma
  - 13.6.3 Systemic lupus erythematosus
  - 13.6.4 Rheumatoid arthritis
  - 13.6.5 Ankylosing spondylitis
  - 13.6.6 Marfan syndrome
  - 13.6.7 Ehlers-Danlos syndrome

## 14 Infectious Diseases

### A) Prevention of Infection

- 14.1 Describe the measures necessary for the prevention of infections, including but not limited to:
  - 14.1.1 Isolation measures
    - 14.1.1.1 Standard precautions
    - 14.1.1.2 Contact precautions
    - 14.1.1.3 Droplet precautions
    - 14.1.1.4 Airborne precautions
  - 14.1.2 Hand hygiene
  - 14.1.3 Effect of tracheal intubation on the development of infectious complications
  - 14.1.4 Aseptic technique
  - 14.1.5 Mechanism of transmission of selected infectious diseases; tuberculosis, MRSA, C difficile, viral hepatitis
  - 14.1.6 Management of needle stick injuries

### B) Infectious Syndromes

- 14.2 Demonstrate knowledge regarding pathophysiology, management and anesthetic considerations of patients presenting an infectious syndrome, including but not limited to:
  - 14.2.1 Infectious syndromes leading to uni or multi-systemic decompensation, including the differential diagnosis and treatment modalities
  - 14.2.2 Septic shock
  - 14.2.3 Infection in the immunocompromised host
  - 14.2.4 Multiple organ failure
  - 14.2.5 Community acquired infection
    - 14.2.5.1 Community acquired pneumonia
    - 14.2.5.2 Meningitis and encephalitis
    - 14.2.5.3 Genito-urinary sepsis
    - 14.2.5.4 Intra-abdominal sepsis
      - 14.2.5.4.1 Perforated viscus
      - 14.2.5.4.2 Cholecystitis and ascending cholangitis
      - 14.2.5.4.3 Pancreatitis



14.2.5.4.4 Spontaneous bacterial peritonitis

14.2.5.5 Soft tissue infection – severe cellulitis and necrotizing fasciitis

14.2.5.6 Head and neck infection

14.2.5.6.1 Epiglottitis

14.2.5.6.2 Ludwig's angina

14.2.5.6.3 Tetanus

14.2.5.6.4 Toxic shock syndrome

14.2.5.6.5 Infections with group A streptococci

14.2.5.6.6 Herpes zoster

14.2.5.7 Bacterial endocarditis

14.3 Demonstrate knowledge of preventive measures and management of nosocomial infection

14.3.1 Line-related bloodstream infection

14.3.2 Clostridia difficile colitis

14.3.3 Hospital acquired pneumonia

### **C) Patients with Immunodeficiency Syndromes**

14.4 Demonstrate knowledge of the problems related to, and anesthetic considerations of, immunodeficiency syndromes, including but not limited to:

14.4.1 AIDS

14.4.2 Chemotherapy

14.4.3 Connective tissue disease and autoimmune disease on immunologic therapy

14.4.4 Transplantation

### **D) Antibiotic Prophylaxis**

14.5 Demonstrate knowledge of the rationale behind surgical antibiotic prophylaxis for surgical site infection

14.6 Demonstrate an understanding of timing of perioperative antibiotic dosing

14.7 The anesthesiologist must demonstrate knowledge of the indications and considerations for the prevention of endocarditis and be able to administer the appropriate doses of the antibiotics indicated

14.8 Importance of timing of first dose of antibiotics in the unstable septic

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patient

**E) Upper Respiratory Tract Infections**

- 14.9 Demonstrate knowledge of the issues related to the management of patients with current or recent upper respiratory tract infections

**F) Pharmacology**

- 14.10 Pharmacology, spectrum, and complications of antibacterial, antiviral and antifungal therapy
- 14.11 Major antimicrobial agents
- 14.11.1 Indications and dosing
  - 14.11.2 Complications related to their use (toxicity, superinfection)
  - 14.11.3 Microbiological techniques used to make adjustment to therapy (dosage, culture, sensitivity)
- 14.12 Explain the role of the different treatment modalities for the management of a patient with septic shock (supportive treatment, antibiotics, surgery) - see Chapter 6 – Critical Care

## 15 Monitoring and Equipment

Upon completion of this training, the Anesthesiologist shall demonstrate an understanding of the principles of monitoring as they apply to perioperative care, including knowledge of the CAS guidelines for perioperative monitoring:

For all monitors, demonstrate knowledge of:

- Appropriate equipment selection
- Indication
- Contraindication
- Complications
- Common sources of error, identification and remedy

### A) Monitoring

#### 15.1 Principles of Measurement

- 15.1.1 Define the various units of mass, energy, pressure and density commonly used in Anesthesiology
- 15.1.2 Define the terms accuracy, precision and bias as related to measurement
- 15.1.3 Describe how most anesthesia monitors measure force (Newton's 2<sup>nd</sup> Law) and energy

#### 15.2 Pressure Measurement

- 15.2.1 Demonstrate knowledge of the principles of measurement, including but not limited to:
  - 15.2.1.1 Static Pressure Measurement
    - 15.2.1.1.1 Describe the principle of measuring static columns of fluid (gas and liquid)
    - 15.2.1.1.2 Define 1 atmosphere of pressure
    - 15.2.1.1.3 Convert between commonly used pressure units
  - 15.2.1.2 Dynamic Pressure Management
    - 15.2.1.2.1 Demonstrate knowledge of how modern pressure transducers work
    - 15.2.1.2.2 Describe the effects of compliance, natural resonant frequency damping and dynamic response of pressure in these systems
    - 15.2.1.2.3 Describe the characteristics of the pressure versus

time waveform in clinical practice

- 15.2.1.2.4 Describe the wave characteristics and causes of an overdamped or underdamped pressure and ways to remedy these problems

#### 15.2.1.3 Signal-Processed Pressure Monitor

- 15.2.1.3.1 Use of non-invasive blood pressure (NIBP) monitor properly
- 15.2.1.3.2 Understand mechanisms of blood pressure determination by NIBP
- 15.2.1.3.3 Describe the different false readings associated with NIBP

### 15.3 Flow Measurement

- 15.3.1 Demonstrate knowledge of the principles behind flow measurement, including but not limited to:

#### 15.3.1.1 Principles of Flow

- 15.3.1.1.1 Describe the differences between flow and velocity
- 15.3.1.1.2 Describe the relationship between pressure and flow
- 15.3.1.1.3 Describe the different forces that can act on fluids (gravity, pressure gradient, and viscous force/friction)
- 15.3.1.1.4 Demonstrate knowledge of the Bernoulli equation and its relevance in Anesthesiology
- 15.3.1.1.5 Demonstrate knowledge of the relevance of the Reynolds number in Anesthesiology
- 15.3.1.1.6 Demonstrate knowledge of the relevance of the laminar flow and turbulent flow in Anesthesiology

#### 15.3.1.2 Dilutional Flowmeters

- 15.3.1.2.1 Describe the Fick's principle and its relevance in Anesthesiology
- 15.3.1.2.2 Describe how cardiac output is measured using thermodilution and the potential errors associated with it

#### 15.3.1.3 Velocity/Flow Measurements

- 15.3.1.3.1 Describe how pilot tubes are used in anesthetic monitors
- 15.3.1.3.2 Describe how a venturis tube works and its relationship to the Bernoulli equation

15.3.1.4 Balance-of-Pressure Flowmeters

- 15.3.1.4.1 Describe how the Thorpe and Bourdon flowmeters work and their applications in everyday anesthetic practice

15.4 Sound Measurement

- 15.4.1 Demonstrate knowledge of the principles of sound measurement and its' application to monitoring, including but not limited to:

- 15.4.1.1 Principles of Sound

- 15.4.1.1.1 Describe what sound waves are and how they travel in different media

- 15.4.1.2 Passive – Stethoscope

- 15.4.1.2.1 Describe how different clinical conditions create different sounds heard using the stethoscope
  - 15.4.1.2.2 Describe the basic components of a stethoscope

- 15.4.1.3 Active – Echo, Doppler

- 15.4.1.3.1 Demonstrate knowledge of the principles and physics of ultrasound see Chapter 25 – Point of care ultrasound
  - 15.4.1.3.2 Demonstrate knowledge of the principles and physics of Doppler
  - 15.4.1.3.3 Describe how the Doppler principle is applied in ultrasound
  - 15.4.1.3.4 Describe how M-mode and Two-dimensional echocardiography work
  - 15.4.1.3.5 Describe the principles and features of ultrasound and its use in vascular access, nerve localization, regional anesthesia techniques, neuraxial techniques and heart and lung imaging

15.5 Electricity

- 15.5.1 Demonstrate knowledge of the principles of electricity use in monitoring and the principles of electrical safety, including but not limited to:

- 15.5.1.1 Describe Ohm's law
  - 15.5.1.2 Describe the differences between AC and DC current
  - 15.5.1.3 Demonstrate knowledge of micro and macroshock
  - 15.5.1.4 Demonstrate knowledge of the principles behind electrical isolation in the operating room

15.5.1.5 Demonstrate knowledge of passive electrical examination

15.5.1.5.1 Understand how electrical signals measured on biological surfaces are amplified and processed

15.5.1.5.2 ECG - Describe how the ECG senses electrical impulses and the problems processing these signals

15.5.1.5.3 EEG – Demonstrate an understanding of the use of EEG

15.5.1.5.4 Depth of anesthesia monitors (e.g., BIS)

15.5.1.5.4.1 Understand how depth of anesthesia monitors work

15.5.1.5.4.2 Know how to interpret the depth of anesthesia monitors

15.5.1.6 Active Electrical Examination

15.5.1.6.1 Somatosensory Evoked Potentials (SSEPs)

15.5.1.6.1.1 Understand how SSEPs are measured

15.5.1.6.1.2 Understand the clinical uses of SSEPs in the OR

15.5.1.6.1.3 Describe how anesthetic agents affect measurement of SSEPs

15.5.1.6.2 Motor Evoked Potentials (MEPs)

15.5.1.6.2.1 Understand the uses and limitations of MEPs

15.5.1.6.2.2 Describe how anesthetic agents effect measurement of MEPs

15.6 Measurement Utilizing Light

15.6.1 Demonstrate knowledge of the principles of light transmission and its' utility in various forms of monitoring, including but not limited to:

15.6.1.1 Principles of light

15.6.1.1.1 Demonstrate knowledge

15.6.1.1.2 Demonstrate knowledge of the difference between sound and electromagnetic waves (i.e., different speeds, different propagation waves)

15.6.1.1.3 Define the Beer-Lambert Law and know how it relates to various anesthetic monitors

15.6.1.2 Simple Absorbance Monitors (Capnometer, Agent analyzer)

15.6.1.2.1 Demonstrate understanding of the different Light

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Monitors– Capnometer (mainstream and sidestream),  
Agent Analyzer

15.6.1.2.2 Describe the difference between Raman scattering  
and absorption based gas analysis works

15.6.1.2.3 Describe the different phases in a CO<sub>2</sub> waveform and  
identify clinical correlations in various waveforms

15.6.1.3 Pulse Oximeters function

15.6.1.3.1 Describe the four different species of haemoglobin  
measured

15.6.1.3.2 Demonstrate knowledge of how fractional  
haemoglobin saturation is determined

15.6.1.3.3 Describe how the Beer-Lambert equation relates to  
the pulse oximeter

## 15.7 Temperature Measurement

15.7.1 Demonstrate knowledge of the principles of temperature  
measurement, including but not limited to:

15.7.1.1 Principles of Temperature

15.7.1.1.1 Define specific heat and a calorie

15.7.1.2 Describe mechanisms of heat loss and how they relate to  
perioperative care

15.7.1.2.1 Conduction

15.7.1.2.2 Convection

15.7.1.2.3 Radiation

15.7.1.2.4 Evaporation

15.7.1.3 Temperature Monitors

15.7.1.3.1 Describe the three techniques for measuring  
temperature

15.7.1.3.1.1 Resistance Thermometer

15.7.1.3.1.2 Thermistor

15.7.1.3.1.3 Thermocouple

## 15.8 Neuromuscular Monitors

15.8.1 Demonstrate knowledge of the principles of monitoring of the  
neuromuscular system, including but not limited to:

15.8.1.1 Describe how a peripheral nerve stimulator works

15.8.1.2 Demonstrate knowledge of issues surround qualitative measurements of neuromuscular recovery compared with quantitative

15.8.1.3 Describe the different patterns of nerve stimulation

15.8.1.3.1 Single twitch

15.8.1.3.2 Train of Four (TOF)

15.8.1.3.3 Tetany

15.8.1.3.4 Post Tetanic potentiation

15.8.1.3.5 Double burst stimulation (DBS)

## 15.9 Cardiovascular Monitors

15.9.1 Demonstrate knowledge of the monitoring of the cardiovascular system, including but not limited to:

15.9.1.1 Electrocardiography

15.9.1.1.1 Recognize the limitations of ECG monitoring leads in the OR (3 and 5-lead)

15.9.1.1.2 Be familiar with alternative lead placements

15.9.1.2 Monitoring arterial blood pressure

15.9.1.2.1 Non-invasive blood pressure monitoring

15.9.1.2.2 Invasive arterial blood pressure monitoring

15.9.1.2.2.1 Sites of cannulation

15.9.1.2.2.2 Indications, contraindications

15.9.1.2.2.3 Complications

15.9.1.2.2.4 Insertion technique

15.9.1.2.2.5 Function of the catheter – transducer system and sources of error

15.9.1.2.2.6 Waveform interpretation and limitations to its analysis

15.9.1.3 Monitoring central venous pressure

15.9.1.3.1 Principles of sterile technique and prevention of line – related blood stream infections

15.9.1.3.2 Complications and principles of safe insertion technique

15.9.1.3.3 Sites of cannulation

15.9.1.3.4 Ultrasound guided insertion technique

15.9.1.3.5 Physiology of central venous pressure monitoring and



- limitations of application
- 15.9.1.3.6 Waveform analysis
- 15.9.1.4 Monitoring with Pulmonary artery catheter
  - 15.9.1.4.1 Indications and contraindications
  - 15.9.1.4.2 Insertion technique
  - 15.9.1.4.3 Potential complications of insertion
  - 15.9.1.4.4 Sources of error and principles of trouble shooting
  - 15.9.1.4.5 Principles of monitoring cardiac output, pulmonary artery pressure, pulmonary artery occlusion pressure and calculation of work indices and vascular resistance
  - 15.9.1.4.6 Waveform analysis
  - 15.9.1.4.7 Estimation of fluid responsiveness: Systolic pressure variation and transthoracic thermodilution
  - 15.9.1.4.8 Continuous mixed venous oximetry
  - 15.9.1.4.9 Interpretation of mixed-venous blood gases
  - 15.9.1.4.10 Determination of whole-body oxygen delivery and consumption
- 15.9.1.5 Non-invasive cardiac output measurement and/or estimation
- 15.9.1.6 Echocardiography – see Chapter 25 – Point of care ultrasound (POCUS)
  - 15.9.1.6.1 Transthoracic Echocardiography
    - 15.9.1.6.1.1 Indications
    - 15.9.1.6.1.2 Physiologic measures and clinical significance
    - 15.9.1.6.1.3 Limitations
  - 15.9.1.6.2 Transesophageal Echocardiography
    - 15.9.1.6.2.1 Indications and contraindications
    - 15.9.1.6.2.2 Complications
    - 15.9.1.6.2.3 Knowledge of potential information and applications

## **B) Equipment**

### **15.10 Inhaled Anesthetic Delivery Systems**

- 15.10.1 Demonstrate knowledge of the principles behind the functionality of volatile anesthetic vaporizers

15.10.2 Anesthesia breathing circuits (i.e., bain, circle and other circuit)

15.10.3 Gas laws

15.10.3.1 Boyle's law, Charles' Law, Henry's Law, Graham's law of diffusion, Dalton's law of partial pressures

15.10.3.2 Partial pressure

15.10.3.3 Gas solubility in blood, oil and its importance in anesthesia

15.10.4 Anesthetic Machine

15.10.4.1 Demonstrate in depth knowledge of the anesthetic machines:

15.10.4.1.1 Demonstrate knowledge about the safety features of the anesthetic machine

15.10.4.1.2 Describe the CSA/ASA standards for anesthetic machines

15.10.4.1.3 Pipeline and Cylinder gas supply

15.10.4.1.4 Pin index safety system (PISS), Diameter index safety system (DISS)

15.10.4.1.5 Pressure failure mechanisms

15.10.4.1.5.1 Flowmeter and proportioning systems

15.10.4.1.6 Vaporizers

15.10.4.1.7 CO<sub>2</sub> absorption

15.10.4.1.8 Anesthesia ventilators

15.10.4.1.9 Scavenger systems

15.10.4.1.10 Low-flow anesthesia

15.10.4.1.11 Perform a complete pre-use check of the machine

15.11 Equipment Cleaning and Sterilization

15.11.1 Demonstrate knowledge of the methods of cleaning and sterilizing equipment and the advantages and limitations of these methods

15.12 Lasers

15.12.1 Demonstrate knowledge of the principles of the physics of laser use

15.12.1.1 Describe the three ways that laser light is different than ordinary light

15.12.1.1.1 Monochromatic

15.12.1.1.2 Coherent

- 15.12.1.1.3 Collimated
- 15.12.1.2 Describe the essential components in a laser
- 15.12.1.3 Demonstrate knowledge about the different lasers available in the OR
  - 15.12.1.3.1 CO<sub>2</sub>
  - 15.12.1.3.2 Argon
  - 15.12.1.3.3 Krypton
  - 15.12.1.3.4 Holmium
  - 15.12.1.3.5 Nd:YAG
- 15.12.1.4 Describe the potential hazards of lasers in the OR and how to protect against/manage them
- 15.12.1.5 Describe the Airway Fire Protocol
- 15.12.1.6 Demonstrate knowledge of management of an OR fire

## 16 Neurology/ Neurosurgical Anesthesiology

Upon completion of this training, the Anesthesiologist shall demonstrate proficiency in all of the objectives listed below

### A) Basic Science

16.1 Demonstrate knowledge and an understanding of the anatomic, physiologic, and pharmacologic principles that are unique to the neurosurgical patient, including but not limited to:

#### 16.1.1 Anatomy

- 16.1.1.1 Basic anatomy of the central nervous system, including the spinal cord and meninges
- 16.1.1.2 Anatomy of the Circle of Willis
- 16.1.1.3 Vascular supply to the spinal cord
- 16.1.1.4 Cellular anatomy of the blood brain barrier

#### 16.1.2 Physiology

- 16.1.2.1 Cerebral blood flow and its determinants
- 16.1.2.2 Determinants of cerebral perfusion pressure
- 16.1.2.3 Cerebral metabolic rate for oxygen
- 16.1.2.4 Cerebral pressure autoregulation
- 16.1.2.5 Carbon dioxide reactivity
- 16.1.2.6 Response to hypoxia
- 16.1.2.7 Flow metabolism coupling
- 16.1.2.8 Production, flow and re-absorption of cerebral spinal fluid
- 16.1.2.9 Effects of hypo and hyperthermia
- 16.1.2.10 Effects of increased intracranial pressure

#### 16.1.3 Pharmacology

- 16.1.3.1 Direct and indirect effects of intravenous and inhaled anesthetic agents on cerebral physiology
- 16.1.3.2 Basic principles of neuroprotection and neuroresuscitation
- 16.1.3.3 Mechanism of action of osmotic diuretics and hypertonic saline
- 16.1.3.4 Prevention and treatment of vasospasm
- 16.1.3.5 Controlled hypo- and hypertension
- 16.1.3.6 Anesthetic consideration of anticonvulsants

**B) Neurological diseases**

- 16.2 Demonstrate the ability to independently provide anesthesia care for any type of surgeries for:
  - 16.2.1 Patients with increased intracranial pressure at risk of herniation
    - 16.2.1.1 Supratentorial tumors
    - 16.2.1.2 Posterior fossa tumors
    - 16.2.1.3 Other space-occupying lesions (hemorrhage, abscess, etc.)
  - 16.2.2 Patients with traumatic neurological diseases
    - 16.2.2.1 Spinal cord injury
      - 16.2.2.1.1 Cervical: unstable cervical spine
      - 16.2.2.1.2 Thoracic: autonomic hyperreflexia
      - 16.2.2.1.3 Lumbar
    - 16.2.2.2 Traumatic Brain Injury
  - 16.2.3 Patients with cerebrovascular diseases
    - 16.2.3.1 Carotid stenosis
    - 16.2.3.2 Stroke
      - 16.2.3.2.1 Embolic
      - 16.2.3.2.2 Hemorrhagic
    - 16.2.3.3 Intracranial aneurysms
    - 16.2.3.4 Arteriovenous malformations
    - 16.2.3.5 Cerebral hyperperfusion
    - 16.2.3.6 Moya Moya Disease
  - 16.2.4 Patients with common neurological disorders
    - 16.2.4.1 Parkinson's disease
    - 16.2.4.2 Multiple Sclerosis
  - 16.2.5 Patients with common non-traumatic disorders of the spine
    - 16.2.5.1 Cervical or lumbar disc herniation
    - 16.2.5.2 Spinal stenosis
    - 16.2.5.3 Spondylopathies, including Ankylosing spondylitis

16.2.6 Patients with neuroendocrine disorders

- 16.2.6.1 Hypopituitarism
- 16.2.6.2 Hyperpituitarism
- 16.2.6.3 Diabetes Insipidus
- 16.2.6.4 Syndrome of inappropriate ADH secretion
- 16.2.6.5 Cerebral salt wasting syndrome

16.2.7 Patients with congenital neurological diseases for non-neurosurgical procedures

- 16.2.7.1 Cerebral Palsy
- 16.2.7.2 Meningomyelocele
- 16.2.7.3 Chiari Malformations
- 16.2.7.4 Dandy-Walker complex
- 16.2.7.5 Craniosynostosis
- 16.2.7.6 Tethered spinal cord

**C) Anesthesia for Neurosurgical Procedures**

Upon completion of this training, the Anesthesiologist shall demonstrate knowledge and proficiency in providing competent anesthetic care including thorough preoperative assessment for patients presenting for neurosurgical procedures.

The procedures listed below as italicized items are not expected to be performed independently but the Anesthesiologist shall demonstrate knowledge of the principles of the procedure.

