NATIONAL CURRICULUM FOR CANADIAN ANESTHESIOLOGY RESIDENCY

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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.*

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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 rigid
      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, ProSeal, 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  Fibreoptic 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
1.16.1.10 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 Chosing 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 rennin-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 Constructive 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

4.4.1.10 Aberrant conduction and acute and chronic dysrhythmia (including atrial fibrillation, supra-ventricular tachycardia, Wolf Parkinson White (WPW))

4.4.1.11 Pacemaker and Automatic Implantable Cardioverter Defibrillator (AICD)

4.4.1.12 Cardiac transplant

4.4.1.13 Adult Congenital Heart Disease

4.4.1.14 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- 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, β-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 oximetry
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-/hypocarbia
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:
(see also 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
   5.12.6 Violent patient – Assault (physical, verbal)

5.13 Demonstrate an understanding of the potential risks encounter during practice and potential prevention strategies, including but not limited to:
   5.13.1 Physical injury related to patient lifting
   5.13.2 Noise pollution
   5.13.3 Post Traumatic Stress Disorder (PTSD) after adverse events
   5.13.4 Fatigue
   5.13.5 Substance abuse
   5.13.6 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 Asist-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 dysynchrony

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/Hypernatremia
      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 Abruption placenta
6.25.5 Amniotic fluid embolism
6.25.6 Disseminated intravascular coagulation
6.25.7 Uterine rupture
6.25.8 Management of cardiac arrest in pregnancy
6.25.9 Thromboembolic disease in pregnancy
6.25.10 Postpartum care of the parturient with cardiovascular disease
   6.25.10.1 Acute coronary syndrome
   6.25.10.2 Valvular heart disease
   6.25.10.3 Postpartum cardiomyopathy
6.25.11 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 FiO₂

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 tracheotomy, and provide expert anesthetic management of the patient with or undergoing tracheotomy

7.7.1 Indications for:
  7.7.1.1 Emergent tracheotomy for airway obstruction
    7.7.1.1.1 Epiglottitis
    7.7.1.1.2 Upper airway tumours

  7.7.1.2 Elective tracheotomy
    7.7.1.2.1 For pulmonary toilet
      7.7.1.2.1.1 Prolonged oro-tracheal 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 Antidiuretic 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 Pharmadynamics

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 VO2 for tissue metabolic processes, DO2, oxygen, extraction ratio, DO2 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 Thromboelastrogram 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 unfractioned 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 Methehemoglobin, 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:

- Febrile reactions
- Allergic reactions
- Volume overload
- Transfusion-related acute lung injury (TRALI)
- Acute and delayed haemolytic reactions
- Sepsis
- Coagulopathy
- Electrolyte disturbances
- 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 Erythropoetin 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

B) Hepatic Pharmacology

12.5 Demonstrate knowledge of the pharmacology relevant to the hepatic system
   12.5.1 Pharmacokinetics and pharmacodynamics
   12.5.2 Describe the mechanisms of hepatic drug elimination
   12.5.3 Knowledge of altered response to drugs in cirrhotic patient
   12.5.4 Knowledge of possible hepatotoxic drugs

C) Pathophysiology

12.6 Demonstrate knowledge of:
   12.6.1 Postoperative hepatic dysfunction:
      12.6.1.1 Differential diagnosis
      12.6.1.2 Approach to determine etiology
12.6.2 Pre-, intra-, and post-hepatic dysfunction
12.6.3 Halothane hepatitis
12.6.4 Viral Hepatitis
12.6.5 Other forms of hepatitis and the implications thereof:
   12.6.5.1 Alcoholic
   12.6.5.2 Other drugs/toxins
   12.6.5.3 Infection – non – viral hepatitis
   12.6.5.4 Autoimmune

12.6.6 Liver failure/ End stage liver disease
   12.6.6.1 Etiologies
   12.6.6.2 Child’s classification and Model for End Stage Liver Disease (MELD) score for preoperative risk stratification
   12.6.6.3 End Stage Liver Disease physiology and multi-organ dysfunction

12.6.7 Other disease
   12.6.7.1 Porphyrias

12.6.8 Anesthetic management
   12.6.8.1 Anesthetic management for acute or chronic alcoholism
   12.6.8.2 Anesthetic management for patient with acute or chronic liver failure
   12.6.8.3 Anesthetic management for a patient with a previous liver transplant