16.3 Surgical procedures

16.3.1 Demonstrate knowledge of the implications of, and provide anesthetic care for neurosurgical patients presenting with the following conditions:

16.3.1.1 Intracranial Masses

- 16.3.1.1.1 Supratentorial tumour resection
- 16.3.1.1.2 Posterior fossa tumour resection
- 16.3.1.1.3 Pituitary tumour resection
- 16.3.1.1.4 Awake craniotomy for tumour resection

16.3.1.2 Traumatic Brain Injury

- 16.3.1.2.1 Evacuation of subdural hematoma, acute vs. chronic

- 16.3.1.2.2 Evacuation of epidural hematoma
- 16.3.1.2.3 Evacuation of intracranial hemorrhage
- 16.3.1.2.4 Decompressive craniectomy

16.3.1.3 Intra and Extracranial Vascular disease

- 16.3.1.3.1 Intracranial aneurysm clipping
- 16.3.1.3.2 Intracranial arteriovenous malformation resection
- 16.3.1.3.3 Carotid endarterectomy

16.3.1.4 Hydrocephalus

- 16.3.1.4.1 Ventriculo-peritoneal, ventriculo-pleural or ventriculo-atrial shunt placement
- 16.3.1.4.2 External ventricular drain placement

16.3.1.5 Epilepsy

- 16.3.1.5.1 Epilepsy surgery
- 16.3.1.5.2 Awake craniotomy

16.3.1.6 Interventional Neuroradiology

- 16.3.1.6.1 Intracranial aneurysm coiling
- 16.3.1.6.2 Arteriovenous malformation embolization
- 16.3.1.6.3 Carotid artery stenting

16.3.1.7 Surgery of the Spine see Chapter 20 – Orthopedic Surgery, section E spine surgery

- 16.3.1.7.1 Laminectomy/Discectomy/Decompression
- 16.3.1.7.2 Spinal instrumentation/fusion
- 16.3.1.7.3 Spinal cord tumour resection
- 16.3.1.7.4 Vascular malformation resection

16.3.1.8 Pediatric Neurosurgery

- 16.3.1.8.1 Scoliosis correction surgery

16.4 Specific Perioperative Management

16.4.1 Management of neurosurgical anesthesia emergencies

- 16.4.1.1 Acute increase in intracranial pressure
- 16.4.1.2 Venous air embolism

- 16.4.1.3 Intraoperative aneurysm rupture
- 16.4.1.4 Seizure
- 16.4.1.5 Postoperative failure to awaken
- 16.4.1.6 Cardiac arrest in prone position
  
- 16.4.2 Management of fluid therapy in the neurosurgical patient
- 16.4.3 Management of total intravenous anesthesia
- 16.4.4 Considerations related to intraoperative neurological monitoring
  - 16.4.4.1.1 Demonstrate knowledge and appropriate clinical management related to the anesthetic agents effects on neurological monitoring
  
  - 16.4.4.2 Electroencephalography
  - 16.4.4.3 Depth of anesthesia monitoring
  - 16.4.4.4 Somatosensory Evoked Potentials
  - 16.4.4.5 Motor evoked potential
  - 16.4.4.6 Electromyography
  - 16.4.4.7 Wake up test



## 17 Neuromuscular Junction

Upon completion of this training, the competent Anesthesiologist shall demonstrate in depth knowledge of the neuromuscular junction and its' relevance in anesthesia:

### A) Neuromuscular Junction physiology

#### 17.1 Demonstrate an ability to:

- 17.1.1 Describe a synapse: the motor neuron and the muscle fiber
- 17.1.2 Describe the nerve action potential
- 17.1.3 Describe the formation of neurotransmitters at the motor nerve ending
  - 17.1.3.1 Acetylcholine synthesis
  - 17.1.3.2 Storage
  - 17.1.3.3 Release
  - 17.1.3.4 Recycling
- 17.1.4 Explain acetylcholinesterase action
- 17.1.5 Describe a postjunctional receptor
- 17.1.6 Explain the effects of the prejunctional receptor on nerve transmission
- 17.1.7 Explain the quantal theory at the neuromuscular junction
- 17.1.8 Describe the action potential across nerve membrane, including sodium and calcium channels

### B) Pharmacology of Muscle Relaxants

#### 17.2 Demonstrate an ability to:

- 17.2.1 Explain the action of neuromuscular relaxants, nondepolarizing and depolarizing, on prejunctional and postjunctional receptors
- 17.2.2 Describe the effects of neuromuscular relaxants on the autonomic nervous system
- 17.2.3 Explain a desensitization block
- 17.2.4 Explain how certain drugs can affect neuromuscular relaxants effects
  - 17.2.4.1 Volatile agents
  - 17.2.4.2 Antibiotics
  - 17.2.4.3 Calcium
  - 17.2.4.4 Local anesthetics
  - 17.2.4.5 Antiepileptics

- 17.2.4.6 Diuretics
- 17.2.4.7 Channel blocks and other effects

17.2.5 Pharmacology of succinylcholine

- 17.2.5.1 Pharmacokinetics and pharmacodynamics (including metabolism and elimination)
- 17.2.5.2 Indications and contraindications
- 17.2.5.3 Reversal of succinylcholine
  - 17.2.5.3.1 Butyrylcholinesterase activity
  - 17.2.5.3.2 Pseudocholinesterase deficiency
- 17.2.5.4 Drug interactions and adverse effects
- 17.2.5.5 Clinical uses and dosage including for common comorbidities and specific physiologic conditions (obesity, pregnancy, immobility, sepsis, liver failure, neuromuscular disease, etc.)

17.2.6 Pharmacology of non-depolarizing neuromuscular blocking agents

- 17.2.6.1 Pharmacokinetics and pharmacodynamics of various agents (including metabolism and elimination)
- 17.2.6.2 Indications and contraindications
- 17.2.6.3 Potency of various agents
- 17.2.6.4 Reversal of action
- 17.2.6.5 Drug interactions and adverse effects
- 17.2.6.6 Clinical management and dosage including those for common comorbidities and physiologic conditions (obesity, renal failure, neuromuscular disease, etc.)

**C) Prejunctional, Immature and Extrajunctional Receptors**

- 17.3 Describe the “fade” phenomenon with neuromuscular relaxants through a prejunctional effect, and the effect of different neuromuscular relaxants on that phenomenon
- 17.4 Explain how immature and extrajunctional receptors form, and the effects of depolarizing neuromuscular relaxants on such receptors and its relevance in clinic
- 17.5 Describe the myopathy following long term administration of neuromuscular relaxants during critical illness

**D) Neuromuscular Reversal**

- 17.6 Demonstrate in depth knowledge and ability to
  - 17.6.1 Describe indications for reversal of neuromuscular blockade
  - 17.6.2 Describe the pharmacology and mechanism of neuromuscular blockade reversal agents (e.g., cholinesterase inhibitors, suggamadex)
  - 17.6.3 Explain the role of anticholinergic drugs in neuromuscular reversal
  - 17.6.4 Describe the side effects of anticholinesterase agents

**E) Monitoring Neuromuscular Blockade**

- 17.7 Demonstrate the ability to monitor blockade of the neuromuscular junction using
  - 17.7.1 Peripheral nerve stimulation – electrode placement, varieties of stimulation sequence, interpretation of the information, clinical significance and reliability of information
  - 17.7.2 Definition of adequate reversal
  - 17.7.3 Utility of the clinical indications of reversal

**F) Pathology**

- 17.8 Demonstrate knowledge of the pathophysiology, clinical presentation, classification, and perioperative management of patients with the following conditions:
  - 17.8.1 Myasthenia Gravis
  - 17.8.2 Eaton-Lambert syndrome

**G) Neuromuscular blockade and coexisting disease**

- 17.9 Demonstrate knowledge of appropriate selection and dosage of neuromuscular blocking agents in patients with renal or hepatic disease
- 17.10 Demonstrate knowledge of the management of neuromuscular blockade and reversal as it relates to:
  - 17.10.1 Age
  - 17.10.2 Obesity
  - 17.10.3 Neuromuscular disease

## 18 Obstetrical Anesthesia

### General Issues

Upon completion of this training, the competent Anesthesiologist must demonstrate the ability to function as part of a team with obstetricians, nursing staff, nurse midwives, neonatologists and pediatricians to provide optimal medical, obstetric, and anesthetic care for parturients and their fetuses/neonates.

#### A) Maternal Physiology

- 18.1 Demonstrate knowledge of:
  - 18.1.1 Maternal physiology: time course and changes during gestation
    - 18.1.1.1 Cardiovascular adaptations to pregnancy
    - 18.1.1.2 Pulmonary, respiratory, and airway changes
    - 18.1.1.3 Gastrointestinal, hematologic, and renal changes
    - 18.1.1.4 Central nervous system changes
  - 18.1.2 Minimum Alveolar Concentration (MAC) and local anesthetic adjustments during pregnancy
  - 18.1.3 Approach to CPR in parturient, awareness of need and timing for delivery of baby

#### B) Fetal and Placental Physiology

- 18.2 Demonstrate knowledge of:
  - 18.2.1 Placental development, structure and inability to auto regulate placental flow
  - 18.2.2 Placental gas exchange, nutrient transport, drug transfer
  - 18.2.3 Antenatal fetal evaluation (growth, fluid, position, biophysical profile)
  - 18.2.4 Fetal circulation
  - 18.2.5 Fetal and neonatal effects of maternally administered anesthetic drugs
  - 18.2.6 Fetal adaptations to hypoxia
  - 18.2.7 Fetal heart rate patterns during labour and their response to hypoxia or asphyxia
  - 18.2.8 Impact on fetus of drop in maternal cardiac output
  - 18.2.9 Interpret fetal heart rate patterns during labour

### **C) Neonatal Physiology**

#### 18.3 Demonstrate knowledge of:

- 18.3.1 Intrapartum fetal resuscitation
- 18.3.2 Neonatal physiologic adaptations to extrauterine life
- 18.3.3 Transition from fetal to adult circulation
- 18.3.4 Resuscitation of the newborn – NRP protocol
- 18.3.5 Predict the likelihood of need for resuscitation
- 18.3.6 Recognize the neonate needing resuscitation
- 18.3.7 Initiate resuscitation of a neonate

### **D) Obstetric Management of Labour**

#### 18.4 Demonstrate knowledge of:

- 18.4.1 Physiology of labour and the smooth muscle of the uterus
- 18.4.2 The stages of labour and typical duration
- 18.4.3 Effect of uterine contractions on placental exchange and fetal oxygenation
- 18.4.4 Indications for analgesia during labour
- 18.4.5 Effect of analgesia on labour and delivery
- 18.4.6 Effect on labour of maternal hydration, position, hyperventilation, hypotension
- 18.4.7 Recognition and management of uterine hypertonus or hyperstimulation
- 18.4.8 Commonly used drugs in obstetrics including indications, contraindications, classification, and therapeutic uses and side effects of:
  - 18.4.8.1 Oxytocin, carbitocin
  - 18.4.8.2 Ergotamine
  - 18.4.8.3 Prostaglandins, hemabate
  - 18.4.8.4 Magnesium sulphate
  - 18.4.8.5 Uterine relaxants
  - 18.4.8.6 Nitroglycerine

### **E) Labour Analgesia and Anesthesia**

#### 18.5 Anatomy and physiology of labour pain

- 18.5.1 Describe the pain pathways for stages of labour
- 18.5.2 Describe the anatomy of spinal and epidural space

18.6 Labour analgesia

18.6.1 Demonstrate knowledge and competency on all characteristics listed below for the various analgesic options for labour analgesia

- Patient education
- Informed consent
- Indications
- Contraindications
- Mechanism of action
- Pharmacokinetics/ pharmacodynamics
- Maternal side effects
- Fetal effects
- Effects on uterine blood flow
- Complications
- Management of complications

Analgesic options:

18.6.1.1 Non-pharmacologic options

18.6.1.2 Opioids – IV, IM, SC, IV PCA

18.6.1.3 Inhaled N<sub>2</sub>O

18.6.1.4 Neuraxial opioids (intrathecal and epidural)

18.6.1.5 Neuraxial local anesthetics

18.6.1.5.1 Spinal-single shot

18.6.1.5.2 Combined spinal-epidural

18.6.1.5.3 Continuous spinal catheter

18.6.1.5.4 Continuous epidural catheter

18.6.1.5.5 Dural puncture epidural

18.6.1.6 Pudendal and paracervical blocks

**F) Anesthesia for Obstetrical surgery**

18.7 Demonstrate knowledge and competency on all characteristics listed below for the various anesthetic options for obstetrical surgery

- Patient consent
- Indications

- Contraindications
- Mechanism of action
- Pharmacokinetics/ pharmacodynamics
- Maternal side effects
- Fetal effects
- Effects on uterine blood flow
- Complications
- Management of complications

Anesthetic options:

18.7.1 Regional Anesthesia for Cesarean Section

- 18.7.1.1 Spinal
- 18.7.1.2 Epidural
- 18.7.1.3 Conversion of labour analgesia epidural for anesthesia
- 18.7.1.4 Combined spinal-epidural

18.7.2 General Anesthesia for Cesarean Section

- 18.7.2.1 Indications for general anesthesia with endotracheal intubation
- 18.7.2.2 Risks for morbidity and mortality associated with general anesthetic (GA) in parturient
- 18.7.2.3 Ventilatory requirements of parturients
- 18.7.2.4 Drug choices and doses for induction and maintenance for caesarean or operative delivery
- 18.7.2.5 Impact on the fetus of the induction to delivery and uterine incision to delivery time intervals
- 18.7.2.6 Appropriate pre-op assessment of the parturient for GA
- 18.7.2.7 Physiologic changes of pregnancy impacting on GA management
- 18.7.2.8 Demonstrate knowledge of how to:
  - 18.7.2.8.1 Develop and execute a plan for general endotracheal anesthesia based on the physiologic and physical changes of pregnancy
  - 18.7.2.8.2 Perform a rapid sequence induction
  - 18.7.2.8.3 Recognize and outline management of a difficult airway based on physical examination
  - 18.7.2.8.4 Outline a failed intubation plan

- 18.7.2.8.5 Outline a plan for postoperative management of patient following GA
- 18.7.2.8.6 Recognize pulmonary aspiration of gastric contents and outline a plan for the PACU and postoperative care of a patient who has aspirated
- 18.7.2.9 Inherent maternal anesthetic risk of urgent or emergent delivery
- 18.7.2.10 Surgical and anesthetic management of bleeding during delivery, including drug therapy, surgical manoeuvres, transfusion therapy
- 18.7.3 Anesthesia for other obstetric surgery
  - 18.7.3.1 Retained placenta
  - 18.7.3.2 Double set-up
  - 18.7.3.3 Postpartum tubal ligation
  - 18.7.3.4 Insertion/ removal of suture for cervical incompetence
- 18.7.4 Post-Operative Pain Control
  - 18.7.4.1 Demonstrate knowledge of:
    - 18.7.4.1.1 The various components of multimodal analgesic techniques used after caesarean or vaginal delivery. These include the use of:
      - 18.7.4.1.1.1 Neuraxial opioids
      - 18.7.4.1.1.2 Parenteral opioids
      - 18.7.4.1.1.3 Non-steroidal anti-inflammatory drugs
      - 18.7.4.1.1.4 Adjunctive drugs
      - 18.7.4.1.1.5 Local anesthetics
    - 18.7.4.1.2 Transfer of drugs into breast milk and the effects on the neonate
  - 18.7.4.2 Demonstrate an ability to:
    - 18.7.4.2.1 Recognize and manage inadequate postpartum analgesia
    - 18.7.4.2.2 Provide appropriate post-operative pain management
    - 18.7.4.2.3 Recognize and treat side effects of postoperative pain modalities used



**G) Obstetrical complications and their management**

18.8 Demonstrate knowledge and competency on:

18.8.1 Management of maternal ante – or postpartum hemorrhage

18.8.1.1 Uterine rupture

18.8.1.2 Abruptio or atony

18.8.1.3 Placenta previa or accreta

18.8.1.4 Retained placenta

18.8.2 Management of maternal embolic events

18.8.2.1 Amniotic fluid

18.8.2.2 Air

18.8.2.3 Thrombus

18.8.3 Management of fetal emergencies – (e.g., prolapsed vasa previa)

18.8.4 Management of intra-uterine fetal death

**H) Medical diseases during pregnancy and their peri-operative management**

18.9 Demonstrate knowledge and competency on all characteristics listed below

- How the disease impacts on pregnancy
- How pregnancy impacts on the disease
- The obstetric implications and management of the disease

for all the following diseases:

18.9.1 Hypertensive disorders of pregnancy

18.9.1.1 Classification of hypertensive disorders during pregnancy

18.9.1.2 Epidemiology of preeclampsia and risk factors

18.9.1.3 Pathophysiology of preeclampsia as a multisystem disease

18.9.1.4 Medical/obstetric management of preeclampsia

18.9.1.4.1 Term vs. preterm fetus

18.9.1.4.2 Mild vs. severe diseases

18.9.1.4.3 Assessment of fetal well being

18.9.1.4.4 Seizure prophylaxis and management; magnesium sulphate effects

18.9.1.4.5 Antihypertensive therapy

18.9.1.4.6 Management of oliguria

- 18.9.1.4.7 Indications for invasive monitoring
- 18.9.1.5 Anesthetic selection for and management of the preeclamptic parturient
  - 18.9.1.5.1 Labour and vaginal delivery
  - 18.9.1.5.2 Abdominal delivery – non-urgent
  - 18.9.1.5.3 Abdominal delivery – urgent
- 18.9.2 Morbid obesity
  - 18.9.2.1 Anesthetic considerations for morbidly obese parturient
  - 18.9.2.2 Use of regional anesthesia in morbidly obese patients
  - 18.9.2.3 Management of general anesthesia in obese patients
- 18.9.3 Respiratory disease
  - 18.9.3.1 Asthma
  - 18.9.3.2 ARDS
- 18.9.4 Cardiac disease
  - 18.9.4.1 Demonstrate an understanding of the pathophysiology and management of parturients with:
    - 18.9.4.1.1 Ischemic heart disease
    - 18.9.4.1.2 Valvular heart disease
      - 18.9.4.1.2.1 Aortic stenosis
      - 18.9.4.1.2.2 Aortic insufficiency
      - 18.9.4.1.2.3 Mitral stenosis
      - 18.9.4.1.2.4 Mitral regurgitation
    - 18.9.4.1.3 Peripartum cardiomyopathy
    - 18.9.4.1.4 Idiopathic Hypertrophic Subaortic Stenosis (IHSS)/ Hypertrophic Obstructive Cardiomyopathy (HOCM)
    - 18.9.4.1.5 Palliated or corrected congenital heart disease
  - 18.9.4.2 Demonstrate an understanding of when invasive monitors are needed for delivery and postpartum care
- 18.9.5 Endocrine disease
  - 18.9.5.1 Diabetes mellitus

18.9.5.2 Thyroid disease

18.9.5.2.1 Hyperthyroidism

18.9.5.2.2 Hypothyroidism

18.9.5.3 Pheochromocytoma

18.9.5.4 Management of glucose control in the parturient during caesarean or vaginal delivery

18.9.6 Hematologic and coagulation disorders

18.9.6.1 Anemias

18.9.6.2 Coagulation disorders

18.9.6.3 Demonstrate knowledge of guidelines concerning regional anesthesia and coagulation disorders

18.9.6.4 Demonstrate knowledge of guidelines concerning regional anesthesia and anticoagulation

18.9.7 Miscellaneous disorders

18.9.7.1 Renal disease

18.9.7.2 Liver disease

18.9.7.3 Musculoskeletal disorders

18.9.7.4 Scoliosis

18.9.7.5 Rheumatoid arthritis

18.9.7.6 Spina bifida cystica

18.9.7.7 Autoimmune disorders

18.9.7.8 Prior back surgery including Harrington rod placement

**I) Anesthetic management of non-obstetric surgery during pregnancy**

18.10 Demonstrate an understanding of considerations for elective surgery during pregnancy

18.11 Discuss potential teratogenicity of medications

18.12 Demonstrate an understanding of considerations for trauma or emergency surgery during pregnancy

18.13 Demonstrate an understanding of when fetal monitoring is needed during maternal surgery

18.14 Physiology of pregnancy as it might impact cardiovascular, respiratory and transfusion decisions during surgery

18.15 Discuss risks of elective surgery with patients and colleagues

**J) Ethical issues**

- 18.16 Demonstrate awareness of potential for maternal-fetal conflicts of interest
  - 18.16.1 General anesthesia for stat caesarean delivery in face of perceived fetal jeopardy
- 18.17 Demonstrate respect for all moral and religious points of view
  - 18.17.1 Jehovah Witness patient
- 18.18 Demonstrate awareness of fetal development and current limits of viability
- 18.19 Recognize own ethical attitudes versus patient's moral concerns
- 18.20 Demonstrate willingness to arrange for non-prejudicial transfer of care, if necessary
- 18.21 Recognize need for timely consultation on difficult moral and legal issues

**K) Morbidity and mortality**

- 18.22 Discuss major causes of morbidity and mortality in pregnant patients
- 18.23 Discuss anesthesia related morbidity and mortality in pregnant patients

**L) Ultrasound**

- 18.24 Describe the physics of ultrasound used in medical practice
- 18.25 Describe the relevant ultrasound anatomy of the neuraxis
- 18.26 Perform ultrasound examination of the neuraxis for regional techniques
- 18.27 Perform regional techniques under ultrasound guidance

## 19 Ophthalmology

Upon completion of this training, the Anesthesiologist shall demonstrate knowledge of the relevant anatomy and physiology of the eye. The Anesthesiologist must also demonstrate knowledge of the issues related to providing safe anesthetic care for patients undergoing ophthalmologic surgery.

### A) Anatomy and Physiology

#### 19.1 Demonstrate an ability to:

- 19.1.1 Describe the anatomy of the eye including chambers, relevant blood supply and innervation
  - 19.1.1.1 Describe the oculo-cardiac reflex (OCR) including risk factors and management
- 19.1.2 Describe the determinants of intra-ocular pressure (IOP) and medications/factors that influence it
- 19.1.3 Describe the pathophysiology of glaucoma

### B) Anesthetic Considerations

#### 19.2 Demonstrate an ability to independently provide anesthesia for patients undergoing ophthalmic surgery with respect to:

##### 19.2.1 Preoperative Evaluation

- 19.2.1.1 Identify common medical conditions associated with patients having ocular surgery

##### 19.2.2 Pharmacologic Interventions

- 19.2.2.1 Describe the drugs commonly used in ophthalmologic patients including but not limited to: mydriatics, miotics, topical and systemic drugs used to decrease IOP
- 19.2.2.2 Describe the systemic effects of the aforementioned medications
- 19.2.2.3 Describe the ocular effects of drugs commonly used in anesthesia

##### 19.2.3 Effects of Anesthesia on IOP and Retinal Perfusion

- 19.2.3.1 Describe the perioperative factors that will increase or decrease IOP and influence retinal perfusion

19.2.4 Anesthetic Technique

19.2.4.1 IV sedation

- 19.2.4.1.1 Describe the side effects and complications associated with commonly used sedative medications

19.2.4.2 Topical anesthesia

- 19.2.4.2.1 Describe the local anesthetics commonly used to provide topical anesthesia to the eye and the potential side effects and complications associated with those drugs

19.2.4.3 Regional anesthesia

- 19.2.4.3.1 Describe retrobulbar and peri-bulbar blocks, along with indications and contra-indications for them
- 19.2.4.3.2 Describe the potential complications of these blocks and their management including, but not limited to: globe perforation, optic nerve damage, hemorrhage and total spinal anesthesia

19.2.4.4 General anesthesia

- 19.2.4.4.1 Describe the anesthetic considerations of ophthalmologic surgery, including limited access to the airway, and the importance of smooth induction and emergence
- 19.2.4.4.2 Demonstrate an understanding of the significance of Ketamine, nitrous oxide, and succinylcholine in ophthalmologic surgery

19.2.5 Post-operative Nausea and Vomiting Prophylaxis

- 19.2.5.1 Appreciate the importance of avoiding coughing/retching in ophthalmologic surgery

**C) Specific Eye Surgery**

- 19.3 Demonstrate an understanding of the concerns for specific surgical procedures and an ability to provide anesthetic management for:

19.3.1 Open eye injury / ruptured globe

19.3.2 Strabismus repair

19.3.3 Retinal detachment surgery

19.3.4 Retinal surgery for vitreous hemorrhage

- 19.3.4.1 Know the significance of the intravitreal gas bubble

19.3.5 Cataract surgery

19.3.6 Oculoplastics

19.3.6.1 Blephoroplasty

19.3.6.2 Dacrocystorhinostomy (DCR)

19.3.6.3 Ptosis repair

19.3.6.4 Orbital reconstruction

19.3.7 Corneal transplant

19.3.8 Removal of foreign body

19.3.9 Conjunctival – pterygium

19.3.10 Laser surgery including safety measures required

19.3.11 Enucleation of the eye

## 20 Orthopedic Surgery

Upon completion of this training, the Anesthesiologist must demonstrate knowledge of the issues related to providing anesthetic care for patients undergoing orthopedic surgery with respect to:

### A) General considerations:

- 20.1 Preoperative Assessment
- 20.2 Co-morbid medical conditions
  - 20.2.1 Including rheumatoid arthritis, osteoarthritis, ankylosing spondylitis
- 20.3 Associated chronic pain
- 20.4 Use of anti-coagulants
- 20.5 Local, Regional or General
- 20.6 Positioning
  - 20.6.1 Beach chair
  - 20.6.2 Lateral
- 20.7 Tourniquet
- 20.8 Cement – Methyl methacrylate
- 20.9 Fat embolism, pulmonary embolism
- 20.10 DVT prophylaxis
- 20.11 Infection
- 20.12 Compartment syndrome
- 20.13 Blood loss – transfusion sparing techniques, cell save, etc.
- 20.14 Multi-modal analgesia
  - 20.14.1 Rehabilitation, mobilization, physiotherapy

### B) Limb Fractures

- 20.15 Provide competent anesthetic care for patients with fractures taking into account the following concerns:
  - 20.15.1 Urgent vs. emergent
  - 20.15.2 Open vs. closed fractures
  - 20.15.3 Compound vs. simple
  - 20.15.4 Neurovascular compromise
  - 20.15.5 Compartment syndrome



20.15.6 Hemorrhage

**C) Joint Replacements**

20.16 Provide competent anesthetic care for patients presenting for joint replacement taking into account the general considerations for orthopedic surgery, including

20.16.1 Age, Co-morbidities

20.16.2 Chronic pain

20.16.3 Tourniquet

20.16.4 Cement

20.16.5 Blood loss

20.16.6 Post op pain, regional techniques and multi-modal analgesia

20.16.7 Anti-coagulation

**D) Tendon/Ligament Reconstruction**

20.17 Provide competent anesthetic care for patients presenting for tendon/ligament reconstruction

**E) Spine surgery**

20.18 Demonstrate knowledge and proficiency with the principles of anesthesiology for spinal decompression/ stabilization surgery and provide competent anesthetic care for patients presenting for this surgery

20.18.1 Spinal cord anatomy and physiology

20.18.2 Stable vs. Unstable spine

20.18.3 Emergency vs. Elective

20.18.4 Instrumentation

20.18.5 Spinal shock physiology

20.18.6 Spinal cord compromise

20.18.6.1 Protection

20.18.6.2 Precautions

20.18.6.3 Awake positioning

20.18.7 Spinal cord monitoring

20.18.7.1 Somatosensory Evoked Potentials (SSEP)

20.18.7.2 Motor Evoked Potentials (MEP)

20.18.7.3 Electromyography

20.18.7.4 Wake up tests

20.18.8 Post-operative neurological assessment

20.18.9 Considerations of dural tear

20.18.10 Prolonged duration

20.18.11 Post-operative respiratory function

20.18.12 Post-operative visual loss

20.18.13 Implications of surgery on different levels of the spine including but not limited to:

20.18.13.1 Cervical-spine

20.18.13.1.1 Unstable vs. stable cervical-spine

20.18.13.1.2 Anterior and posterior approaches

20.18.13.1.3 Airway management, shared airway

20.18.13.1.4 Lack of access

20.18.13.1.5 Awake positioning

20.18.13.2 Thoracic-spine

20.18.13.2.1 One lung ventilation

20.18.13.2.2 Blood loss

20.18.13.2.3 Embolism

20.18.13.2.4 Autonomic hyperreflexia

20.18.13.3 Lumbar-spine

20.18.13.3.1 Implications of prone position

20.18.13.3.2 Discectomy/laminectomy

20.18.13.3.3 Spine decompression +/- fusion

20.18.13.3.4 Implications of bone graft/coral graft

20.19 Scoliosis Surgery

20.19.1 Provide competent anesthetic care for patients presenting for scoliosis surgery including:

20.19.1.1 Pre-operative assessment

20.19.1.1.1 Pediatric vs. adult considerations

20.19.1.1.2 Co-morbidities (multiple sclerosis, cerebral palsy, etc.)

20.19.1.1.3 Respiratory function

20.19.1.1.4 Cardiovascular function

- 20.19.1.2 Specific anesthetic management and monitoring
- 20.19.1.3 Prone positioning
- 20.19.1.4 Blood loss and blood conservation strategies
- 20.19.1.5 Venous air embolism
- 20.19.1.6 Postoperative visual loss

## 20.20 Spinal Cord Tumours

- 20.20.1 Demonstrate knowledge and proficiency of the concerns related to spinal cord tumours and provide competent anesthetic care for patients presenting for spinal cord tumours resection surgery
  - 20.20.1.1 Blood loss
  - 20.20.1.2 Neurological compromise – management and monitoring
  - 20.20.1.3 Primary vs. metastases – radiation, chemotherapy etc.

## **F) Pelvic Surgery**

- 20.21 Provide competent anesthetic care for patients presenting for pelvic surgery
  - 20.21.1 Urgent vs. Emergent
  - 20.21.2 Major trauma and associated injuries
  - 20.21.3 Blood loss
  - 20.21.4 Prolonged procedure

## **G) Ambulatory Orthopedics**

- 20.22 Provide competent anesthetic care for patients presenting for orthopedic ambulatory surgery
  - 20.22.1 Arthroscopic surgery
  - 20.22.2 Pain management
    - 20.22.2.1 Regional anesthetic techniques
    - 20.22.2.2 Ambulatory plexus techniques

## **H) Pediatric Orthopedics – see Chapter – Pediatric Anesthesia**

- 20.23 Demonstrate an understanding of the specific concerns related to pediatric patients with respect to:
  - 20.23.1 Emergent vs. elective
  - 20.23.2 Co-morbid conditions

- 20.23.3 Congenital conditions
- 20.23.4 Prolonged surgery
- 20.23.5 Temperature regulation

## 21 Pain Management

### A) Acute Pain

Upon completion of this training, the Anesthesiologist shall demonstrate an understanding of the anatomy and physiology, and an approach to management, of acute pain

#### 21.1 Anatomy and Physiology of Pain

##### 21.1.1 Demonstrate knowledge of the anatomy and physiology of acute pain:

###### 21.1.1.1 Pain Pathways

21.1.1.1.1 Describe the structure of nerve fibers that contribute to pain

21.1.1.1.2 Describe the afferent and efferent pathways at the peripheral, spinal, brainstem, thalamic and cortical levels that are involved in nociception

###### 21.1.1.2 Pain Modulation

21.1.1.2.1 List and describe the function of the major neuromodulators involved in the perception of pain at each anatomic level

21.1.1.2.2 Explain the mechanisms involved in central and peripheral sensitization

21.1.1.2.3 Describe the role and mechanism of mediators of inflammation in the pain process

21.1.1.2.4 Describe the role and mechanism of gene expression in the pain process

###### 21.1.1.3 Neuroendocrine Stress Response

21.1.1.3.1 Describe the acute and chronic effects of neuroendocrine stress response on different systems

21.1.1.3.2 Describe the theoretical mechanism by which analgesia affects neuroendocrine response

21.1.1.3.3 Describe how modification of neuroendocrine response by analgesia may affect patient and surgical outcomes

###### 21.1.1.4 Neuropsychological

21.1.1.4.1 Describe the psychological, social and functional aspects of the pain experience and incorporate them into an analgesic plan

21.2 Assessment of Pain

21.2.1 Demonstrate knowledge of the methods used for assessment of acute pain:

21.2.1.1 Objective vs. Subjective

- 21.2.1.1.1 Explain the relevance of objective assessment relative to patient self-reports, and create useful assessment plans based on these principles

21.2.1.2 Characterization of Pain

- 21.2.1.2.1 Define the different components of acute pain and assess their relative contribution to a patient's pain problem

21.2.1.3 Pain Assessment Tools

- 21.2.1.3.1 Describe common examples of pain assessment tools and their relative advantages and disadvantages

21.3 Analgesic Interventions

21.3.1 Demonstrate knowledge of the various approaches to acute pain management and ability to provide effective management of acute pain

21.3.1.1 Multimodal and Regional Analgesia

- 21.3.1.1.1 Describe the multimodal approach to analgesia, including its components, benefits and limitations
- 21.3.1.1.2 Collaborate with other disciplines to create effective policies for multimodal therapies
- 21.3.1.1.3 Describe the relative merits of different co-analgesics and select an appropriate co-analgesic regimen to improve analgesia and minimize risk or side effects
- 21.3.1.1.4 Identify common impediments to analgesia and modify therapy appropriately

21.3.1.2 Methods of Delivering Analgesics

- 21.3.1.2.1 Demonstrate knowledge and an ability to use the various methods of delivering analgesics available for management of acute pain and be able to describe the various analgesics according to the properties of each method, including but not limited to:
- Describe the pharmacokinetic rationale
  - List and manage the potential risk
  - Device appropriate management protocols

- Troubleshoot suboptimal management
- Prescribe appropriately
- List advantages, disadvantages, indication and contraindications
- Describe agents which may be used (where appropriate)

21.3.1.2.1.1 Patient-Controlled Analgesia

21.3.1.2.1.2 Peripheral Nerve Blocks

21.3.1.2.1.3 Epidural Analgesia

21.3.1.2.1.4 Neuraxial Opioids

#### 21.3.1.3 General Analgesic Pharmacology

21.3.1.3.1 Describe and utilize the pharmacokinetics and analgesic therapies taking into account the characteristics of specific agents and routes of administration

21.3.1.3.2 Identify patients with special pharmacokinetic and pharmacodynamics characteristics and modify therapy appropriately

### 21.4 Analgesic Agents

21.4.1 Demonstrate knowledge and an ability to use the various groups of analgesics available for management of acute pain and be able to describe the various analgesics according to the properties of each agent, including but not limited to:

- Describe the indications, contraindications, advantages and disadvantages of the agents including issues specific to all routes of administration
- List the systemic effects of each agent
- Identify and minimize the complications and side effects
- Contrast the pharmacokinetic and dynamic characteristics of different agents
- Select the appropriate dose, and route of administration for each agent

#### 21.4.1.1 Opioids

21.4.1.1.1 Describe the mechanism of action of opioids

21.4.1.1.2 Describe the types of opioid receptors with reference to their functions and distribution in the body

- 21.4.1.1.3 Develop protocols and policies to govern the administration of opioids in the perioperative setting
  - 21.4.1.2 NSAIDs
    - 21.4.1.2.1 Describe the mechanism of action of NSAIDs
    - 21.4.1.2.2 Develop protocols and policies to govern the administration of NSAIDs in the perioperative setting
    - 21.4.1.2.3 NSAIDs vs. Cox-2
  - 21.4.1.3 Acetaminophen
    - 21.4.1.3.1 Describe the mechanism of action of acetaminophen
    - 21.4.1.3.2 Develop protocols and policies to govern the administration of acetaminophen in the perioperative setting
  - 21.4.1.4 Topical Analgesics
    - 21.4.1.4.1 Identify appropriate situations and agents for topical analgesia
    - 21.4.1.4.2 Discuss the relative advantages and disadvantages of this route with specific reference to the agent and the situation
    - 21.4.1.4.3 Prescribe topical opioids appropriately
    - 21.4.1.4.4 Describe the indications, contraindications and rationale for the use of other topical analgesics
    - 21.4.1.4.5 Describe the use of topical agents to a patient
  - 21.4.1.5 Lidocaine Infusion
    - 21.4.1.5.1 Describe the mechanism of action of IV lidocaine infusion
    - 21.4.1.5.2 Develop protocols and policies to govern the administration of IV lidocaine infusion in the perioperative setting
  - 21.4.1.6 NMDA Antagonists
    - 21.4.1.6.1 Contrast the pharmacokinetic and pharmacodynamics characteristics of NMDA antagonists
    - 21.4.1.6.2 Describe the mechanism of action of NMDA antagonists
    - 21.4.1.6.3 Develop protocols and policies to govern the administration of NMDA antagonists in the perioperative setting
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21.4.1.7 Anticonvulsants

- 21.4.1.7.1 Describe the indications, contraindications, advantages and disadvantages of anticonvulsants in acute pain management
- 21.4.1.7.2 Describe the analgesic mechanism of action of anticonvulsants
- 21.4.1.7.3 Develop protocols and policies to govern the administration of anticonvulsants in the perioperative setting

21.4.1.8 Alpha-Agonists

- 21.4.1.8.1 Describe the mechanism of action of alpha-agonists
- 21.4.1.8.2 Develop protocols and policies to govern the administration of Alpha-agonists in the perioperative setting

21.4.1.9 Antidepressants

- 21.4.1.9.1 Describe the mechanisms of action of Antidepressants with respect to acute pain management
- 21.4.1.9.2 Develop protocols and policies to govern the administration of antidepressants in the perioperative setting

21.4.1.10 Tramadol

- 21.4.1.10.1 Identify and minimize related complications and side effects
- 21.4.1.10.2 Describe the mechanism of action of Tramadol

21.4.1.11 Cannabinoids

- 21.4.1.11.1 Describe the indications, contraindications, advantages and disadvantages of cannabinoids including issues specific to all relevant routes of administration
- 21.4.1.11.2 Describe the types of cannabinoids available (tetrahydrocannabinol (THC), cannabidiol (CBD), cannabis)
- 21.4.1.11.3 List the systemic effects of cannabinoids including variations specific to particular routes of administration

- 21.4.1.11.4 Identify and minimize related complications and side effects
- 21.4.1.11.5 Describe the mechanism of action of cannabinoids with respect to analgesia
- 21.4.1.11.6 Develop protocols and policies to govern the administration of cannabinoids in the perioperative setting

## 21.5 Non-Pharmacologic Interventions

- 21.5.1 Demonstrate an understanding and ability to use/prescribe non-pharmacologic interventions for the management of acute pain
  - 21.5.1.1 Recognize the importance of non-pharmacologic factors in analgesia
  - 21.5.1.2 Support allied health professional in provision of non-pharmacologic interventions
  - 21.5.1.3 Trans-cutaneous electrical nerve stimulation (TENS)
    - 21.5.1.3.1 Explains the theoretical mechanism of TENS in analgesia
    - 21.5.1.3.2 Discuss the efficacy of TENS in acute pain management
    - 21.5.1.3.3 Coordinate access to TENS as a non-pharmacologic adjunct in appropriate situations

## 21.6 Acute Pain Management

- 21.6.1 Demonstrate knowledge of the outcomes relevant to the various modalities of analgesia used for management of acute pain
  - 21.6.1.1 Outcomes
    - 21.6.1.1.1 Discuss the extent to which analgesia may contribute to acute and chronic patient outcomes, and the mechanisms for such contribution
    - 21.6.1.1.2 Design analgesia plans that optimize recovery for patient
- 21.6.2 Acute Pain Service
  - 21.6.2.1 Describe the roles and responsibility of acute pain service
  - 21.6.2.2 Recognize and manage side effects and adverse events as a results of pain management modalities
  - 21.6.2.3 Provide appropriate transition analgesic management, for example converting IV agents to oral agents

21.6.3 Addiction, Tolerance and Substance Abuse

- 21.6.3.1 Identify and distinguish between tolerance, dependence and addiction
- 21.6.3.2 Identify the special physiological, psychological, pharmacokinetic and pharmacodynamics issues in the tolerant or abusing patient
- 21.6.3.3 Recognize addictive behaviour and warning signs of substance abuse
- 21.6.3.4 Educate allied health and other medical professional to the risks and appropriate management of tolerance and addiction in relation to acute analgesic therapy
- 21.6.3.5 Describe the biopsychosocial aspects of substance abuse and its interaction with analgesic therapy
- 21.6.3.6 Generate an appropriate acute pain plan in cooperation with the patient setting realistic analgesic and functional goals
- 21.6.3.7 Recognize and treat opioid withdrawal

**B) Chronic Pain**

The Anesthesiologist shall demonstrate an understanding of the anatomy and physiology and an approach to management of chronic pain

21.7 Anatomy and Physiology of Pain

21.7.1 Demonstrate knowledge of the anatomy and physiology of acute pain:

21.7.1.1 Pain Pathways

- 21.7.1.1.1 Describe the structure of nerve fibers that contribute to pain
- 21.7.1.1.2 Describe the afferent and efferent pathways at the peripheral, spinal, brainstem, thalamic and cortical levels that are involved in nociception

21.7.1.2 Pain Modulation

- 21.7.1.2.1 List and describe the function of the major neuromodulators involved in the perception of pain at each anatomic level
- 21.7.1.2.2 Explain the mechanisms involved in central and peripheral sensitization
- 21.7.1.2.3 Describe the role and mechanism of mediators of inflammation in the pain process
- 21.7.1.2.4 Describe the role and mechanism of gene expression in the pain process

21.7.1.3 Neuroendocrine Stress Response

21.7.1.3.1 Describe the acute and chronic effects of neuroendocrine stress response on different systems

21.7.1.3.2 Describe the theoretical mechanism by which analgesia affects neuroendocrine response

21.8 Assessment of pain

21.8.1 Demonstrate knowledge of the methods used for assessment of chronic pain, including but not limited to:

21.8.1.1 Objective vs. Subjective

21.8.1.1.1 Delineate between nociceptive (somatic and visceral) and neuropathic

21.8.1.1.2 Explain the relevance of objective assessment relative to patient self-reports, and create useful assessment plans based on these principles

21.8.1.1.3 Assess the relative contributions of somatic, inflammatory, functional and neuropathic processes in a given patient's pain problem

21.8.1.1.4 Perform a comprehensive assessment of the patient in pain, including functional and psychosocial impacts

21.8.1.1.5 Interpret the results of multidimensional pain indices, and compare the clinical utility of different instruments

21.8.1.2 Pain Assessment Tools

21.8.1.2.1 Describe common examples of pain assessment tools and their relative advantages and disadvantages

21.9 Analgesia, outcomes, and goals of therapy

21.9.1 Rehabilitative and Functional Outcomes

21.9.1.1 Describe the affective and functional aspects of the pain experience and incorporate them into an analgesic plan

21.9.1.2 Generate an appropriate plan in cooperation with the patient setting realistic analgesic and functional goals

21.9.1.3 Coordinate a multidisciplinary pain management plan, making appropriate use of allied health professionals and resources

21.10 Tolerance, Addiction and Substance Abuse

- 21.10.1 Identify and distinguish between tolerance, dependence and addiction
- 21.10.2 Identify the special physiological, psychological, pharmacokinetic and pharmacodynamics issues in the tolerant or abusing patient
- 21.10.3 Recognize addictive behaviour and warning signs of substance abuse
- 21.10.4 Educate allied health and other medical professionals to the risks and appropriate management of tolerance and addiction in relation to chronic analgesic therapy
- 21.10.5 Describe the biopsychosocial aspects of substance abuse and its interaction with chronic analgesic therapy
- 21.10.6 Generate an appropriate comprehensive long-term plan in cooperation with the patient setting realistic analgesic and functional goals

21.11 Analgesic Interventions

- 21.11.1 Demonstrate knowledge of the various approaches to chronic pain management and ability to provide effective management of chronic pain

21.11.1.1 Multimodal and Regional Analgesia

- 21.11.1.1.1 Describe the multimodal approach to analgesia, including its benefits and limitations
- 21.11.1.1.2 Advocate with other disciplines to create effective policies for multimodal therapies
- 21.11.1.1.3 Describe the relative merits of different co-analgesics
- 21.11.1.1.4 Select an appropriate co-analgesic regimen to improve analgesia and minimize risk or side effects in a spectrum of patients
- 21.11.1.1.5 Identify common impediments to analgesia and modify therapy appropriately
- 21.11.1.1.6 Discuss the advantages, disadvantages, indications, contraindications and complications of the regional techniques as they apply to chronic pain management
- 21.11.1.1.7 Identify and manage complications and adverse effects of regional analgesic techniques in an ambulatory chronic pain population

21.11.1.2 Pharmacologic Interventions

21.11.1.2.1 General Analgesic Pharmacology

- 21.11.1.2.1.1 Describe and utilize the pharmacokinetics of analgesic therapies taking into account the

characteristics of specific agents and the relative advantages and disadvantages of multiple routes of administration

- 21.11.1.2.1.2 Predict the differences in effect expected with oral, rectal, transcutaneous, IM, IV, and SC administration of analgesic agents and modify therapy to utilize these routes appropriately
- 21.11.1.2.1.3 Identify patients with special pharmacokinetic and dynamic characteristics and modify therapy appropriately
- 21.11.1.2.1.4 Collaborate with hospital pharmacists and allied health professionals to implement policies that take into account the relative advantages and disadvantages of different routes of administration

## 21.12 Analgesic agents

21.12.1 Demonstrate knowledge and an ability to use the various groups of analgesics available for management of acute pain and be able to describe the various analgesics according to the properties of each agent, including but not limited to:

- Describe the indications, contraindications, advantages and disadvantages of the agents including issues specific to all routes of administration
- List the systemic effects of each agent
- Identify and minimize the complications and side effects
- Contrast the pharmacokinetic and dynamic characteristics of different agents
- Select the appropriate dose, and route of administration for each agent

### 21.12.1.1 Topical Analgesics

- 21.12.1.1.1 Identify appropriate situations and agents for topical analgesia
- 21.12.1.1.2 Discuss the relative advantages and disadvantages of this route with specific reference to the agent and the situation
- 21.12.1.1.3 Prescribe topical opioids appropriately
- 21.12.1.1.4 Describe the indications, contraindications and rationale for the use of other topical analgesics
- 21.12.1.1.5 Describe the use of topical agents to a patient