D) Anesthesia for Hepatobiliary Procedures

12.7 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

12.8 Demonstrate competence in providing anesthetic care for patients presenting for:
   12.8.1 Cholecystectomy: open and laparoscopic
   12.8.2 Endoscopic biliary tract procedures
   12.8.3 Pancreatic resection
   12.8.4 Whipples’ procedure
12.8.5 Liver resections
12.8.6 Liver donation
12.8.7 Transjugular Intrahepatic Portosystemic Shunt (T.I.P.S.) procedure
12.8.8 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 Hemaglutinin 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 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 2nd 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 venturi 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 of the difference between sound and electromagnetic waves (i.e., different speeds, different propagation waves)
   15.6.1.1.2 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 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 CO2 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  CO₂ 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 CO₂
   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
- Basic anatomy of the central nervous system, including the spinal cord and meninges
- Anatomy of the Circle of Willis
- Vascular supply to the spinal cord
- Cellular anatomy of the blood brain barrier

16.1.2 Physiology
- Cerebral blood flow and its determinants
- Determinants of cerebral perfusion pressure
- Cerebral metabolic rate for oxygen
- Cerebral pressure autoregulation
- Carbon dioxide reactivity
- Response to hypoxia
- Flow metabolism coupling
- Production, flow and re-absorption of cerebral spinal fluid
- Effects of hypo and hyperthermia
- Effects of increased intracranial pressure

16.1.3 Pharmacology
- Direct and indirect effects of intravenous and inhaled anesthetic agents on cerebral physiology
- Basic principles of neuroprotection and neuroresuscitation
- Mechanism of action of osmotic diuretics and hypertonic saline
- Prevention and treatment of vasospasm
- Controlled hypo- and hypertension
- 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 hemiation
   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/Disectomy/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 presynaptic 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 presynaptic and postsynaptic 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) Prejunctival, Immature and Extrajunctional Receptors
17.3 Describe the “fade” phenomenon with neuromuscular relaxants through a prejunctival 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, sugammadex)

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 N₂O
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 intravitreous gas bubble
19.3.5 Cataract surgery
19.3.6 Oculoplastics
  19.3.6.1 Blephoraplasty
  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 of 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
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
21.4.11.4 Identify and minimize related complications and side effects

21.4.11.5 Describe the mechanism of action of cannabinoids with respect to analgesia

21.4.11.6 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 Explain 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 result 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
21.12.11.5 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

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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 Gastrochisis
   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 Dexmedetomidine
      23.22.1.7 Intravenous lidocaine
23.22.2 Narcotics/Opioids and adjuncts
   23.22.2.1 Fentanyl
   23.22.2.2 Remifentanil
   23.22.2.3 Sufentanil
   23.22.2.4 Alfentanil
   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 Reimplantation

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

24.2.1 General and regional anesthetic options for limb reimplantation

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
- Gastric antrum
- Liver
- Pancreas
- SMA – superior mesenteric artery
- Aorta
- 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
- Empty
- Fluid filled
- 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
- Tracheal rings
- Cricoid cartilage
- Cricothyroid membrane
- Thyroid cartilage
- Thyroid, neck vessels

25.30 Imaging – Demonstrate the ability to identify the ultrasonic images of the essential airway structures in longitudinal and transverse planes
- 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 CO₂ 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 Reducing 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 VO₂ 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 VO₂ 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 X-ray 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; methaemoglobinemia;
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
  28.8.8.1  Topicalization
  28.8.8.2  Superior laryngeal nerve block
  28.8.8.3  Lingual nerve block
  28.8.8.4  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

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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, osmolarity, 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 Endoureteral 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 PO2
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 PO₂
31.2.8.20 Mechanisms and Effects of hypoxia
31.2.8.21 V/Q mismatch, shunt, decreased FiO₂, 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 CO₂ in the blood
31.2.9.8 Factors affecting carbon dioxide tension
31.2.9.9 Alveolar CO₂ – effect of ventilation
31.2.9.10 End expiratory CO₂
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 (α)

32.4.1.2 Desired power (1 –β)

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 an original study, a 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 O₂ 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

34.8 Demonstrate knowledge of the principles of anesthetic perioperative management of patients receiving a heart transplantation, lung transplantation and liver transplantation. The anesthesiologist is not expected to perform the anesthetic management for these surgeries independently.
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 1st 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$_2$) 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$_2$) – 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 (PaCO₂)
35.6.6.3  Mechanics of ventilation
35.6.6.4  Response to Carbon Dioxide (CO₂)
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 thymidyl synthetase 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