21.12.1.2 Opioids

- 21.12.1.2.1 Describe the mechanism of action of opioids
- 21.12.1.2.2 Describe the types of opioid receptors with reference to their functions and distribution in the body
- 21.12.1.2.3 Develop protocols and policies to govern the administration of opioids in the perioperative setting
- 21.12.1.2.4 Intrathecal/epidural route
- 21.12.1.2.5 Mechanisms to avoid/reverse opioid tolerance (opioid rotation; use of antagonists etc.)
- 21.12.1.2.6 Detoxification protocols (slow vs. rapid detox)
- 21.12.1.2.7 Discuss opioid conversions – equipotency; iv:po conversions
- 21.12.1.2.8 Methadone
  - 21.12.1.2.8.1 Titration protocol; mechanism of action; conversion; ways of administration
- 21.12.1.2.9 Suboxone
  - 21.12.1.2.9.1 Protocol; mechanism of action

21.12.1.3 NSAIDs

- 21.12.1.3.1 Describe the mechanism of action of NSAIDs
- 21.12.1.3.2 Develop protocols and policies to govern the administration of NSAIDs in the chronic pain setting
- 21.12.1.3.3 NSAIDs vs. Cox-2

21.12.1.4 Acetaminophen

- 21.12.1.4.1 Describe the mechanism of action of Acetaminophen
- 21.12.1.4.2 Develop protocols and policies to govern the administration of acetaminophen in the chronic pain setting

21.12.1.5 NMDA Antagonists

- 21.12.1.5.1 Describe the mechanism of action of NMDA antagonists
- 21.12.1.5.2 Describe the role of excitatory amino acids in pain and sensitization
- 21.12.1.5.3 Develop protocols and policies to govern the administration of NMDA antagonists in the chronic pain setting

21.12.1.6 Anticonvulsants

- 21.12.1.6.1 Describe the analgesic mechanism of action of anticonvulsants
- 21.12.1.6.2 Develop protocols and policies to govern the administration of anticonvulsants in the chronic pain setting

21.12.1.7 IV lidocaine therapy

- 21.12.1.7.1 Describe the analgesic mechanism of action of IV lidocaine therapy

21.12.1.8 Alpha-agonists

- 21.12.1.8.1 Describe the mechanism of action of Alpha-agonists
- 21.12.1.8.2 Develop protocols and policies to govern the administration of Alpha-agonists in the chronic pain setting

21.12.1.9 Antidepressants

- 21.12.1.9.1 Describe the mechanisms of action antidepressants with respect to analgesia
- 21.12.1.9.2 Develop protocols and policies to govern the administration of antidepressants in the chronic pain setting

21.12.1.10 Tramadol

- 21.12.1.10.1 Identify and minimize related complications and side effects
- 21.12.1.10.2 Describe the mechanism of action of Tramadol

21.12.1.11 Cannabinoids

- 21.12.1.11.1 Describe the indications, contraindications, advantages and disadvantages of cannabinoids including issues specific to all relevant routes of administration
- 21.12.1.11.2 List the systemic effects of cannabinoids including variations specific to particular routes of administration
- 21.12.1.11.3 Identify and minimize related complications and side effects
- 21.12.1.11.4 Describe the mechanism of action of cannabinoids with respect to analgesia



- 21.12.1.11.5 Develop protocols and policies to govern the administration of cannabinoids in the chronic pain setting

#### 21.13 Non-Pharmacologic Interventions

- 21.13.1 Demonstrate knowledge and ability to use/prescribe non-pharmacologic interventions for the management of chronic pain
- 21.13.2 Recognize the importance of non-pharmacologic factors in analgesia
- 21.13.3 Support allied health professional in provision of non-pharmacologic interventions TENS and acupuncture
- 21.13.4 Explain the theoretical mechanism of TENS in analgesia
- 21.13.5 Discuss the efficacy of TENS in chronic pain management
- 21.13.6 Coordinate access to TENS as a non-pharmacologic adjunct in appropriate situations

##### 21.13.6.1 Other Non-Pharmacologic Interventions

- 21.13.6.1.1 Use of Biofeedback
- 21.13.6.1.2 Chiropractic interventions
- 21.13.6.1.3 Massage
- 21.13.6.1.4 Physiotherapy – ultrasound/interferential/TENS etc.

##### 21.13.6.2 Spinal Cord and Peripheral Nerve Stimulation

- 21.13.6.2.1 Identify clinical situations in which stimulation may be of benefit
- 21.13.6.2.2 Describe the purported mechanism of action of stimulation
- 21.13.6.2.3 Coordinate access to stimulation for appropriate patients
- 21.13.6.2.4 Discuss the relative advantages, disadvantages, indications and contraindications of stimulation for chronic pain
- 21.13.6.2.5 Identify complications of implanted stimulators

##### 21.13.6.3 Neuraxial pumps

- 21.13.6.3.1 Identify clinical situation in which neuraxial pumps may be of benefit
- 21.13.6.3.2 Demonstrate an understanding of the use of intrathecal pumps/spinal & epidural catheters

- 21.13.6.3.3 Demonstrate an understanding of the common drugs use with neuraxial catheter – opioids/baclofen/local anesthetics/clonidine/ketamine

## 22 Pediatric Anesthesia

### A) Basic Science

Upon completion of this training, the competent Anesthesiologist must demonstrate knowledge and an understanding of the anatomic, physiologic, psychological and pharmacological features which are unique to the pediatric population including the maturation process which takes place in all systems

#### 22.1 Anatomy/ Physiology

##### 22.1.1 Demonstrate knowledge of:

##### 22.1.1.1 The Respiratory System

22.1.1.1.1 Anatomic features of the neonatal, infant, pediatric and adolescent airway

22.1.1.1.2 The physiology of the respiratory system and its' maturation over time with respect to

22.1.1.1.2.1 Control of respiration

22.1.1.1.2.2 Compliance

22.1.1.1.2.3 Lung volumes

22.1.1.1.2.4 Oxygen consumption/metabolic rate

22.1.1.1.2.5 Normal values for different stages of development

22.1.1.1.2.6 Pediatric basic and advanced life support

##### 22.1.1.2 The Cardiovascular System

22.1.1.2.1 The anatomy and physiology relevant to the transitional circulation

22.1.1.2.2 Maturation of the myocardium and the autonomic nervous system

22.1.1.2.3 Normal values for different stages of development

22.1.1.2.4 Pediatric basic and advanced life support

##### 22.1.1.3 The Central Nervous System

22.1.1.3.1 Anatomy – size, fontanelles

22.1.1.3.2 Physiology – Intracranial pressure and volume, cerebral blood flow, autoregulation

##### 22.1.1.4 The Genitourinary System

22.1.1.4.1 Renal maturation

22.1.1.4.2 Fluid and electrolyte management

- 22.1.1.4.3 Fluid distribution
- 22.1.1.4.4 Maintenance requirements
- 22.1.1.4.5 Hydration

22.1.1.5 The Gastrointestinal/Hepatic System

- 22.1.1.5.1 Feeding, fasting guidelines
- 22.1.1.5.2 Glucose control
- 22.1.1.5.3 Maturation of hepatic function

22.1.1.6 Thermoregulation

- 22.1.1.6.1 Body surface area
- 22.1.1.6.2 Ability to thermoregulate
- 22.1.1.6.3 Heat loss

22.1.1.7 Psychological Issues

- 22.1.1.7.1 Anxiety and understanding and coping mechanism in different age groups and premedication
- 22.1.1.7.2 Separation, effects of hospitalization
- 22.1.1.7.3 Parental anxiety
- 22.1.1.7.4 Consent in the pediatric population

22.2 Pharmacology

22.2.1 Demonstrate an understanding of the variations in drug handling in infants and children as a result of differences in

22.2.1.1 Pharmacokinetics/ pharmacodynamics

- 22.2.1.1.1 Absorption
- 22.2.1.1.2 Volume of distribution
- 22.2.1.1.3 Protein binding
- 22.2.1.1.4 Pharmacokinetics/Pharmacodynamics
- 22.2.1.1.5 Metabolism
- 22.2.1.1.6 Clearance
- 22.2.1.1.7 Excretion
- 22.2.1.1.8 Toxicity
  - 22.2.1.1.8.1 Acute
  - 22.2.1.1.8.2 Anesthesia and the developing brain

## **B) Pain Management**

- 22.3 Demonstrate knowledge of options for perioperative analgesia and the indications, contraindications, advantages and disadvantages of each modality in the pediatric population, including but not limited to:
  - 22.3.1 Systemic analgesia
  - 22.3.2 Local infiltration
  - 22.3.3 Regional nerve blocks
  - 22.3.4 Neuraxial analgesia
- 22.4 Demonstrate competence in ordering continuous opioid infusions, PCA and epidural orders
- 22.5 Demonstrate competence in performing single shot caudal blocks
- 22.6 Demonstrate knowledge of age-specific equipment

## **C) Coexisting Diseases in Pediatric Patients**

- 22.7 The Anesthesiologist must demonstrate the ability to independently provide anesthetic care for:
  - 22.7.1 Full term infants, preterm infants, former preterm infants, children and adolescents presenting for common surgical procedures
  - 22.7.2 Children with cardiovascular diseases
    - 22.7.2.1 Atrial Septal Defect, Ventricular Septal Defect, Patent Ductus Arteriosus
    - 22.7.2.2 Cardiomyopathies
    - 22.7.2.3 Heart transplant recipients
  - 22.7.3 Pediatric patients with respiratory diseases
    - 22.7.3.1 Upper respiratory tract infections
    - 22.7.3.2 Asthma, including management of status asthmaticus
    - 22.7.3.3 Cystic Fibrosis
    - 22.7.3.4 Chronic Lung Disease
    - 22.7.3.5 Stridor
  - 22.7.4 Patients with diseases of the gastrointestinal tract
    - 22.7.4.1 Hepatobiliary disease
    - 22.7.4.2 Gastroesophageal reflux
    - 22.7.4.3 Feeding disorders

22.7.5 Patients with Neuromuscular diseases

- 22.7.5.1 Hydrocephalus
- 22.7.5.2 Spina bifida
- 22.7.5.3 Cerebral palsy
- 22.7.5.4 Seizure disorders, including management of status epilepticus
- 22.7.5.5 Duchenne's Muscular Dystrophy
- 22.7.5.6 Myotonic Dystrophy
- 22.7.5.7 Developmental delay

22.7.6 Patients with Infectious diseases

- 22.7.6.1 Septic shock
- 22.7.6.2 Communicable diseases
  - 22.7.6.2.1 HIV
  - 22.7.6.2.2 Hepatitis
  - 22.7.6.2.3 Tuberculosis

22.7.7 Patients with Renal Disease

- 22.7.7.1 Nephrotic syndrome
- 22.7.7.2 Hemolytic Uremic Syndrome
- 22.7.7.3 End-stage renal failure

22.7.8 Patients with Endocrine/metabolic diseases

- 22.7.8.1 Diabetes
- 22.7.8.2 Thyroid diseases
- 22.7.8.3 Obesity
- 22.7.8.4 Mitochondrial diseases

22.7.9 Patients with Hematologic diseases/malignancies

- 22.7.9.1 Anemias including Sickle cell disease, Thalassemia
- 22.7.9.2 Bleeding disorders: hemophilia, Von Willebrand's disease
- 22.7.9.3 Others: Immune thrombocytopenic purpura, leukemia
- 22.7.9.4 Malignancies
- 22.7.9.5 Mediastinal masses

22.7.10 Psychological

- 22.7.10.1 Perioperative anxiety in pediatric patients presenting for multiple types of surgery

22.7.11 Children with common syndromes

- 22.7.11.1 Down's syndrome
- 22.7.11.2 Developmental Delay
- 22.7.11.3 Autism
- 22.7.11.4 Malignant hyperthermia susceptibility

**D) Anesthesia for Surgical Procedures**

- 22.8 The Anesthesiologist must be able to demonstrate understanding of the implications of, and to independently provide anesthetic care for children presenting for:

22.8.1 Neonatal/Infant Surgery

- 22.8.1.1 Pyloromyotomy
- 22.8.1.2 Inguinal hernia repair
- 22.8.1.3 Laparotomy

22.8.2 General Surgery

- 22.8.2.1 Emergency surgery and the implications thereof:

- 22.8.2.1.1 Full stomach
- 22.8.2.1.2 Evaluation and Resuscitation
- 22.8.2.1.3 Fluid and electrolytes

- 22.8.2.2 Trauma surgery
- 22.8.2.3 Laparoscopic surgery
- 22.8.2.4 Antireflux surgery
- 22.8.2.5 Cholecystectomy/splenectomy

22.8.3 Otolaryngology

- 22.8.3.1 Tonsillectomy and adenoidectomy (including bleeding tonsil)
- 22.8.3.2 Myringotomy
- 22.8.3.3 Mastoidectomy
- 22.8.3.4 Thyroidectomy
- 22.8.3.5 Tympanoplasty

- 22.8.3.6 Removal of foreign body from the airway/esophagus
- 22.8.3.7 Epiglottitis
- 22.8.3.8 Laryngoscopy (diagnostic/therapeutic)
- 22.8.3.9 Bronchoscopy (rigid/flexible)
- 22.8.3.10 Tracheostomy

22.8.4 Orthopedic Surgery

- 22.8.4.1 Fracture reduction and/or fixation
- 22.8.4.2 Hip reconstruction
- 22.8.4.3 Soft tissue surgery
- 22.8.4.4 Spinal surgery

22.8.5 Plastic Surgery

- 22.8.5.1 Cleft lip/palate repair
- 22.8.5.2 Burn debridement/skin graft
- 22.8.5.3 Correction of congenital limb deformities

22.8.6 Neurosurgery

- 22.8.6.1 Ventriculo-Peritoneal shunt insertion, revision
- 22.8.6.2 Tumour resection
- 22.8.6.3 Drainage of extra/subdural hematoma
- 22.8.6.4 Management of raised intracranial pressure

22.8.7 Urology

- 22.8.7.1 Circumcision, Hypospadias repair
- 22.8.7.2 Ureteric reimplantation
- 22.8.7.3 Cystoscopy
- 22.8.7.4 Nephrectomy
- 22.8.7.5 Insertion Peritoneal Dialysis catheter

22.8.8 Ophthalmology

- 22.8.8.1 Strabismus repair
- 22.8.8.2 Cataract surgery
- 22.8.8.3 Glaucoma
- 22.8.8.4 Eyelid surgery



- 22.8.8.5 Laser for retinopathy of prematurity
- 22.8.9 Dental Surgery
  - 22.8.9.1 Dental extractions/restorations
  - 22.8.9.2 Orthognathic surgery
- 22.8.10 Remote Locations
  - 22.8.10.1 MRI/CT
  - 22.8.10.2 Interventional radiology procedures
  - 22.8.10.3 Medical procedures: e.g., Bone marrow aspiration/biopsy, LP, gastroscopy, colonoscopy, joint injections
- 22.8.11 Demonstrate an understanding of the principles of anesthetic management for, but not provide independent anesthetic care for:
  - 22.8.11.1 Tracheo-esophageal fistula repair
  - 22.8.11.2 Omphalocele
  - 22.8.11.3 Gastroschisis
  - 22.8.11.4 Necrotizing enterocolitis
  - 22.8.11.5 Congenital diaphragmatic hernia
  - 22.8.11.6 Thoracic surgery, including the need for lung isolation
  - 22.8.11.7 Neonatal airway surgery
  - 22.8.11.8 Laryngeal/tracheal reconstruction
  - 22.8.11.9 Airway papillomas
- 22.8.12 Perioperative/PACU issues
  - 22.8.12.1 Demonstrate the ability to evaluate and manage common problems which may arise perioperatively:
    - 22.8.12.1.1 Criteria for day surgery, especially for exprematures
    - 22.8.12.1.2 Un-cooperative patient
    - 22.8.12.1.3 Delirium
    - 22.8.12.1.4 Post extubation stridor
    - 22.8.12.1.5 Pain
    - 22.8.12.1.6 Nausea and vomiting
    - 22.8.12.1.7 Laryngospasm
    - 22.8.12.1.8 Anaphylaxis

## 23 Pharmacology

Upon completion of this training, the Anesthesiologist shall demonstrate knowledge of the terminology and principles relevant to the pharmacology of all agents

### A) Terminology: Definitions and distinctions

- 23.1 Hyperactivity
- 23.2 Hypersensitivity
- 23.3 Tolerance
- 23.4 Tachyphylaxis
- 23.5 Synergism
- 23.6 Antagonism
- 23.7 Potency of drugs
- 23.8 Efficacy of drugs

### B) Transfer of drugs between compartments

- 23.9 Demonstrate an ability to:
  - 23.9.1 Describe the following processes:
    - 23.9.1.1 Passive diffusion
    - 23.9.1.2 Active transport
    - 23.9.1.3 Facilitated diffusion
  - 23.9.2 Explain the impact of the pKa of drugs and of the acidic or basic state on their transfer between compartments
  - 23.9.3 Explain the different aspects of binding of drugs to proteins, and describe the impact of various factors affecting the binding, such as age, sex, liver and kidney function and placental membranes

### C) Transit of drugs

- 23.10 Intake
  - 23.10.1 Explain and describe the specific properties of the following routes of administration:
    - 23.10.1.1 Oral
    - 23.10.1.2 Sublingual
    - 23.10.1.3 Transcutaneous
    - 23.10.1.4 Intramuscular
    - 23.10.1.5 Subcutaneous

- 23.10.1.6 Neuraxial
- 23.10.1.7 Inhalational
- 23.10.1.8 Intravenous

### 23.11 Distribution

23.11.1 Describe the various properties, processes and structures involved in the distribution of drugs and their impact on drug action:

- 23.11.1.1 Water and lipid solubility
- 23.11.1.2 Ionisation
- 23.11.1.3 Binding to proteins and tissues
- 23.11.1.4 Placental transfer
- 23.11.1.5 Blood brain barrier
- 23.11.1.6 Perfusion gradients

### 23.12 Elimination

23.12.1 Demonstrate an ability to:

- 23.12.1.1 Define clearance, extraction ratio, intrinsic clearance
- 23.12.1.2 Describe the components of clearance of drugs by the kidney and liver. Explain the impact of changes of blood flow in both organs and of the variability of intrinsic clearance by the liver
- 23.12.1.3 Explain the impact of alterations of liver function and blood flow on the extraction process
- 23.12.1.4 Describe the main pathways of drug metabolism: biotransformation (phase 1 reactions) and conjugation (phase II)
- 23.12.1.5 Describe the impact of various factors affecting metabolism
  - 23.12.1.5.1 Individual variability
  - 23.12.1.5.2 Age
  - 23.12.1.5.3 Sex
  - 23.12.1.5.4 Exposure to other substances (induction and inhibition)
  - 23.12.1.5.5 Liver and kidney disease

**D) Pharmacokinetic Principles**

23.13 Demonstrate an ability to:

- 23.13.1 Define the term pharmacokinetics
- 23.13.2 Explain the evolution from perfusion models to compartmental pharmacokinetics
- 23.13.3 Define: rate constant, half-times, (elimination half-time, context sensitive half-time), half life, volumes of distribution
- 23.13.4 Explain the distinction between zero and first order kinetics, and between one, two and three compartments pharmacokinetic models
- 23.13.5 Explain the impact of changes in liver and renal function on kinetics
- 23.13.6 Describe the links between the kinetics of drugs and their transit

**E) Pharmacodynamic Principles**

23.14 Define pharmacodynamics

23.15 Describe the information provided by the following elements of dose-response curves

- 23.15.1 Potency
- 23.15.2 Slope of curves
- 23.15.3 Efficacy
- 23.15.4 Variability

23.16 Explain the time lag between end of injections or infusions and drug effect

23.17 Describe the impact of factors affecting this time lag:

- 23.17.1 Organ perfusion
- 23.17.2 Partition coefficients
- 23.17.3 Rate of transit
- 23.17.4 Drug receptor affinity
- 23.17.5 Delay between receptor exposure and drug effect

23.18 Describe the elements governing drug-receptor interaction

- 23.18.1 Law of mass action
- 23.18.2 Affinity for receptors
- 23.18.3 Spare receptors
- 23.18.4 Ion channels

- 23.18.5 Guanosine nucleotide-binding proteins (G proteins)
- 23.18.6 Second messenger
- 23.19 Define biophase and explain the interrelationship between kinetics, dynamics and effect
- 23.20 Explain the differences between agonists, partial agonists and antagonists
- 23.21 Drug interactions
  - 23.21.1 Explain the overall benefits and pitfalls of the drug interaction processes in Anesthesiology
  - 23.21.2 Describe mechanisms which create interactions
    - 23.21.2.1 Physico-chemical properties of drugs
    - 23.21.2.2 Interference with transit of drugs
    - 23.21.2.3 Competition of binding sites
    - 23.21.2.4 Enzyme induction and inhibition

## **F) Anesthetic Drugs**

23.22 Demonstrate in-depth knowledge of the following:

- Mechanism of action
- Pharmacokinetics and dynamics
- Dose range
- Clinical effects/ complications
- Indications
- Contraindications
- Drug interactions

For each of the following drugs:

- 23.22.1 Intravenous induction agents, sedatives and adjuncts
  - 23.22.1.1 Propofol
  - 23.22.1.2 Barbiturates including thiopental and methohexital
  - 23.22.1.3 Ketamine
  - 23.22.1.4 Etomidate
  - 23.22.1.5 Midazolam
    - 23.22.1.5.1 Benzodiazepine antagonist – Flumazenil
  - 23.22.1.6 Dexmethomidine
  - 23.22.1.7 Intravenous lidocaine

23.22.2 Narcotics/Opioids and adjuncts

23.22.2.1 Fentanyl

23.22.2.2 Remifentanyl

23.22.2.3 Sufentanyl

23.22.2.4 Alfentanyl

23.22.2.5 Morphine

23.22.2.6 Hydromorphone

23.22.2.7 Meperidine

23.22.2.8 Buprenorphine

23.22.2.8.1 Opioid antagonist - Naloxone

23.22.3 Muscle relaxants and associated reversal agents - See Chapter 17  
- Neuromuscular Junction

23.22.4 Antiemetics - See Chapter 26 – Post-Anesthetic Care Unit

23.22.5 Volatiles agents - See Chapter 35- Volatiles Agents

23.22.6 Vasopressors and inotropes - See Chapter 3 - Autonomic Nervous  
System

23.22.7 Local anesthetics- See Chapter 28 – Regional Anesthesia

**G) Miscellaneous**

23.23 Demonstrate knowledge of the pharmacokinetics, pharmacodynamics,  
mechanisms of action, routes of delivery and elimination and adverse  
effects of

23.23.1 Common recreational drugs

23.23.2 Herbal or over the counter products

## 24 Plastic Surgery

### A) Thermal Injuries

24.1 The Anesthesiologist must demonstrate an understanding of the pathophysiology of burns and the relevance to anesthetic management

#### 24.1.1 Burns

24.1.1.1 Describe the types and pathophysiology of burns including thermal, chemical and electrical burns

24.1.1.2 Describe the initial assessment and resuscitation of the burn patient, including:

24.1.1.2.1 Airway management of burn victims

24.1.1.3 Describe the anesthetic considerations of the burn patient presenting for non-cardiac surgery including plastic procedures

24.1.1.3.1 Skin flaps

24.1.1.3.2 Skin grafts

24.1.1.3.3 Dressing changes

24.1.1.4 Describe the use of hyperbaric oxygen in the treatment of burns and carbon monoxide poisoning

24.1.1.4.1 Describe the mechanism of action of hyperbaric oxygen

#### 24.1.2 Cold Injuries

24.1.2.1 Describe the anesthetic considerations of the patient presenting with frostbite

24.1.2.2 Describe the use of hyperbaric oxygen in the treatment of frostbite

24.1.2.3 Describe the use of regional anesthesia in the treatment of frostbite

### B) Anesthesia for Limb Replantation

24.2 The Anesthesiologist must demonstrate an understanding of the concerns related to limb replantation with respect to:

24.2.1 General and regional anesthetic options for limb replantation

24.2.2 Maneuvers used to increase digital blood flow

24.2.3 General principles of prolonged procedures

24.2.3.1 Temperature maintenance

- 24.2.3.2 Fluid and blood loss
- 24.2.3.3 Pressure point padding and positioning

**C) Anesthesia for Free Flap and Pedicle Flap Surgery**

- 24.3 The Anesthesiologist must demonstrate an understanding of:
  - 24.3.1 General and regional anesthetic options for free flap and pedicle flap surgery
  - 24.3.2 Factors that influence flap perfusion including but not limited to fluids, temperature, vasoactive substances
  - 24.3.3 Common co-morbidities of patients presenting for flap surgery
    - 24.3.3.1 Cancer
    - 24.3.3.2 Infection
    - 24.3.3.3 Paraplegia
    - 24.3.3.4 Quadriplegia
  - 24.3.4 The indications for hyperbaric oxygen therapy and other techniques for flap preservation
  - 24.3.5 The postoperative complications of surgery
    - 24.3.5.1 Flap necrosis
    - 24.3.5.2 Infection/sepsis

**D) Cosmetic Surgery**

- 24.4 The Anesthesiologist must demonstrate an understanding of the anesthetic implications of the following surgeries
  - 24.4.1 Liposuction
  - 24.4.2 Breast augmentation, reduction mammoplasty, and mastopexy
  - 24.4.3 Abdominoplasty
  - 24.4.4 Facelift, neck lift, brow lift, and blepharoplasty
  - 24.4.5 Rhinoplasty
  - 24.4.6 Facial laser resurfacing



### **E) Hand Procedures**

24.5 The Anesthesiologist must demonstrate an understanding of the anesthetic concerns for patients undergoing hand surgery including:

24.5.1 Anesthetic options for hand procedures

24.5.2 Advantages/disadvantages and complications of the various anesthetic techniques

24.5.2.1 Local infiltration

24.5.2.2 IV block (Bier block)

24.5.2.3 Peripheral nerve block

24.5.2.4 General anesthesia

### **F) Major Debridement**

24.6 Escharotomy

24.7 Necrotizing fasciitis

24.8 Debridement of Fournier's Gangrene

### **G) Craniofacial**

24.9 Adult Craniofacial

24.9.1 Demonstrate knowledge of the anesthetic concerns for adult patients undergoing craniofacial surgery including:

24.9.1.1 Facial reconstructive surgery

24.9.1.2 Maxillo-facial trauma surgery

24.9.1.3 Mandibular fractures

24.10 Pediatric Craniofacial

24.10.1 Describe the anesthetic implications of the following pediatric craniofacial surgeries:

24.10.1.1 Cleft lip/palate surgery

24.10.1.2 Ear reconstruction

## 25 Point of care ultrasound (POCUS)

Upon completion of this training, the Anesthesiologist must demonstrate the ability to use bedside ultrasound to assist in the diagnosis and management of hemodynamically unstable and/or critically ill patients and to enhance monitoring for patients in the perioperative setting.

### A) Clinical application

Ultrasound is a versatile tool and can be used to aid in the initial diagnosis and ongoing management of various clinical conditions. The following are considered key clinical applications for anesthesia providers.

- 25.1 Resuscitative / Diagnostic: Demonstrate the ability to use ultrasound to
  - 25.1.1 Assist in diagnosing the cause of persistent hypotension
  - 25.1.2 Assist with identifying the cause of respiratory distress
  - 25.1.3 Guide management during cardiac arrest
- 25.2 Monitoring: Demonstrate the use of POCUS as a monitor of ongoing resuscitation with the sequential assessment of
  - 25.2.1 Cardiac function
  - 25.2.2 Fluid responsiveness
  - 25.2.3 Response to treatment of interstitial lung syndrome
- 25.3 Procedural Guidance: Demonstrate the ability to use POCUS as an aid in
  - 25.3.1 Vascular access (central and peripheral access) – not discussed specifically in this chapter
  - 25.3.2 Regional anesthesia techniques and neuraxial techniques – see Chapter 28 - Regional Anesthesia and Chapter 18 – Obstetrical Anesthesia
- 25.4 Demonstrate the ability to recognize the potential risk of distraction from patient care associated with the use of POCUS

### B) Basics of ultrasound and equipment

- 25.5 Demonstrate basic knowledge of probe selection
- 25.6 Demonstrate an understanding of how patient positioning may affect the quality of the ultrasound image as well as the distribution of air and fluid in the chest or abdomen
- 25.7 Demonstrate a basic knowledge of ultrasound physics:
  - 25.7.1 Characteristics of sound waves (amplitude, wavelength, frequency, velocity)

- 25.7.2     Ultrasound interactions with tissues (shadowing, attenuation, reflection, refraction, scattering, enhancement, mirror images, reverberation)
- 25.7.3     Impact of transducer frequency on image resolution and depth
- 25.8     Demonstrate an understanding of using ultrasound controls to optimize imaging including depth, gain, TGC (time gated compensation), focus, sector, size, zoom, frame rate, transmit frequency

### **C) Nomenclature**

- 25.9     Demonstrate an understanding of the terms “orientation indicator” and “orientation marker”
- 25.10    Demonstrate an understanding of the terms used to define transducer movements: tilt, sweep, rotate, slide, rock, and angle
- 25.11    Demonstrate an understanding of the terms “cardiac convention” and “general/radiology convention” with reference to the orientation indicator

### **D) Clinical Governance**

- 25.12    Demonstrate an understanding of sterility, health and safety and machine cleaning
- 25.13    Demonstrate the ability to obtain informed consent for POCUS procedures when scanning for both educational and diagnostic purposes
- 25.14    Demonstrate the ability to archive images while respecting patient confidentiality and privacy
- 25.15    Demonstrate the ability to report findings of bedside ultrasound to the patient and to relevant health care providers and document the exam thoroughly in the patient’s medical record
- 25.16    Demonstrate awareness of the limitations of bedside ultrasound and the need to refer to other colleagues or to make use of other diagnostic modalities as appropriate

### **E) Focused Transthoracic Cardiac Ultrasound**

General objective: Demonstrate the ability to use cardiac ultrasound as an adjunct to clinical exam

- 25.17    Anatomy – Demonstrate an understanding of the basic anatomy of the heart, coronary arteries, and great vessels and correlate with 2D views
  - 25.17.1    Left and right ventricle
  - 25.17.2    Basic anatomy of tricuspid, mitral, aortic and pulmonic valves
  - 25.17.3    Coronary sinus

- 25.17.4 Inferior vena cava anatomy (differentiate from aorta and hepatic vessels)
- 25.17.5 Basic anatomy of pericardial space and differentiation from pleural space
- 25.18 Imaging – Demonstrate the ability to obtain the following focused transthoracic cardiac ultrasound views in a timely fashion
  - 25.18.1 Parasternal long axis
  - 25.18.2 Parasternal short axis
  - 25.18.3 Apical 4-chamber
  - 25.18.4 Subcostal 4-chamber
  - 25.18.5 Subcostal inferior vena cava (IVC) – demonstrate change in dimensions in response to spontaneous and positive pressure ventilation
  - 25.18.6 M-mode: TAPSE (Tricuspid annular plane systolic excursion), IVC
  - 25.18.7 No Doppler requirements at General Anesthesiologist level
- 25.19 Interpretation – Demonstrate the ability to recognize the focused cardiac ultrasound findings of
  - 25.19.1 Dilated left ventricle
  - 25.19.2 Severe right ventricular dilatation  
(no measurement of cardiac chamber dimensions required at General Anesthesiologist level – an appreciation of comparative sizes of different cardiac chambers is adequate)
  - 25.19.3 Grossly underfilled left ventricle
  - 25.19.4 Severely impaired left ventricular function
  - 25.19.5 Severe right ventricular dysfunction – including use of TAPSE
  - 25.19.6 Pericardial effusion
  - 25.19.7 Major valvular abnormalities – 2D exam (thickening and/or calcification of valvular apparatus, failure of coaptation, prolapse / flail leaflets / vegetations)

## F) Focused Lung Ultrasound

General objective: Demonstrate the ability to integrate the use of lung ultrasound in the assessment of the patient with respiratory compromise in the perioperative period

### 25.20 Anatomy – Demonstrate knowledge of the relevant anatomy

- 25.20.1 Hemidiaphragm – right and left and relations to liver, spleen, kidneys
- 25.20.2 Chest wall layers including ribs, intercostal muscles and pleura
- 25.20.3 Spine

### 25.21 Imaging – Demonstrate an understanding of the 2D sonographic anatomy and ultrasound artefact generated by aerated lung to identify the presence or absence of the following

- 25.21.1 Lung / pleural sliding in 2D
- 25.21.2 “Seashore / stratosphere sign” on M-Mode
- 25.21.3 A lines
- 25.21.4 B lines
- 25.21.5 Lung point
- 25.21.6 “Curtain sign”
- 25.21.7 “Spine sign”

### 25.22 Interpretation – Demonstrate the ability to recognize the focused lung ultrasound findings of

- 25.22.1 Pneumothorax
- 25.22.2 Interstitial syndromes (pulmonary edema, pneumonia, etc.)
- 25.22.3 Pleural effusion
- 25.22.4 Endobronchial intubation
- 25.22.5 Lung isolation

## **Appendix Content – Chapter 25 Point of care ultrasound (POCUS)**

The following sections (G, H and I) currently are not considered key clinical applications by the NC Editorial Board, but are included as educational content that we expect will be integrated in training in the upcoming years. POCUS is a rapidly evolving discipline and awareness of new and emerging applications is mandatory.

### **G) Focused Abdominal Ultrasound**

General objective: Demonstrate the ability to diagnose the presence of free intraperitoneal fluid and combine this with limited cardiac and lung scanning to assess a hemodynamically unstable patient

25.23 Anatomy – Demonstrate knowledge of intraperitoneal fluid collection areas within the abdomen and relevant anatomical structures

25.23.1 Diaphragm

25.23.2 Liver

25.23.3 Spleen

25.23.4 Kidney

25.23.5 Bladder

25.23.6 Uterus / prostate (location respective to other pelvic structures)

25.24 Imaging – Demonstrate the use of limited abdominal ultrasound to detect the presence of free fluid in the following locations

25.24.1 Right upper quadrant view: hepato renal interface (Morrison's pouch) is first identified with subsequent assessment of the more cephalad subphrenic and pleural space

25.24.2 Left upper quadrant / peri-splenic view: spleno renal interface is first identified with subsequent assessment of the more cephalad subphrenic and pleural space

25.24.3 Pelvic / suprapubic view: rectovesicular space is visualized using the bladder as the sonographic window

25.25 Interpretation – Demonstrate an understanding of how gravity will affect the collection of fluid within the abdomen

## H) Gastric Volume Assessment

General objective: Use gastric ultrasound to assist in the identification of a patient with increased risk of aspiration

25.26 Anatomy – Demonstrate knowledge of the anatomical location of the following structures and their relation to each other

- 25.26.1 Gastric antrum
- 25.26.2 Liver
- 25.26.3 Pancreas
- 25.26.4 SMA – superior mesenteric artery
- 25.26.5 Aorta
- 25.26.6 Bowel

25.27 Imaging – Demonstrate the ability to visualize the gastric antrum in both supine and right lateral decubitus positions

25.28 Interpretation – Demonstrate the ability to distinguish gastric antrum in the following states

- 25.28.1 Empty
- 25.28.2 Fluid filled
- 25.28.3 Solid content / thick fluid

## I) Airway Ultrasound

General objective: Demonstrate the use of focused ultrasound of the airway to

- Identify the cricothyroid membrane correctly when planning a surgical airway
- Identify esophageal intubation

25.29 Anatomy – Demonstrate knowledge of basic airway anatomy and important adjacent structures

- 25.29.1 Tracheal rings
- 25.29.2 Cricoid cartilage
- 25.29.3 Cricothyroid membrane
- 25.29.4 Thyroid cartilage
- 25.29.5 Thyroid, neck vessels

25.30 Imaging – Demonstrate the ability to identify the ultrasonic images of the essential airway structures in longitudinal and transverse planes

- 25.30.1 Longitudinal; string of beads (or pearls) - tracheal rings, cricoid,

thyroid

- 25.30.2 Transverse; inverted U shaped cartilage – cricoid cartilage
  - 25.30.3 Transverse; triangular shape cartilage – thyroid cartilage
  - 25.30.4 Thyroid gland and vessels in the neck
- 
- 25.31 Interpretation – Demonstrate the ability to correctly identify the cricothyroid membrane and mark the area for a cricothyroid puncture
  - 25.32 Demonstrate the ability to identify the sonographic appearance of an endotracheal tube in the esophagus



## 26 Post-Anesthetic Care Unit (PACU)

Upon completion of this training, the Anesthesiologist must demonstrate an understanding of the structure and function of the PACU and an ability to identify, prevent and treat common problems arising in the PACU

### A) Physical and Staffing Requirements

- 26.1 Demonstrate knowledge of the physical and staffing requirements of the PACU, including but not limited to:
  - 26.1.1 Space
  - 26.1.2 Personnel
  - 26.1.3 Equipment
  - 26.1.4 Monitoring
  - 26.1.5 Medications, IV fluids

### B) Patient Management

- 26.2 Demonstrate an understanding of the considerations for patients entering the PACU and an approach to management of patients in the PACU, including but not limited to:
  - 26.2.1 Fluid and electrolyte management
    - 26.2.1.1 Goals of resuscitation
    - 26.2.1.2 Accurate measures of volume status
    - 26.2.1.3 Fluid responsiveness
  - 26.2.2 Pain management: indications/contraindications of multimodal approach including local anesthetics, regional and neuraxial blocks, opioids, NSAIDs and adjuncts including acetaminophen, gabapentin, pregabalin, ketamine, tricyclic antidepressants, cannabinoids, and magnesium
  - 26.2.3 Antiemetics
  - 26.2.4 Monitoring guidelines
  - 26.2.5 Discharge criteria (e.g., commonly used aids – ALDRETE score, post-anesthesia discharge scoring systems (PADS))

### C) Complications

- 26.3 Identify and manage common problems in the PACU, including but not limited to:
  - 26.3.1 Respiratory complications
    - 26.3.1.1 Chronic obstructive pulmonary disease (COPD)

- 26.3.1.2 Aspiration
- 26.3.1.3 Negative pressure pulmonary edema
- 26.3.2 Hypoxemia and hypoventilation
  - 26.3.2.1 Assessment of ventilation
  - 26.3.2.2 Recognition and diagnosis
  - 26.3.2.3 Oxygen delivery systems including non-invasive ventilation and high-flow oxygen
- 26.3.3 Recognition and treatment of upper airway obstruction, stridor, aspiration, obstructive sleep apnea
- 26.3.4 Hypotension and Hypertension
  - 26.3.4.1 Diagnosis and management
  - 26.3.4.2 Shock
- 26.3.5 Hemorrhage
  - 26.3.5.1 Identification including occult bleeding
  - 26.3.5.2 Assessment (e.g., volume status, laboratory assessment, consequences of hematoma (e.g., airway patency))
  - 26.3.5.3 Need for transfusion
  - 26.3.5.4 Transfusion reactions and complications – see Chapter 11 – Hematology
- 26.3.6 Cardiac complications
  - 26.3.6.1 Myocardial ischemia/chest pain
  - 26.3.6.2 Brady/tachycardia
  - 26.3.6.3 Dysrhythmias
  - 26.3.6.4 Cardiogenic shock
  - 26.3.6.5 Cardiogenic pulmonary edema
- 26.3.7 Allergy and Anaphylaxis
- 26.3.8 Inadequate analgesia
  - 26.3.8.1 Pain assessment and scoring (including for children)
  - 26.3.8.2 Blocks and neuraxial anesthesia
  - 26.3.8.3 Opiates
  - 26.3.8.4 Non-opiates

26.3.8.5 Multimodal analgesia

26.3.9 Oliguria/Polyuria

26.3.9.1 Assessment of volume status

26.3.9.2 Post-operative renal failure

26.3.9.3 Bladder ultrasound scanning

26.3.9.4 Differential diagnosis

26.3.10 Post-Operative Mental Status Changes

26.3.10.1 Delirium identification, assessment and differential diagnosis

26.3.10.2 Delayed Emergence

26.3.10.3 Decreased level of consciousness

26.3.10.4 Acute cerebrovascular accident (CVA)

26.3.11 Fluid and Electrolyte Abnormalities

26.3.11.1 Acid base analysis, including differential diagnosis for metabolic abnormalities

26.3.11.2 Trans-urethral prostatectomy (TURP) Syndrome, Hysteroscopy syndrome

26.3.11.3 Hypo- and Hyper-calcemia, kalemia, natremia, chloremia, magnesemia, phosphatemia, glycemia

26.3.12 Nausea and Vomiting

26.3.12.1 Risk factors

26.3.12.2 Treatment

26.3.13 Hyperthermia, Hypothermia & Shivering

26.3.13.1 Postoperative fever

26.3.13.2 Malignant Hyperthermia

26.3.13.3 Hypothermia

26.3.14 Neurological

26.3.14.1 Residual Neuromuscular Blockade

26.3.14.2 Prolonged regional blocks and peripheral nerve blocks

26.3.14.3 Peripheral Neuropathies

## 27 Preoperative Consultation

Upon completion of this training, the Anesthesiologist must demonstrate an ability to assess, evaluate, optimize and manage patients in the preoperative period with considerations of illnesses presented throughout the National Curriculum and within this chapter.

The Anesthesiologist must demonstrate appropriate use of the various preoperative guidelines available.

### A) Cardiovascular

#### 27.1 Hypertension

- 27.1.1 Identify significant hypertension and predict the impact on intraoperative risk and on long-term health
- 27.1.2 Recommend appropriate timing of surgery relative to severity of hypertension and urgency of surgical indication. Coordinate further investigation and consultations
- 27.1.3 Prescribe appropriate therapy to correct preoperative hypertension
- 27.1.4 Liaise with primary care provider to facilitate long-term management

#### 27.2 Coronary Artery Disease

- 27.2.1 Identify coronary artery disease and assess its severity through history, physical examination and investigations
- 27.2.2 Review and optimize preoperative medical management of patients with coronary artery disease
- 27.2.3 Identify and refer patients at increased risk of perioperative ischemic complications for further investigation and risk reduction, including possible revascularization

#### 27.3 Pulmonary Hypertension

- 27.3.1 Identify patients with pulmonary hypertension by history, physical exam and laboratory/imaging findings
- 27.3.2 Identify the impact of the proposed anesthesia and surgery on the underlying disease
- 27.3.3 Coordinate further investigations and consultations necessary to safely and expeditiously perform the necessary surgery
- 27.3.4 Coordinate the availability of special equipment/monitors/expertise (such as TEE), in addition to the possible perioperative use of special medications, such as nitric oxide, inhaled epoprostenol or inhaled milrinone

27.4 Cardiomyopathy

- 27.4.1 Identify cardiomyopathy by use of history, physical and laboratory findings/imaging
- 27.4.2 Outline the appropriate preoperative management of ventricular dysfunction, specific to the underlying cardiomyopathy
- 27.4.3 Collaborate with appropriate consultants to optimize ventricular function

27.5 Valvular Disease

- 27.5.1 Utilize history and physical examination to identify the presence of valvular heart disease
- 27.5.2 Identify patients that require a preoperative echocardiogram
- 27.5.3 Outline strategies for preoperative optimization of patients with valvular heart disease
- 27.5.4 Identify risk factors for bacterial endocarditis
- 27.5.5 Prescribe appropriate prophylaxis for endocarditis per current guidelines

27.6 Congestive Heart Failure

- 27.6.1 Utilize history, physical examination and investigation to identify the presence of either left or right heart failure
- 27.6.2 Initiate management of acute heart failure preoperatively
- 27.6.3 Together with consult services, optimize treatment for heart failure, including from diastolic dysfunction
- 27.6.4 Identify patients in whom surgery should be delayed due to excessive risk from preoperative heart failure

27.7 Congenital Heart Disease

- 27.7.1 Obtain and utilize history, physical and laboratory findings to identify and grade the severity of congenital lesions, pulmonary hypertension, right-to-left and left-to-right shunts, partially corrected lesions
- 27.7.2 Describe the physiology and design appropriate management plans for R-L, L-R and bidirectional shunts
- 27.7.3 Prescribe appropriate prophylaxis for endocarditis

27.8 Pacemakers/Implantable Cardioverter/Defibrillator

- 27.8.1 Identify indications for preoperative pacemaker/ ICD insertion or intraoperative pacing
- 27.8.2 Coordinate consultation for perioperative pacing

- 27.8.3 Identify the type of pacemaker/ICD and obtain the information necessary to ensure proper functioning prior to any planned procedure
- 27.8.4 Coordinate appropriate perioperative assessment and programming of a pacemaker/ICD, including an appropriate intraoperative management plan
- 27.9 Arrhythmia
  - 27.9.1 Identify the presence, type and severity of abnormal rhythms, using history, physical and EKG
  - 27.9.2 Identify rhythm abnormalities requiring preoperative therapeutic or prophylactic therapy
  - 27.9.3 Prescribe appropriate therapeutic or suppressive therapy
  - 27.9.4 Utilize consultants effectively to coordinate appropriate pharmacologic or electrophysiologic therapy
- 27.10 Conduction Abnormalities
  - 27.10.1 Identify the presence, severity and type of abnormalities of conduction
  - 27.10.2 Identify those patients requiring perioperative pacing
  - 27.10.3 Identify and manage reversible contributors to abnormal conduction
- 27.11 Peripheral Vascular Disease
  - 27.11.1 Identify the presence, severity and physiologic impact of peripheral vascular disease
  - 27.11.2 Predict the impact of carotid disease on intraoperative risk
  - 27.11.3 Identify the important preoperative variables that affect outcome in major vascular surgery, and provide a plan to optimize them
- 27.12 Patient with heart transplantation
- 27.13 Cardiac tamponade and constrictive pericarditis
  - 27.13.1 Identify patients with cardiac tamponade or constrictive physiology through history, physical exam and investigation
  - 27.13.2 Coordinate with cardiology to optimize these patients preoperatively, including organizing pericardiocentesis if necessary
- 27.14 Superior vena cava syndrome

27.15 Cardiac risk assessment

- 27.15.1 Utilize history, physical examination and laboratory/imaging findings to identify patients with active cardiac conditions that require further evaluation and treatment prior to noncardiac surgery
- 27.15.2 Identify patients with clinical risk factors who would benefit from further preoperative testing, balancing the potential risks and the urgency of the surgical indication
- 27.15.3 Apply commonly used cardiovascular risk scores such as the RCRI
- 27.15.4 Apply commonly used preoperative guidelines such as the Canadian Cardiovascular Society Guidelines on Perioperative Cardiac Risk Assessment and Management for Patients Who Undergo Noncardiac Surgery
- 27.15.5 Advise patients about their risk of perioperative cardiovascular morbidity and mortality, and assist them to make informed decisions about proceeding with surgery

27.16 Cardiac risk reduction

- 27.16.1 Utilize pharmacologic therapy to reduce perioperative cardiac risk
- 27.16.2 Describe the risks and benefits of beta-blockers, alpha-2 agonists, statins, and anti-platelet therapy for the reduction of perioperative cardiac risk
- 27.16.3 Identify indications for preoperative surgical or interventional revascularization for cardiac risk reduction
- 27.16.4 Utilize appropriate consultation to coordinate preoperative cardiac risk reduction
- 27.16.5 Identify patients with Percutaneous Coronary Intervention (PCI) and develop a plan for the perioperative management of antiplatelet medications and timing of surgery based on the type of PCI and urgency of surgery

27.17 Cardiovascular testing

- 27.17.1 Use the results of the following to assess risk and appropriately modify perioperative management
  - 27.17.1.1 EKG
  - 27.17.1.2 Laboratory tests (e.g., troponin and BNP)
  - 27.17.1.3 Echocardiography
  - 27.17.1.4 Stress testing, (e.g., dobutamine stress echocardiography)
  - 27.17.1.5 Perfusion imaging
  - 27.17.1.6 Coronary angiography
  - 27.17.1.7 Ventriculography

## **B) Respiratory**

### **27.18 Airway assessment – see also Chapter 1 Airway Evaluation and Management**

- 27.18.1 Predict difficulty with laryngoscopy and intubation by use of history and physical findings
- 27.18.2 Predict difficulty with manual ventilation by use of history and physical findings
- 27.18.3 Use investigations including x-ray, computed tomography, nasopharyngoscopy report and pulmonary function studies to identify and/or quantify airway management concerns
- 27.18.4 Identify, grade the severity and list the implications of special airway situations including
  - 27.18.4.1 Airway obstruction – intra and extrathoracic
  - 27.18.4.2 Full Stomach
  - 27.18.4.3 Mediastinal mass
  - 27.18.4.4 Bronchopleural fistula
  - 27.18.4.5 Tracheo-esophageal fistula
  - 27.18.4.6 Tracheal stenosis
  - 27.18.4.7 Anatomic/structural abnormalities congenital and acquired
  - 27.18.4.8 Difficult airway and cognitive impairment
  - 27.18.4.9 Patient scheduled for tracheotomy
- 27.18.5 Prescribe appropriate preoperative therapy to facilitate difficult airway management
- 27.18.6 Coordinate the availability of special equipment, support and logistical preparation for special airway situations
- 27.18.7 Provide pertinent information to prepare the patient with awake intubation or possibility of dental damage
- 27.18.8 Reduce side effects and complications of intubation e.g., dental damage

### **27.19 Respiratory risk assessment**

- 27.19.1 Identify, grade the severity and estimate the impact on risk of perioperative complications of
  - 27.19.1.1 COPD, asthma and other obstructive diseases
  - 27.19.1.2 Restrictive defects (parenchymal and musculoskeletal causes)
  - 27.19.1.3 Active smoking



- 27.19.1.4 Bullous lung disease
- 27.19.1.5 Bronchopleural fistula
- 27.19.1.6 CO<sub>2</sub> retention
- 27.19.1.7 Obstructive or central sleep apnea
- 27.19.1.8 Recurrent aspiration
- 27.19.1.9 ARDS
- 27.19.1.10 Cystic Fibrosis /bronchiectasis
- 27.19.1.11 Infection (pneumonia (bacterial and viral), upper respiratory tract infection, empyema)
- 27.19.1.12 Pneumothorax and other pleural space diseases, including preoperative chest tube management

## 27.20 Reduction of respiratory risk

- 27.20.1 Identify patients with contagious pulmonary infection, coordinate special precautions for perioperative period
  - 27.20.1.1 Identify and coordinate the availability of special intraoperative interventions to manage patients with respiratory conditions including any of the above problems
  - 27.20.1.2 Ensure optimal preoperative condition and provide appropriate preoperative therapy to reduce the severity of respiratory conditions including the above problems
  - 27.20.1.3 Timely aspiration prophylaxis
  - 27.20.1.4 Smoking cessation
  - 27.20.1.5 Utilize consultants effectively to assist in assessing perioperative respiratory problems and reducing risk
  - 27.20.1.6 Recommend appropriate timing for surgical intervention balancing the inherent risk of the procedure, the incremental risk imposed by the respiratory problem, and the negative consequences of delay
  - 27.20.1.7 Identify patients that would benefit from postoperative monitoring in an enhanced or intensive care unit

## 27.21 Assessment for lung resection

- 27.21.1 Estimate the impact of the proposed procedure on perioperative outcome using history, physical and laboratory information
- 27.21.2 Assess the patient's operability by estimating the extent of resection that an individual patient is expected to tolerate utilizing PFTs, ABG, and VO<sub>2</sub> max testing

27.22 Pulmonary testing

- 27.22.1 Order appropriate lung function testing to assist with perioperative decision making
- 27.22.2 Interpret and use the results of the following to assess risk and appropriately modify perioperative management
  - 27.22.2.1 Flow and volume studies
  - 27.22.2.2 Diffusion measurement
  - 27.22.2.3 MIP and MEP
  - 27.22.2.4 Exercises and  $\text{VO}_2$  studies
  - 27.22.2.5 Arterial blood gases
  - 27.22.2.6 X-rays of chest, neck, airway
  - 27.22.2.7 CT of airway/lungs
- 27.22.3 Integrate the results of the following to assess risk and appropriately modify perioperative management
  - 27.22.3.1 Sleep studies
  - 27.22.3.2 Exercise studies
  - 27.22.3.3 Ventilation/perfusion scan
  - 27.22.3.4 CT chest

**C) Neurological**

27.23 Intracranial mass

- 27.23.1 Assess the implications for perioperative outcome and anesthetic management of intracranial mass lesions based on location, size, the proposed procedure and possible endocrinologic activity
- 27.23.2 Manage reversible contributions to increase ICP
- 27.23.3 Identify and assess the severity of increased ICP

27.24 Seizure disorder

- 27.24.1 Utilize consultation appropriately to identify, diagnose and treat seizure disorders
- 27.24.2 Utilize the information from that consultation to anticipate appropriate modifications to perioperative management
- 27.24.3 Coordinate the availability of required special resources
- 27.24.4 Predict the impact of and appropriately manage anticonvulsant therapy

27.25 Cognitive impairment

- 27.25.1 Assess the ability of the patient to participate in informed consent and cooperate with perioperative interventions
- 27.25.2 Obtain appropriate surrogate consent in the event of incapacity
- 27.25.3 Assess the need for, impediments to, and optimal methods to reduce perioperative anxiety, including sedation
- 27.25.4 Coordinate the availability of required special perioperative resources, including environmental and management modifications to enhance cooperation and pain management
- 27.25.5 Discuss the effects of general anesthesia on cognitive disorders

27.26 Neurovascular

- 27.26.1 Categorize and grade the severity of intracranial hemorrhage
- 27.26.2 Estimate the risk of bleeding and/or vasospasm perioperatively
- 27.26.3 Assess the implications for perioperative outcome and anesthetic management of intracranial vascular lesions based on location, size, and proposed procedure

27.27 Peripheral Neuropathy

- 27.27.1 Identify common causes of perioperative neuropathy
- 27.27.2 Utilize appropriate consultation to diagnose peripheral neuropathy
- 27.27.3 Discuss the relevance of peripheral neuropathy to choice of anesthetic

27.28 Spinal cord

- 27.28.1 Assess and optimize (including through consultation) preoperative management of spinal cord diseases such as ALS and spina bifida
- 27.28.2 Assess the severity and anesthetic implications of spinal cord impingement and threats to spinal cord perfusion
- 27.28.3 Assess the physiologic effects and anesthetic implications of pre-existing spinal cord injury (acute and long-standing)
- 27.28.4 Assess the risk and anesthetic implication of autonomic hyperreflexia

27.29 Movement Disorders

- 27.29.1 Identify movement disorders significant for anesthetic management
- 27.29.2 Utilize appropriate consultation to diagnose and stabilize movement disorders preoperatively
- 27.29.3 Identify anesthetic implications of movement disorders, including

implications of pharmacotherapy used for movement disorders and its withdrawal

27.30 Myopathies

- 27.30.1 Utilize appropriate consultation to assess the severity and systemic effects of muscular dystrophies
- 27.30.2 Identify risk factors for intra- and postoperative complications in patients with muscular dystrophies

27.31 Neuromuscular Disorders

- 27.31.1 Identify the anesthetic considerations for myasthenia gravis and develop a perioperative plan including the use of anticholinesterase medication
- 27.31.2 Identify patients at risk for Eaton-Lambert syndrome and its anesthetic considerations

27.32 Psychiatric Disease

- 27.32.1 Identify patients taking antidepressant medication and be aware of the anesthetic considerations and potential drug interactions especially with monoamine oxidase inhibitors and SSRIs
- 27.32.2 Identify patients with severe psychiatric disease, including those who may not be able to provide consent
- 27.32.3 Assess patient suitability for ECT and identify patient at increased risk for morbidity from ECT

27.33 Neurologic investigations

- 27.33.1 Be able to apply the results of the following studies to assess risk and appropriately modify perioperative management
  - 27.33.1.1 CT head, spine
  - 27.33.1.2 Xray c-spine
  - 27.33.1.3 MRI Transcranial Doppler Imaging, Carotid Doppler, Angiography
  - 27.33.1.4 EEG
  - 27.33.1.5 EMG

**D) Gastrointestinal**

- 27.34 Identify risk factors for preoperative reflux and provide appropriate prophylaxis
- 27.35 Use information from consultants to characterize, grade the severity and assess the physiologic and anesthetic implications of hepatic dysfunction

- 27.36 Identify the presence and type of infectious hepatitis and assess the infectious risk
- 27.37 Identify the presence and characterize the type of hyperbilirubinemia, including implications for other systems (e.g., hematologic)
- 27.38 Identify the presence of portal hypertension, and – together with consultant services – optimize patients preoperatively
- 27.39 Identify patients with alcohol use disorder, and establish and optimal preoperative plan around perioperative alcohol use and withdrawal prophylaxis
- 27.40 Identify the physiologic effects, comorbidities, metastatic spread, and anesthetic implications of GI malignancies, carcinoid syndrome, paraneoplastic syndrome, thrombosis
- 27.41 Assess the anesthetic implications of chemotherapy used and coordinate laboratory/investigation for their systemic effects
- 27.42 Use the results of the following to assess risk and appropriately modify perioperative management
  - 27.42.1 Abdominal imaging
  - 27.42.2 Liver function testing

#### **E) Musculoskeletal**

- 27.43 Assess the severity, mobility consequences, multisystem involvement and anesthetic implications of:
  - 27.43.1 Rheumatoid arthritis and other inflammatory arthritis
  - 27.43.2 Osteoarthritis
  - 27.43.3 Ankylosing spondylitis
  - 27.43.4 Osteogenesis imperfecta
  - 27.43.5 Osteoporosis
  - 27.43.6 Bone metastasis
  - 27.43.7 Sarcoidosis
  - 27.43.8 Muscular dystrophies
  - 27.43.9 Myopathies such as dermatomyositis
- 27.44 Assess the anesthetic implications of pharmacologic management for the above and recommend appropriate perioperative management
- 27.45 Interpret and apply the results of C-spine X-ray and C-spine CT to assess risk of instability and to appropriately plan perioperative management

27.46 Apply the results of the following to assess risk and appropriately modify perioperative management

27.46.1 CT C-spine

27.46.2 Xray and CT of thoracic and lumbar spine

**F) Dermatologic**

27.47 Assess the severity, multisystem involvement, and anesthetic implications of:

27.47.1 Bullous diseases

27.47.2 Psoriasis

27.47.3 Scleroderma

27.47.4 Burns

27.48 Assess the anesthetic implications of pharmacotherapy for the above and recommend appropriate perioperative management

**G) Others**

27.49 Demonstrate thorough preoperative assessment of patient presenting with malignant hyperthermia susceptibility

27.50 Coordinate resources and appropriate preoperative preparation for a patient with malignant hyperthermia susceptibility

## 28 Regional Anesthesia

Upon completion of this training, the Anesthesiologist shall demonstrate knowledge of the anatomy and physiology of, and an approach to, regional anesthesia

### A) Pharmacology

28.1 Demonstrate knowledge of the pharmacology of the local anesthetic (LA) with respect to:

#### 28.1.1 Mechanism of Action

- 28.1.1.1 Explain the effects of sodium channel blockade on the action potential
- 28.1.1.2 Explain how local anesthetic blocks the sodium channel
- 28.1.1.3 Identify and understand the mechanism of action of factors facilitating and hindering local anesthetic effect at the sodium channel

#### 28.1.2 Toxicity

- 28.1.2.1 Identify the manifestations of systemic toxicity
- 28.1.2.2 Demonstrate knowledge of the different forms of local anesthetic toxicity – cardiac toxicity, direct neurotoxicity; methaemoglobinaemia;
- 28.1.2.3 Identify and provide appropriate management of local anesthetic toxicity
- 28.1.2.4 Describe the mechanisms of local anesthetic neurologic and cardiac toxicity
- 28.1.2.5 Demonstrate knowledge of factors influencing the development of neurologic and cardiac toxicity (e.g., speed of injection; site of injection; maximal doses; LA potency; hypercarbia; use of vasoconstrictors; cardiac/liver disease)

#### 28.1.3 Kinetics

- 28.1.3.1 Describe drug, patient and technical factors contributing to speed of onset of local anesthetics
- 28.1.3.2 Describe the drug, patient and technical factors contributing to recovery from local anesthetics
- 28.1.3.3 Describe the determinants of serum local anesthetic concentration, its measurement, and the role of protein binding

#### 28.1.4 Structure Activity Relationships

- 28.1.4.1 Describe the molecular structure of local anesthetic, and

the resultant effects on kinetics and dynamics

28.1.4.2 Describe the differences between amide & ester local anesthetics with examples of each. Understand the physicochemical properties of potency; protein binding; pKa & pH

28.1.4.3 Describe the relationship between local anesthetic & differential blockade

#### 28.1.5 Adjuvants

28.1.5.1 The Anesthesiologist must be able to explain the rationale for & against adding different adjuvants to local anesthetic for both peripheral and neuraxial blocks, and be able to describe the mechanism, dose, clinical effects and adverse effects of:

##### 28.1.5.1.1 Epinephrine

28.1.5.1.1.1 List the clinical indications for and advantages of inclusion of epinephrine in local anesthetic for spinal epidural, regional and local infiltration

28.1.5.1.1.2 Describe the dose and effect of epinephrine on blockade characteristics when added to local anesthetic in spinal, epidural, regional and local infiltration

28.1.5.1.1.3 Describe the potential detrimental effects of inclusion of epinephrine in local anesthetic in spinal, epidural, regional and local infiltration

28.1.5.1.1.4 Describe the mechanisms of the above effects

##### 28.1.5.1.2 Bicarbonate

28.1.5.1.2.1 Give the arguments for and against the addition of bicarbonate to local anesthetics

28.1.5.1.2.2 Describe the mechanism of action of potentiation of local anesthetic blockade by bicarbonate

##### 28.1.5.1.3 Opioids

28.1.5.1.3.1 Discuss the rationale for and against, and clinical effects and adverse effects of opioids to local anesthetics for peripheral regional blockade

28.1.5.1.3.2 Describe the mechanisms, doses, clinical effects and adverse effects of opioids in neuraxial blockade



28.1.5.1.4 Alpha-agonists

- 28.1.5.1.4.1 Discuss the rationale for and against and clinical utility of addition of alpha-agonists to local anesthetics for peripheral regional blockade
- 28.1.5.1.4.2 Describe the mechanisms, doses, clinical effects and adverse effects of alpha-agonists in neuraxial blockade

28.1.5.1.5 NMDA Antagonists

- 28.1.5.1.5.1 Discuss the rationale for and against and clinical utility of addition of NMDA antagonists to local anesthetics for peripheral regional blockade
- 28.1.5.1.5.2 Describe the mechanisms, doses, clinical effects and adverse effects of NMDA antagonists in neuraxial blockade

28.1.5.1.6 Steroids

- 28.1.5.1.6.1 Discuss the rationale for and against and clinical utility of addition of steroids to local anesthetics for peripheral regional blockade
- 28.1.5.1.6.2 Describe the mechanisms, doses, clinical effects and adverse effects of steroids in neuraxial blockade

**B) Physiology**

28.2 Describe the following physiologic principles relevant to regional anesthesia

28.2.1 Nerve Conduction

- 28.2.1.1 Describe the structural classification of nerve types and the relevance to local anesthetic action
- 28.2.1.2 Explain the generation of nerve action potential, refractory period and recovery
- 28.2.1.3 Describe the structure of nerves

28.2.2 Effects of Neuraxial Blockade

- 28.2.2.1 Describe the cardiorespiratory effects of neuraxial blockade
- 28.2.2.2 Describe the differences and similarities between spinal and epidural blockade with respect to mechanism of action, effects of adjuvants and cardiorespiratory physiology
- 28.2.2.3 Describe the effects of neuraxial blockade on coagulation
- 28.2.2.4 Describe the effects of neuraxial blockade on the neurohumoral stress response

- 28.2.2.5 Describe the effects of neuraxial blockade on postoperative respiratory effects of surgery
- 28.2.2.6 Describe the effects of neuraxial blockade on intraoperative blood loss (controlled hypotension)
- 28.2.2.7 Identify factors influencing spread of spinal/epidural anesthesia

28.2.3 The Neuroendocrine Stress Response

- 28.2.3.1 Describe the systems affected by the stress response, and the overall impact on each of those systems
- 28.2.3.2 Describe the specific changes within each of the affected systems that leads to the overall functional impact on those systems
- 28.2.3.3 Describe the extent to which the stress response is modified by anesthesia, the theoretical effect of such modification on surgical outcomes, and the extent to which the modification of stress response has been shown to affect outcomes

**C) Technology**

- 28.3 Demonstrate an understanding of the technology available for identification of nerves for the performance of plexus and peripheral nerve blocks

28.3.1 Nerve Stimulation

- 28.3.1.1 Describe the rationale for the use of stimulations for locating nerves
- 28.3.1.2 Discuss the advantages, disadvantages and limitations of nerve stimulation as a means of locating nerves
- 28.3.1.3 List and explain the characteristics of the ideal nerve stimulator
- 28.3.1.4 Describe the response characteristics of different nerve fibers to stimulation
- 28.3.1.5 Use stimulation to aid safe and effective regional blocks
- 28.3.1.6 Understand the different types of needles – insulated vs. non-insulated needles

28.3.2 Ultrasound

- 28.3.2.1 Describe the relative advantages, disadvantages and limitations of ultrasound as a method of locating nerves
- 28.3.2.2 Describe the basic physics principles of ultrasound and their clinical relevance in identifying different anatomic structures
- 28.3.2.3 Choose the appropriate ultrasound probe and machine

- settings to properly identify the desired structure
- 28.3.2.4 List and explain the characteristics of the ideal ultrasound machine
- 28.3.2.5 Identify the ultrasonographic anatomy relevant to nerve and spine localization
- 28.3.2.6 Use ultrasound to safely and effectively perform regional blocks
- 28.3.2.7 Understand the static vs. dynamic use of ultrasound
- 28.3.2.8 Describe In-plane vs. Out-of-plane techniques
- 28.3.2.9 Understand the different type of needles – echogenic vs. non-echogenic

#### **D) Clinical Application of Regional Anesthesia**

28.4 Perform the following specific objectives for all regional anesthetic techniques relevant to the anesthesiologist's level of training as indicated below, and in the context of anesthetic care situations within the anesthesiologist's sphere of practice:

##### **28.4.1 Anesthetic Planning**

- 28.4.1.1 Generate and implement an anesthetic plan including appropriate options, contingency plans and expectations
- 28.4.1.2 Select an appropriate regional anesthetic technique(s) for anesthetic care
- 28.4.1.3 Discuss completely the relative advantage, disadvantage and physiologic implications of regional vs. general anesthesia, including specific risks and outcome in the context of anesthetic care situations within his/her sphere of practice
- 28.4.1.4 Discuss regional PLUS GA vs. GA vs. regional
- 28.4.1.5 Discuss the use of regional techniques pre vs. post induction of general anesthesia
- 28.4.1.6 Discuss unique challenges of regional techniques in pediatric anesthesia
- 28.4.1.7 Demonstrate understanding of appropriate patient positioning and monitoring of patient during performance of regional anesthetic technique

##### **28.4.2 Nerve Localization**

- 28.4.2.1 Describe anatomic landmarks for performance of blocks
- 28.4.2.2 Utilize nerve stimulation and ultrasound for identification of plexuses and peripheral nerves for regional anesthetic techniques within his/her scope of practice

- 28.4.2.3 Contrast the relative advantages and disadvantages of all applicable techniques of nerve localization including anatomic, stimulation, paresthesia, and image-guided approaches

## **E) Contraindications and Complications**

- 28.5 Demonstrate knowledge of the limitations of regional anesthesia including contraindications and complications

- 28.5.1 Contraindications to Regional Anesthesia

- 28.5.1.1 Identify and, where appropriate, manage relative and absolute contraindications to regional anesthetics

- 28.5.2 Anticoagulation and Regional Anesthesia

- 28.5.2.1 Develop an approach to regional anesthesia (including neuraxial techniques) in the patient with abnormal coagulation parameters
  - 28.5.2.2 Plan regional anesthesia with reference to the current published guidelines from anesthetic associations and regulatory bodies pertaining to the conduct of regional anesthesia in the context of anticoagulation
  - 28.5.2.3 Assess the appropriate timing of regional anesthetic procedures relative to anticoagulation therapy
  - 28.5.2.4 Modify the anticoagulation, anesthetic plan or both appropriately in order to minimize overall risk and improve outcome

- 28.5.3 Complications of Regional Anesthesia

- 28.5.3.1 Describe complications of regional anesthesia, risk factors, presentation, diagnosis and treatment of complications such as:
    - 28.5.3.1.1 Incomplete / Failed block
    - 28.5.3.1.2 Intravascular injection of local anesthetic
    - 28.5.3.1.3 Overdose / Toxicity of local anesthetic
    - 28.5.3.1.4 Neuraxial hematoma
    - 28.5.3.1.5 Neuraxial abscess/infection
    - 28.5.3.1.6 Anterior spinal artery syndrome
    - 28.5.3.1.7 Post Dural Puncture Headache (PDPH)
    - 28.5.3.1.8 Post-operative neuropathy/nerve injury
    - 28.5.3.1.9 Transient neurologic symptoms / Transient radicular irritation

- 28.5.3.1.10 Inadvertent spinal/subdural block
  - 28.5.3.1.11 Total spinal
  - 28.5.3.1.12 Cardiovascular complications (e.g., bradycardia, hypotension)
  - 28.5.3.1.13 Respiratory complications
  - 28.5.3.1.14 Allergic reaction
- 28.5.3.2 Demonstrate an understanding of the retrobulbar and peribulbar block performed by ophthalmologist and manage their complications including brain stem anesthesia

## **F) Spectrum of Anesthesia Techniques**

- 28.6 Demonstrate knowledge of the spectrum of regional anesthetic techniques and perform those relevant to the anesthesiologist's level of training
- 28.7 Demonstrate knowledge of basic surface anatomy & palpable landmarks and the dermatomal & peripheral nerve distribution as applicable to each specific block
- 28.8 Describe site-specific equipment; indications; contraindications & drug selection for each block
- 28.8.1 Neuraxial Blocks including
    - 28.8.1.1 Spinal
      - 28.8.1.1.1 Single shot - midline and paramedian approach
      - 28.8.1.1.2 Spinal catheter techniques
    - 28.8.1.2 Epidural – midline and paramedian approach
      - 28.8.1.2.1 Thoracic
      - 28.8.1.2.2 Lumbar
      - 28.8.1.2.3 Caudal
    - 28.8.1.3 Combined Spinal-Epidural (CSE)
  - 28.8.2 Upper Extremity Blocks including
    - 28.8.2.1 Interscalene
    - 28.8.2.2 Supraclavicular
    - 28.8.2.3 Infraclavicular
    - 28.8.2.4 Axillary
    - 28.8.2.5 At the elbow
-

- 28.8.2.5.1 Median nerve
- 28.8.2.5.2 Musculocutaneous nerve
- 28.8.2.5.3 Radial nerve

28.8.2.6 At the wrist and hand

- 28.8.2.6.1 Ulnar nerve
- 28.8.2.6.2 Median nerve
- 28.8.2.6.3 Radial Nerve

28.8.2.7 Digital nerves

28.8.3 Lower Extremity Blocks including

- 28.8.3.1 Lumbar plexus
- 28.8.3.2 Femoral nerve block
- 28.8.3.3 Saphenous (Adductor Canal) block
- 28.8.3.4 Sciatic nerve block
- 28.8.3.5 Popliteal nerve block
- 28.8.3.6 Ankle block

28.8.4 All Limbs – IV regional anesthesia (Bier block)

28.8.5 Trunk Blocks

- 28.8.5.1 Parvertebral block
- 28.8.5.2 Intercostal nerve block
- 28.8.5.3 Ilioinguinal/iliohypogastric
- 28.8.5.4 Transversus abdominis plane (TAP) and rectus sheath blocks

28.8.6 Penile block

28.8.7 Head and Neck Blocks including

- 28.8.7.1 Supraorbital nerve block
- 28.8.7.2 Occipital nerve block
- 28.8.7.3 Superficial cervical plexus

- 28.8.8 Airway Blocks including
- 28.8.9 Topicalization
- 28.8.10 Superior laryngeal nerve block
- 28.8.11 Lingual nerve block
- 28.8.12 Transtracheal block

## 29 Remote Locations

Upon completion of this training, the competent Anesthesiologist must demonstrate an understanding of the considerations related to providing anesthetic care in non-traditional locations such as MRI suites, IVR suites, Cardiac Catheterization Laboratories, Image Guided therapy suites therapeutic radiation and oncology centres, dental suites and endoscopy suites

### A) Physical Requirements

29.1 Demonstrate an understanding of the physical requirements for provision of anesthesia in remote locations:

29.1.1 Compliance with all applicable building codes, such as:

29.1.1.1 The anesthetizing location must conform to electrical code and excess anesthetic gas scavenging

29.1.1.2 Medical gas pipelines must meet the same standards as a regular operating room

29.1.2 The anesthetic machine must conform to CAS standards

29.1.3 Standard CAS monitors are required

29.1.4 Standard emergency drugs and equipment must be readily available

29.1.5 Anesthetic machines, monitoring and scavenging are the same as would be expected in a regular operating room, including resuscitation equipment etc.

29.1.6 Sufficient space for the anesthesiology team

### B) Personnel

29.2 Demonstrate an understanding of the personnel required to provide safe anesthesia

29.2.1 Appropriate ancillary help must be available to the anesthesiologist and reliable communication to request assistance

### C) The Nature of the Remote Locations

29.3 Demonstrate understanding of the implications of working in an unfamiliar space with a relative distance of skilled assistance

29.4 Demonstrate an understanding of the unique considerations for each location, including the fact that these are frequently distant from the main operating room

29.4.1 Interventional Radiology

29.4.1.1 Radiation exposure: Patients and staff safety



29.4.1.2 Specific Anesthetic considerations

- 29.4.1.2.1 Limited access to patient
- 29.4.1.2.2 Movement of radiological equipment
- 29.4.1.2.3 Temperature management

29.4.1.3 Contrast media complications

- 29.4.1.3.1 Anaphylaxis
- 29.4.1.3.2 Interaction with Metformin
- 29.4.1.3.3 Renal failure

29.4.1.4 Types of procedures and their implications, including

- 29.4.1.4.1 Biopsies
- 29.4.1.4.2 Angiography
- 29.4.1.4.3 AAA stent graft
- 29.4.1.4.4 Carotid artery stent
- 29.4.1.4.5 Kyphoplasty/vertebroplasty
- 29.4.1.4.6 TIPS (transjugular intrahepatic portosystemic shunt)
- 29.4.1.4.7 Cerebral Aneurysm / AV malformation coiling
- 29.4.1.4.8 Radiofrequency ablation
- 29.4.1.4.9 Others including vascular access procedures, drain insertion techniques, vascular embolization techniques

29.4.2 MRI

- 29.4.2.1 Implications of magnetic field
- 29.4.2.2 Patient selection
- 29.4.2.3 MRI compatible anesthesia equipment and monitors
- 29.4.2.4 Management of resuscitation
- 29.4.2.5 Noise
- 29.4.2.6 Management of patient claustrophobia

29.4.3 Cardiac Catheterization Laboratory

- 29.4.3.1 Considerations as per Interventional Radiology
- 29.4.3.2 Specific considerations for cardiac patients
  - 29.4.3.2.1 Pediatric congenital heart disease
  - 29.4.3.2.2 Adult valvular heart disease

- 29.4.3.2.3 Coronary artery disease
- 29.4.3.2.4 Cardiomyopathies
- 29.4.3.2.5 Dysrhythmias – pacemakers and ICD's

29.4.3.3 Type of procedures and their implications including

- 29.4.3.3.1 AICD
- 29.4.3.3.2 Electrophysiologic Studies

29.4.4 Endoscopy Suites

- 29.4.4.1 Implications of bowel preparation on hydration and electrolytes
- 29.4.4.2 Shared airway (e.g., upper endoscopy)

**D) Types of Anesthesia**

- 29.5 Monitored anesthesia care
- 29.6 Regional anesthesia
- 29.7 General anesthesia
- 29.8 Anesthetic implications for each type of anesthesia in remote location including preoperative considerations, preoperative preparation and monitoring
- 29.9 Demonstrate knowledge of advantages and disadvantages of each type of anesthesia depending upon the type of procedures, patient age and location

**E) Electroconvulsive Therapy**

- 29.10 Indications
- 29.11 Contraindications
- 29.12 Seizure modification, including monitoring options
- 29.13 Side effects and complications and their management
  - 29.13.1 Bradycardia
  - 29.13.2 Tachycardia
  - 29.13.3 Hypertension
  - 29.13.4 Failure of seizure
- 29.14 Anesthetic considerations
  - 29.14.1 Airway management

29.14.2 Choice of medication and drug interaction

**F) Post Procedure Disposition**

29.15 Demonstrate knowledge with respect to postanesthetic care of these patients

29.15.1 Location

29.15.1.1 Local vs. OR PACU

29.15.1.2 Transportation

29.15.2 Discharge planning

29.15.3 Anticipation of complications

29.15.4 Localization and means of communication with anesthesiology personnel available to deal with emergencies

### 30 Renal / Urologic

Prevention of perioperative morbidity and mortality depends in part upon an understanding of renal physiology and pharmacology and the effects of alterations on both (i) the excretion of drugs administered during and after surgery, and (ii) fluid, electrolytes and acid-base management in the perioperative period. Therefore, the anesthesiologist must demonstrate knowledge and understanding of Anesthesiology and the renal system.

#### A) Basic Science

##### 30.1 Demonstrate knowledge of the anatomy and physiology of the renal excretory system

###### 30.1.1 Functional Anatomy of the Kidneys, Ureters, and Bladder

- 30.1.1.1 Description of the nephron
- 30.1.1.2 Description of the renal circulation and its regulation
- 30.1.1.3 Description of the innervation of the kidneys, ureters, and bladder

###### 30.1.2 Physiology of Urine Formation

- 30.1.2.1 Sodium, potassium and other electrolyte filtration and reabsorption
- 30.1.2.2 Water filtration and reabsorption
- 30.1.2.3 Physiologic control of glomerular filtration and solute reabsorption (e.g., glucose, bicarbonate)

###### 30.1.3 Neurohumoral Regulation of Renal Function

- 30.1.3.1 Aldosterone
- 30.1.3.2 Antidiuretic hormone
- 30.1.3.3 Atrial natriuretic peptide
- 30.1.3.4 Prostaglandins

###### 30.1.4 Neuroendocrine Response to Stress of Trauma and Surgery

###### 30.1.5 Effects of Anesthesia on Renal Function

- 30.1.5.1 Regulation of renal perfusion
- 30.1.5.2 Effects of anesthesia and surgery upon renal perfusion and renal protection
- 30.1.5.3 Effects of anesthesia upon electrolyte, fluid and acid-base regulation

30.1.6 Evaluation and Interpretation of Renal Function Tests

30.1.6.1 BUN, creatinine, glomerular filtration ratio (GFR), creatinine clearance (CrCl)

30.1.6.2 Urinalysis: Na, osmolality, proteinuria, hematuria, urine sediment, specific gravity

30.1.7 Pharmacology of the Renal System

30.1.7.1 Potential nephrotoxic agents

30.1.7.2 Renal excretion of anesthetic drugs and the effect of renal impairment on their action

30.1.7.3 Pharmacology and classification of diuretics

**B) Renal Protection**

30.2 Demonstrate an understanding of different renal protection strategies and the evidence in their use. The anesthesiologist must be able to describe an approach for renal protection in both the perioperative and the critical care settings

**C) Pathology**

30.3 Demonstrate knowledge of pathologies related to the renal system:

30.3.1 Chronic Renal Failure

30.3.1.1 Clinical characteristics of the uremic syndrome

30.3.1.2 Dialysis treatment: indications, types, physiologic effects, complications, and perioperative management strategies

30.3.1.3 Anesthetic management of the patient with chronic renal insufficiency and chronic renal failure:

30.3.1.3.1 Preoperative evaluation & optimization

30.3.1.3.2 Monitoring

30.3.1.3.3 Selection of anesthetic agents

30.3.2 Acute Renal Failure

30.3.2.1 Pathophysiology and prevention of acute renal failure

30.3.2.1.1 Types (pre-renal, intrinsic and post-renal)

30.3.2.1.2 Diagnostic tests

30.3.2.1.3 Management

30.3.3 Hepatorenal Syndrome

30.3.3.1 Pathophysiology

- 30.3.3.2 Treatment
- 30.3.3.3 Response to liver transplant

- 30.4 Demonstrate competent perioperative management including optimization of preoperative condition, intraoperative anesthetic management and postanesthetic care of patients with renal disease undergoing surgery

#### **D) Anesthesia for Urologic Procedures**

- 30.5 Demonstrate an appreciation of the pathology that can alter normal renal physiology and the non-physiologic insults to which patients might be subjected during urological procedures
  - 30.6 Demonstrate understanding of the considerations of, and to independently provide anesthetic care for patients presenting for urologic procedures including:
    - 30.6.1 Transurethral Resection of the Prostate
      - 30.6.1.1 Diagnose and assess complications including TURP
      - 30.6.1.2 Describe the TURP syndrome and its management
    - 30.6.2 Prostatectomy: Open and Laparoscopic, Robotic Assisted
      - 30.6.2.1 Simple, radical
    - 30.6.3 Therapy for Renal Stone Disease
      - 30.6.3.1 Percutaneous nephrolithotomy and nephrolithotripsy
      - 30.6.3.2 Extracorporeal shock wave lithotripsy (ESWL)
      - 30.6.3.3 Endouretal lithotripsy (anterograde and retrograde)
    - 30.6.4 Endourologic Procedures
      - 30.6.4.1 Urethral (e.g., hypospadias repair)
      - 30.6.4.2 Bladder (e.g., TURBT)
      - 30.6.4.3 Ureteral (e.g., stenting)
    - 30.6.5 Laser and fluoroscopy procedures
    - 30.6.6 Nephrectomy – Open and Laparoscopic
      - 30.6.6.1 Simple, partial, radical
    - 30.6.7 Cystectomy
      - 30.6.7.1 Simple, partial, radical
      - 30.6.7.2 Ileal conduit and other diversion procedures
-

30.6.8 Procedures on testicles

30.6.8.1 Orchiectomy

30.6.8.2 Testicular torsion or undescended testicle

30.6.8.3 Reversal vasectomy

30.6.8.4 Hydrocelectomy

30.6.9 Procedures on the Penis

30.6.9.1 Circumcision

30.6.9.2 Priapism

30.6.10 Adrenalectomy

30.6.10.1 Assessment and preparation of patients with pheochromocytoma

30.6.10.2 Perioperative management, including strategies for monitoring and hemodynamic control

30.6.11 Renal Transplant

30.6.11.1 Donor

30.6.11.2 Recipient

## 31 Respiratory Physiology and Thoracic Anesthesia

Upon completion of this training, the Anesthesiologist must demonstrate an in depth knowledge with respect to anatomy and physiology of the respiratory system

### A) Respiratory anatomy and physiology

#### 31.1 Anatomy of respiratory tract

- 31.1.1 Anatomy of the airway and upper airway muscles
- 31.1.2 Anatomy of the Tracheobronchial tree
- 31.1.3 Functional histology and anatomy of the alveolus
- 31.1.4 Pulmonary and bronchial circulation
- 31.1.5 Pulmonary lymphatics

#### 31.2 Pulmonary physiology

##### 31.2.1 Pulmonary mechanics: Elastic forces and lung volumes

- 31.2.1.1 Elastic recoil of the lungs and chest wall
- 31.2.1.2 Surface tension, surfactant, and its effects on lung mechanics
- 31.2.1.3 Alveolar, intrapleural and transmural pressures and their relationship
- 31.2.1.4 Hysteresis
- 31.2.1.5 Lung and chest wall compliance and elastance
- 31.2.1.6 Static compliance versus dynamic compliance
- 31.2.1.7 Lung volumes, Functional Residual Capacity (FRC)
- 31.2.1.8 Physiologic changes with aging
- 31.2.1.9 Principles of measurement of lung volumes, lung compliance

##### 31.2.2 Pulmonary mechanics: Respiratory system resistance

- 31.2.2.1 Principles of gas flow and resistance: laminar flow, turbulent flow, flow through and orifice, Reynolds number
- 31.2.2.2 Respiratory system resistance
- 31.2.2.3 Gas trapping
- 31.2.2.4 Airway closure, closing capacity and closing volumes
- 31.2.2.5 Flow-related airway collapse
- 31.2.2.6 Neuromuscular control of airway diameter
- 31.2.2.7 Pharmacology affecting airway resistance



31.2.2.8 Measurement of airway resistance and closing capacity

31.2.3 Control of breathing

- 31.2.3.1 Central nervous system control of respiratory drive
- 31.2.3.2 Peripheral receptors and respiratory drive
- 31.2.3.3 Lung reflexes
- 31.2.3.4 Carbon dioxide and respiratory control
- 31.2.3.5 Oxygen, respiratory control and the response to hypoxia
- 31.2.3.6 Effects of drugs on respiratory drive
- 31.2.3.7 Methods of assessing control of breathing and sensitivity to hypoxia

31.2.4 Pulmonary ventilation

- 31.2.4.1 Functional anatomy of the muscles of respiration
- 31.2.4.2 Postural effects on respiratory muscle function
- 31.2.4.3 Work of breathing
- 31.2.4.4 Work against resistance
- 31.2.4.5 Work against elastic recoil
- 31.2.4.6 Measurement of ventilation
- 31.2.4.7 Neuronal control of respiratory muscle function
- 31.2.4.8 Respiratory muscle fatigue

31.2.5 Pulmonary circulation

- 31.2.5.1 Pulmonary blood flow and blood volume
- 31.2.5.2 Pulmonary vascular pressures
- 31.2.5.3 Pulmonary vascular resistance
- 31.2.5.4 Control of vascular tone – cellular mechanisms and neural control
- 31.2.5.5 Control of vascular tone – pharmacology
- 31.2.5.6 Effects of hypoxia and hypoxic pulmonary vasoconstriction
- 31.2.5.7 Effects of lung volume
- 31.2.5.8 Effect of lung inflation on pulmonary blood flow, pulmonary vascular resistance, and cardiac output
- 31.2.5.9 Principles of measurement of pulmonary flow, cardiac output and pulmonary vascular resistance

31.2.6 Distribution of pulmonary blood flow and ventilation

- 31.2.6.1 Distribution of ventilation
- 31.2.6.2 Anatomical distribution of ventilation
- 31.2.6.3 Gravitational effects on compliance and ventilation distribution
- 31.2.6.4 Gravitational effects on pleural pressure
- 31.2.6.5 Distribution related to rate of alveolar filling – time constants
- 31.2.6.6 Distribution of perfusion
- 31.2.6.7 Gravitational effects on perfusion distribution
- 31.2.6.8 Gravity independent determinants of regional blood flow, (cardiac output, lung volume)
- 31.2.6.9 West's four zones of the lung
- 31.2.6.10 Ventilation: perfusion matching – V/Q ratio
- 31.2.6.11 Alveolar gas tensions
- 31.2.6.12 Dead space – anatomical and physiological
- 31.2.6.13 Quantification of dead space
- 31.2.6.14 Bohr (dead space) equation
- 31.2.6.15 Venous admixture or shunt
- 31.2.6.16 Effect of V/Q ratio on arterial PO<sub>2</sub>
- 31.2.6.17 Measurement of ventilation / perfusion matching
- 31.2.6.18 Alveolar air equation
- 31.2.6.19 Measurement of dead space

31.2.7 Gas diffusion

- 31.2.7.1 Diffusion of oxygen from alveolus to the red blood cell (RBC)
- 31.2.7.2 Diffusion of oxygen within the RBC and uptake by hemoglobin
- 31.2.7.3 Diffusion of carbon monoxide by hemoglobin and measurement of diffusing capacity
- 31.2.7.4 Factors affecting diffusing capacity

31.2.8 Oxygen

- 31.2.8.1 The oxygen cascade
- 31.2.8.2 Factors affecting alveolar oxygen tension
- 31.2.8.3 The shunt equation

- 31.2.8.4 Oxygen carriage in the blood
  - 31.2.8.5 Oxygen delivery and oxygen consumption and its measurement
  - 31.2.8.6 Physical solution
  - 31.2.8.7 Hemoglobin
  - 31.2.8.8 The oxyhemoglobin dissociation curve and factors affecting affinity of hemoglobin for oxygen
  - 31.2.8.9 Abnormal forms of hemoglobin
  - 31.2.8.10 Oxygen stores
  - 31.2.8.11 The role of oxygen in the cell
  - 31.2.8.12 Energy production
  - 31.2.8.13 Aerobic and anaerobic metabolism
  - 31.2.8.14 Oxidative phosphorylation
  - 31.2.8.15 Critical oxygen tension
  - 31.2.8.16 Cyanosis
  - 31.2.8.17 Methods of oxygen delivery
  - 31.2.8.18 Oxygen toxicity
  - 31.2.8.19 Measurement of oxygen levels – blood gases, pulse oximetry, tissue PO<sub>2</sub>
  - 31.2.8.20 Mechanisms and Effects of hypoxia
  - 31.2.8.21 V/Q mismatch, shunt, decreased FiO<sub>2</sub>, hypoventilation
  - 31.2.8.22 Mechanisms of hypoxia under anesthesia
  - 31.2.8.23 Physiologic effects of hypoxia
  - 31.2.9 Carbon dioxide
    - 31.2.9.1 Carriage of carbon dioxide in the lung
    - 31.2.9.2 Physical solution
    - 31.2.9.3 Carbonic acid and effect of carbonic anhydrase
    - 31.2.9.4 Bicarbonate ion
    - 31.2.9.5 Carbamino carriage
    - 31.2.9.6 Haldane effect
    - 31.2.9.7 Distribution of CO<sub>2</sub> in the blood
    - 31.2.9.8 Factors affecting carbon dioxide tension
    - 31.2.9.9 Alveolar CO<sub>2</sub> – effect of ventilation
    - 31.2.9.10 End expiratory CO<sub>2</sub>
    - 31.2.9.11 Carbon dioxide output
-

- 31.2.9.12 Measurement of carbon dioxide
- 31.2.9.13 Physiologic effects of hypercapnia and hypocapnia

31.3 Non-respiratory functions of the lung

- 31.3.1 Filtration
- 31.3.2 Biological hazards
- 31.3.3 Metabolism of endogenous compounds
- 31.3.4 Pulmonary interstitial fluid mechanics
- 31.3.5 Starling equation

**B) Monitoring of gas delivery** - see Chapter 15 - Monitoring and Equipment

**C) Physiology of mechanical ventilation** – see Chapter 6 – Critical Care

**D) Thoracic Anesthesia**

- 31.4 Demonstrate the knowledge and ability to provide care for patients presenting for thoracic surgery, including but not limited to:
  - 31.4.1 Preoperative assessment and optimization of the patient for thoracic surgery
    - 31.4.1.1 Evaluation of respiratory function; pulmonary parenchymal function, lung mechanical function and cardiopulmonary reserve
    - 31.4.1.2 Global assessment of the patient with lung cancer
  - 31.4.2 Chest radiology reviews and implications of findings (mass localization, mass effect, easiness of anticipated isolation, etc.)
  - 31.4.3 Fiberoptic bronchoscopy
    - 31.4.3.1 Recognize normal anatomy vs. anomaly
  - 31.4.4 Physiology of the lateral decubitus position, the open chest and one lung ventilation
  - 31.4.5 Physiology of one lung ventilation
    - 31.4.5.1 Indications for one lung ventilation
    - 31.4.5.2 Various isolation devices, advantages and disadvantages of each one
    - 31.4.5.3 Prediction of hypoxemia with one lung ventilation and strategies to mitigate the risk

- 31.4.6 Regional anesthesia for thoracic surgery
- 31.4.7 Anesthetic management for thoracotomy and pulmonary resection
- 31.4.8 Anesthesia for esophageal and mediastinal surgery, including management of patients with a mediastinal mass
- 31.4.9 Management of thoracic trauma
- 31.4.10 Lung isolation for management of hemoptysis and bronchopleural fistula

#### **E) Thoracic Surgical Procedures**

- 31.5 Independently provide anesthetic management, including knowledge of the considerations, preoperative optimization and preparation, intraoperative and postoperative management for:
  - 31.5.1 Tracheostomy
  - 31.5.2 Rigid and fiberoptic bronchoscopy
  - 31.5.3 Bronchoscopy and Mediastinoscopy
  - 31.5.4 Endobronchial surgery, including laser resection
  - 31.5.5 One-lung ventilation
  - 31.5.6 Lobectomy/Pneumonectomy
  - 31.5.7 Video assisted thoracoscopy
  - 31.5.8 Pleurectomy / decortication surgery
  - 31.5.9 Esophageal resection
  - 31.5.10 Tracheal resection
  - 31.5.11 Bronchopulmonary lavage
  - 31.5.12 Mediastinal mass resection
  - 31.5.13 Transthoracic vertebral surgery
  - 31.5.14 Management of post-thoracotomy pain
  - 31.5.15 Management of post-thoracotomy complications

## 32 Statistics and Evidence Based Medicine

### A) Definition of terms

- 32.1 Define the following statistical terms, state their differences where appropriate, and understand how to calculate them where applicable:
  - 32.1.1 Mean; median; mode
  - 32.1.2 Standard deviation (SD); standard error of the mean (SEM); 95% confidence interval (95% CI)
  - 32.1.3 Type of data: continuous (ordinal/interval/ratio) vs. categorical (nominal)
  - 32.1.4 Distribution of data: e.g., normal (Gaussian) vs. non-normal
  - 32.1.5  $\alpha$  and P value (level of statistical significance) vs.  $\beta$  and statistical power (1- $\beta$ )
  - 32.1.6 Type 1 error vs. type II error
  - 32.1.7 One vs. two sample tests; multiple sample tests
  - 32.1.8 One-tailed vs. two-tailed tests and when to use them
  - 32.1.9 Linear regression vs. correlation
  - 32.1.10 Bias
- 32.2 Define the following statistical terms and concepts, and independently compute corresponding values:
  - 32.2.1 Sensitivity
  - 32.2.2 Specificity
  - 32.2.3 Positive predictive value
  - 32.2.4 Negative predictive value
  - 32.2.5 Incidence
  - 32.2.6 Prevalence
  - 32.2.7 Odds ratio
  - 32.2.8 Relative risk
  - 32.2.9 Absolute risk
  - 32.2.10 Number needed to treat (NNT)
  - 32.2.11 Number needed to harm (NNH)
  - 32.2.12 Intention-to-treat analysis

## B) Statistical tests

32.3 Demonstrate knowledge of when the following statistical tests should be used for the following data types:

32.3.1 Comparisons of two groups

32.3.1.1 Continuous Gaussian data: Student's *t* test (parametric testing)

32.3.1.2 Continuous non-Gaussian data: Mann-Whitney *U* test / Wilcoxon rank-sum test (non-parametric testing)

32.3.1.3 Categorical data: Fisher's exact test or chi-square test (contingency tables)

## C) Study Characteristics

32.4 Perform the following:

32.4.1 State the variables required for an *a priori* power analysis/sample size projection:

32.4.1.1 Desired level of statistical significance ( $\alpha$ )

32.4.1.2 Desired power ( $1 - \beta$ )

32.4.1.3 Minimum clinically important difference to be detected

32.4.2 Evaluate statistical and clinical significance of the findings

32.4.2.1 Correctly interpret P values

32.4.2.2 Correctly interpret measures of data scatter/dispersion/variance (e.g., standard deviation)

32.4.2.3 State the difference between primary and secondary outcome variables

32.4.2.4 Understand the effect of multiple comparisons on statistical significance measures and understand how to correct for this effect

32.5 Define and state the differences between the following types of experimental design

32.5.1 Systematic reviews of the literature and meta-analyses

32.5.1.1 Experimental studies

32.5.1.2 Non-randomized and quasi-randomized controlled trials

32.5.1.3 Randomized controlled clinical trials (RCTs)

32.5.1.3.1 Double-blinded

32.5.1.3.2 Single-blinded

32.5.1.3.3 Non-blinded

- 32.5.1.4 Observational analytic studies (retrospective or prospective)
  - 32.5.1.4.1 Cross-sectional studies
  - 32.5.1.4.2 Case-control studies
  - 32.5.1.4.3 Cohort studies
- 32.5.1.5 Descriptive studies
  - 32.5.1.5.1 Surveys
- 32.5.2 Demonstrate awareness of the following methods/tools and be able to explain their purpose, but is not expected to manage by themselves
  - 32.5.2.1 Univariate and multivariate statistic
  - 32.5.2.2 Kaplan-Meyer analysis and comparison of survival curves (logrank test)

#### **D) Critical Appraisal of the Literature**

- 32.6 Be able to perform critical appraisal of the scientific medical literature, and other sources of evidence (e.g., online sources, expert opinion) in order to guide anesthetic practice:
  - 32.6.1 Understand the different levels of evidence supporting practice
  - 32.6.2 Be familiar with standardized study design and reporting guidelines, such as the CONSORT Statement
  - 32.6.3 Understand the difference between and original study, as systematic review and a meta-analysis
  - 32.6.4 Understand the important components of a scientific publication, including:
    - 32.6.4.1 Ethics board review
    - 32.6.4.2 Correct statistical analysis
    - 32.6.4.3 Peer review and publication
    - 32.6.4.4 Sources of bias
    - 32.6.4.5 Applicability to local patient demographics and practice patterns
    - 32.6.4.6 Concordance with published literature



- 32.6.5 Understand the difference between practice guidelines and the evidence upon which guidelines are based
- 32.6.6 Participate in learning events which support evidence-based practice, such as journal clubs, grand rounds local and national conferences, and departmental research days

### 33 Thermoregulation

Upon completion of this training, the Anesthesiologist must demonstrate knowledge of the physiology and pathophysiology of thermoregulation and its' relevance in Anesthesiology

#### A) Basic Science

- 33.1 Define mild, moderate and deep hypothermia
- 33.2 Demonstrate knowledge of the mechanisms of heat loss during anesthesia
  - 33.2.1 Convection
  - 33.2.2 Conduction
  - 33.2.3 Radiation
  - 33.2.4 Evaporation
  - 33.2.5 Decreased heat production/metabolism
  - 33.2.6 Prepping, draping/exposure
  - 33.2.7 IV fluid & blood products
  - 33.2.8 Vasodilation/Central neural blockade

#### B) Principles of temperature measurement

- 33.3 Sites
- 33.4 Accuracy
- 33.5 Modality (e.g., different types of temperature measurement devices – thermistor, infrared, etc.)

#### C) Thermoregulation

- 33.6 Body Temperature Regulation
  - 33.6.1 Neonate
  - 33.6.2 Infant
  - 33.6.3 Child
  - 33.6.4 Adult
  - 33.6.5 Elderly
- 33.7 Physiological changes with hypothermia
  - 33.7.1 Cardiovascular
  - 33.7.2 Respiratory
  - 33.7.3 CNS

- 33.7.4 Metabolic/endocrine
  - 33.7.5 Musculoskeletal
  - 33.7.6 Renal
  - 33.7.7 Haematological
  - 33.7.8 Gastro-Intestinal
- 33.8 Consequences and physiological effect of temperature
- 33.8.1 Changes on gases solubilities
  - 33.8.2 Temperature compensation of arterial blood gases (ABGs)
  - 33.8.3 Effect of temperature changes on hemoglobin O<sub>2</sub> binding and tissue delivery
  - 33.8.4 Effect of temperature on vaporizer delivery of anesthetic agents, and how they compensate for variations in ambient temperature

**D) Intraoperative heat loss**

- 33.9 Demonstrate competence and knowledge of the description, mechanism, effectiveness, and complications of the following techniques:
- 33.9.1 Methods of prevention of heat loss and raise of body temperature under anesthesia
    - 33.9.1.1 Ambient temperature
    - 33.9.1.2 Humidification and circle systems
    - 33.9.1.3 Fluid and blood warmers
    - 33.9.1.4 Warming blankets
    - 33.9.1.5 Reflection blankets
    - 33.9.1.6 Core re-warming including CPB, bladder, peritoneal and other forms of dialysis
    - 33.9.1.7 Body thermal gradients & complications of re-warming
  - 33.9.2 Adverse consequences of hypothermia including the following:
    - 33.9.2.1 Delayed awakening
    - 33.9.2.2 Delayed drug metabolism
    - 33.9.2.3 Shivering including increased oxygen consumption
    - 33.9.2.4 Hypotension during re-warming
    - 33.9.2.5 Impaired wound healing and infection
    - 33.9.2.6 Cardiac complications (arrhythmias, ischemia, hypertension, poor peripheral perfusion)
    - 33.9.2.7 Bleeding and coagulopathy

- 33.9.2.8 Cold diuresis
- 33.9.2.9 Augmented hormonal and metabolic "Stress response"
- 33.9.2.10 Decreased patient comfort

33.9.3 Deleterious effects of perioperative hyperthermia

**E) Deliberate or therapeutic hypothermia**

- 33.10 Cardiac surgery
- 33.11 Neurosurgery
- 33.12 Vascular surgery
- 33.13 Critically ill patient
- 33.14 Following cardiac arrest

**F) Resuscitation Medicine**

- 33.15 Implications of accidental hypothermia in non-anesthetized patients:
  - 33.15.1 Emergency Room (trauma / ATLS)
  - 33.15.2 Intensive Care Unit
- 33.16 Alterations in ACLS protocols in severe hypothermia
- 33.17 Management of re-warming patients with severe hypothermia

**G) Malignant Hyperthermia**

- 33.18 Demonstrate knowledge of the pathophysiology, and independently diagnose and manage Malignant Hyperthermia (MH)
  - 33.18.1 Genetics of MH, including counselling MH susceptible patients or parents
  - 33.18.2 Testing options for MH, including familiarity with referral services
  - 33.18.3 Signs and symptoms of MH in the awake and anesthetized patient
  - 33.18.4 Management of an MH crisis, including demonstration of good CRM skills

## 34 Transplantation

### A) Multiple organ donation

- 34.1 Define brain death and criteria for certifying brain death
- 34.2 Demonstrate knowledge of the various tests to confirm the diagnosis of brain death and be able to performed them
- 34.3 Describe and manage organ dysfunction after brain death especially cardiopulmonary complications, coagulopathy, temperature changes and diabetes insipidus
- 34.4 Demonstrate knowledge and proficiency in providing competent anesthetic care including preoperative evaluation and intraoperative management of single organ donors, multi-organ donors and extended criteria organ donors
  - 34.4.1 Multi-organ brain dead donors
  - 34.4.2 Living related donors for kidney & liver
  - 34.4.3 Donation after cardiac death (DCD)

### B) Organ recipients

- 34.5 Demonstrate an understanding of post-transplant complications including rejection, infection, immunosuppression, and secondary organ dysfunction from anti-rejection medications
- 34.6 Be able to conduct anesthesia for non-transplant surgical procedures in patients post-organ transplantation
  - 34.6.1 Heart transplantation
    - 34.6.1.1 Perform a preoperative evaluation for a post heart transplant patient undergoing non-cardiac surgery including assessment of signs and symptoms of rejection
    - 34.6.1.2 Describe altered cardiac physiology post heart transplant
    - 34.6.1.3 Describe altered cardiac anatomy post heart transplant
    - 34.6.1.4 Demonstrate an understanding of the effects of cardiac deafferentation and deafferentation (denervation physiology)
    - 34.6.1.5 Describe altered cardiac response to pharmacology post heart transplant
    - 34.6.1.6 Describe relevant anesthetic pharmacology in relation to cardiac function and preconditioning
  - 34.6.2 Lung transplantation
    - 34.6.2.1 Perform a preoperative evaluation of a post lung transplant patient presenting for non-transplant surgery including

- assessment of signs and symptoms of rejection
- 34.6.2.2 Understand the relevant post lung transplant anatomy (anastomosis/suture lines) and physiology and their anesthetic implications
- 34.6.3 Liver transplantation
  - 34.6.3.1 Perform a preoperative evaluation on a post liver transplant patient presenting for non-transplant surgery including assessment of signs and symptoms of rejection
  - 34.6.3.2 Outline the anesthesia considerations for a patient with liver dysfunction
  - 34.6.3.3 Describe the pharmacologic and physiologic consequences of poor postoperative graft function
- 34.6.4 Renal transplantation
  - 34.6.4.1 Perform a preoperative evaluation of a post renal transplant patient presenting for non-transplant surgery including assessment of signs and symptoms of rejection
  - 34.6.4.2 Describe relevant anesthetic considerations in post renal transplant patient

### **C) Transplantation procedures**

- 34.7 Demonstrate knowledge and proficiency in providing competent anesthetic care including preoperative evaluation, intraoperative management and postoperative follow-up for patients receiving an organ (recipients for organ transplantation)
  - 34.7.1 Renal transplantation

## 35 Inhaled Anesthetic Agents

Upon completion of this training, the Anesthesiologist must demonstrate knowledge of the inhaled anesthetics with regard to safety, efficacy, toxicity, and inertness of gases currently in use. The anesthesiologist must be able to discuss the theories of the mechanism of action of inhaled anesthetics. The inhaled agents discussed include at least:

- Nitrous Oxide
- Halothane, isoflurane, desflurane, sevoflurane

### A) Physical Characteristics

35.1 Explain and demonstrate knowledge of the following pharmacokinetic concepts, including how each applies to the specific anesthetic inhaled agent in common use:

35.1.1 Physical characteristics of gases

- 35.1.1.1 Chemical potential (escaping tendency)
- 35.1.1.2 Vapor pressure
- 35.1.1.3 Boiling point
- 35.1.1.4 Mixtures
- 35.1.1.5 Gases in solutions
- 35.1.1.6 Gas-liquid interface
- 35.1.1.7 Tension or partial pressure
- 35.1.1.8 Fractional volume
- 35.1.1.9 Solubility

35.1.2 Properties of Inhaled Anesthetics

- 35.1.2.1 Bidirectional transfer and equilibration
- 35.1.2.2 Relative lack of absorption by tissues
- 35.1.2.3 Metabolism

35.1.3 Uniqueness of Inhaled Anesthetics

- 35.1.3.1 Route of administration
- 35.1.3.2 Bidirectionality and equilibrium
- 35.1.3.3 Adjustability

## B) Uptake and Distribution

35.2 Demonstrate a thorough understanding of the concepts underlying uptake and distribution, and the factors which increase and decrease the rate of rise of alveolar fraction/inspired fraction ( $F_A/F_I$ )

35.2.1 Alveolar gas concentration/ Inspired gas concentration ( $F_A/F_I$ )

- 35.2.1.1 Effect of fresh gas flow
- 35.2.1.2 Capacity of circuit
- 35.2.1.3 Effect of fractional concentration or pressure of gas
- 35.2.1.4 Effect of time and time constant
- 35.2.1.5 1<sup>st</sup> order kinetic
- 35.2.1.6 Effect of circuit absorbents
- 35.2.1.7 Theory with and without uptake
- 35.2.1.8 Effect of functional residual capacity (FRC)
- 35.2.1.9 Effect of ventilation perfusion mismatching
- 35.2.1.10 Concentration effect
- 35.2.1.11 Overpressurization
- 35.2.1.12 Second Gas effect

35.2.2 Compartment model

- 35.2.2.1 Vessel rich group/Muscle/Fat/Vessel poor group
- 35.2.2.2 Gradient from machine to brain
- 35.2.2.3 Partition coefficients, especially
  - 35.2.2.3.1 Blood gas
  - 35.2.2.3.2 Blood brain

35.2.3 Clinical differences between prolonged and short anesthesia

35.2.4 Elimination

- 35.2.4.1 Percutaneous and visceral
- 35.2.4.2 Diffusion between tissues
- 35.2.4.3 Metabolism
- 35.2.4.4 Exhalation

35.2.5 Diffusion hypoxia



### **C) Toxicity**

- 35.3 Discuss and describe the metabolism and biotransformation of volatile agents
  - 35.3.1 Desflurane and Carbon Monoxide
  - 35.3.2 Effect of hepatic and renal disease on metabolism
  - 35.3.3 Sevoflurane and compound A
  - 35.3.4 Fluoride production
  - 35.3.5 Hepatotoxicity ("halothane hepatitis")
  - 35.3.6 Clinical overview of agents

### **D) Occupational Exposure**

- 35.4 Demonstrate knowledge of the occupational and environmental concerns in the use of volatile anesthetic agents, including:
  - 35.4.1 Standards for allowable workplace pollution by anesthetic gases; National Institute for Occupational Safety and Health (NIOSH) standards
  - 35.4.2 Role of scavenging and how scavenging technology works
  - 35.4.3 Specificities related to pregnant worker
  - 35.4.4 Environmental effects of anesthetic gases discharged from hospitals

### **E) Pharmacology**

- 35.5 Demonstrate knowledge with respect to the following issues related to use of the various agents:
  - 35.5.1 Halothane
    - 35.5.1.1 Solubility and metabolism
    - 35.5.1.2 Controversy over its' continued use
  - 35.5.2 Isoflurane
    - 35.5.2.1 Fluoride production
    - 35.5.2.2 Seizure activity on EEG
    - 35.5.2.3 Coronary Steal controversy
  - 35.5.3 Desflurane
    - 35.5.3.1 Blood gas solubility
    - 35.5.3.2 Low potency, stability, pungency, high vapor pressure, low metabolism

- 35.5.3.3 Peculiarity of vaporizer
- 35.5.3.4 Associated tachycardia and hypertension
- 35.5.3.5 Effect of dry carbon dioxide (CO<sub>2</sub>) absorbent and carbon monoxide (CO) production
- 35.5.3.6 Role in outpatient surgery

35.5.4 Sevoflurane

- 35.5.4.1 Acceptability as inhalational induction agent
- 35.5.4.2 Solubility
- 35.5.4.3 Coronary vasodilation and pre-conditioning
- 35.5.4.4 Non-production of antibody formation
- 35.5.4.5 CO production and heat
- 35.5.4.6 Compound A during low flow anesthesia
- 35.5.4.7 Nephrotoxicity controversy – Fluoride

35.5.5 Nitrous Oxide

- 35.5.5.1 Characteristics
- 35.5.5.2 Role as adjuvant
- 35.5.5.3 Role in postoperative pain
- 35.5.5.4 Controversies
- 35.5.5.5 Effect on sympathetic nervous system (SNS)
- 35.5.5.6 Effect of PONV
- 35.5.5.7 Inactivation of B12 metabolism
- 35.5.5.8 Effect on closed, and potential air spaces
- 35.5.5.9 Environmental considerations

**F) Clinical Effects**

35.6 Discuss and describe the following with respect to clinical utility of volatile agents:

35.6.1 Minimum Alveolar Concentration (MAC)

- 35.6.1.1 Definitions, types (MAC awake, MAC movement, MAC aware, MAC BAR)
- 35.6.1.2 Describe the factors that increase and decrease MAC
- 35.6.1.3 MAC for commonly used agents

35.6.2 Induction

- 35.6.2.1 Volatile induction
- 35.6.2.2 Appropriate agents
- 35.6.2.3 Risks and benefits

35.6.3 Maintenance

- 35.6.3.1 Safety
- 35.6.3.2 Adjustability
- 35.6.3.3 Generalizability of use regardless of age, habitus
- 35.6.3.4 Cardiac and cerebral blood flow
- 35.6.3.5 Predictable recovery
- 35.6.3.6 Absence of analgesia
- 35.6.3.7 Post-operative nausea and vomiting (PONV)
- 35.6.3.8 CO and Hepatitis

35.6.4 Central Nervous System

- 35.6.4.1 Cerebral Metabolic Rate of oxygen (CMRO<sub>2</sub>) – effect on EEG
- 35.6.4.2 Cerebral Blood Flow (CBF)
- 35.6.4.3 ICP
- 35.6.4.4 Autoregulation and Uncoupling
- 35.6.4.5 Role of individual agents
- 35.6.4.6 Role of nitrous oxide
- 35.6.4.7 Effect on CSF production
- 35.6.4.8 Effect on response to hyper and hypocarbia
- 35.6.4.9 Cerebral protection

35.6.5 Circulatory System

- 35.6.5.1 Hemodynamics
- 35.6.5.2 Cardiac Index
- 35.6.5.3 Central Venous Pressure (CVP)
- 35.6.5.4 Systemic vascular resistance, pulmonary vascular resistance
- 35.6.5.5 Contractility
- 35.6.5.6 Preconditioning
- 35.6.5.7 Distribution of blood flow

35.6.5.8 Halothane, sensitization of myocardium

35.6.5.9 Relation to adrenaline

35.6.6 Pulmonary System

35.6.6.1 Effects in spontaneously breathing patients

35.6.6.2 Resting Arterial pressure of carbon dioxide ( $\text{PaCO}_2$ )

35.6.6.3 Mechanics of ventilation

35.6.6.4 Response to Carbon Dioxide ( $\text{CO}_2$ )

35.6.6.5 Response to hypoxia

35.6.6.6 Smooth muscle tone and bronchodilations

35.6.6.7 Mucociliary function

35.6.6.8 Pulmonary vascular resistance and hypoxic pulmonary vasoconstriction (HPV) and relevance to one-lung ventilation (OLV)

35.6.7 Liver

35.6.7.1 Relevance of hepatic blood supply and architecture of the liver

35.6.7.2 Effects of volatile agents

35.6.7.2.1 Mechanisms for Halothane Hepatitis

35.6.7.3 Antibody formation

35.6.7.4 Mechanism for

35.6.7.5 Epidemiology

35.6.7.6 Non-antibody mediated mild form

35.6.8 Neuromuscular System and Malignant Hyperthermia (MH)

35.6.8.1 Effect on skeletal muscle

35.6.8.2 Triggering of MH response; relative potency of different agents

35.6.8.3 Investigation for MH

35.6.9 Reproductive and genetic effects

35.6.9.1 Limitation of animal studies

35.6.9.2 Low grade long term exposure

35.6.10 Effects of Volatile Agents in Pregnant Patients

- 35.6.10.1 Effect of methionine synthetase and thymidylsynthetase by nitrous oxide
- 35.6.10.2 Effect on uterine smooth muscle
- 35.6.10.3 Placental transfer and effect on fetus
- 35.6.10.4 Effect on fetal loss
- 35.6.10.5 Toxicity and teratogenicity