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OF PHYSICIANS AND SURGEONS OF CANADA
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NATIONAL CURRICULUM FOR CANADIAN ANESTHESIOLOGY RESIDENCY

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*For a complete list of contributors, please see Appendix A

National Curriculum Guide For Anesthesiology

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

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

MEDICAL EXPERT

1 Airway Evaluation and Management - See also Ear, Nose and Throat (Section 7)

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

A) Basic Science

- 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) Airway Obstruction

- 1.3 Demonstrate knowledge of the etiologies of airway obstruction
- 1.4 Demonstrate knowledge of the complications of airway obstruction, including but not limited to:
 - 1.4.1 Hypercarbia/acidosis
 - 1.4.2 Hypoxia
 - 1.4.3 Aspiration

C) Basic Airway Management

- 1.5 Demonstrate knowledge and expertise in basic airway management for the patient with an upper airway obstruction

1.6 Acute Airway Obstruction

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

1.6.1.1 Basic Life Support (BLS) protocols:

- 1.6.1.1.1 Assessing patient responsiveness
- 1.6.1.1.2 Obtaining assistance
- 1.6.1.1.3 Patient positioning
- 1.6.1.1.4 Recovery position
- 1.6.1.1.5 Chin lift, head tilt, jaw thrust
- 1.6.1.1.6 Indications for and use of pharmacologic agents, including management of laryngospasm
- 1.6.1.1.7 Rescue breathing
- 1.6.1.1.8 Cardiopulmonary resuscitation

1.7 Bag-Valve-Mask Ventilation

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

- 1.7.1.1 Selection of appropriately-sized masks
- 1.7.1.2 Assembly, use, and trouble-shooting of self-inflating ventilation devices
- 1.7.1.3 Two-person mask ventilation techniques
- 1.7.1.4 Role of positive end expiratory pressure (PEEP) valve
- 1.7.1.5 Role of reservoir bag

1.8 Basic Airway Adjuncts

1.8.1 Demonstrate understanding of the use of basic adjuncts to overcome acute airway obstruction including appropriate sizing and insertion techniques, including but not limited to:

- 1.8.1.1 Oropharyngeal airway
- 1.8.1.2 Nasopharyngeal airway

D) Oxygen Delivery Systems

1.9 Demonstrate an understanding of systems designed for delivery of oxygen to the patient, including but not limited to:

- 1.9.1 Oxygen sources
- 1.9.2 Wall oxygen systems and specifications
- 1.9.3 High pressure oxygen supply

- 1.9.4 Diameter Index Safety System (DISS)
- 1.9.5 Quick-connect systems
- 1.9.6 Flowmeters
- 1.9.7 Cylinder sizes, pressures, capacities
- 1.9.8 Regulators and flowmeters
- 1.9.9 Nasal Cannulae
- 1.9.10 Flow rates and delivered oxygen
- 1.9.11 Capnography
- 1.9.12 Face masks
- 1.9.13 Types: Simple, Venturi, Non-rebreathing
- 1.9.14 Flow rates and delivered oxygen

E) Universal Precautions - See Infectious Disease (Section 14)

- 1.10 Demonstrate knowledge and understanding of the role of universal precautions in patient care, including airway management using face shields, barrier masks, gloves

F) Airway Evaluation

- 1.11 Demonstrate advanced knowledge and expertise in assessment of patient airways, particularly those features predisposing to difficulty in airway management
 - 1.11.1 Elicit a satisfactory patient history, including but not limited to:
 - 1.11.1.1 Review of old records
 - 1.11.1.2 History of prior encounters with anesthetics
 - 1.11.1.3 Dental/soft tissue damage
 - 1.11.2 Perform a complete physical examination, including but not limited to:
 - 1.11.2.1 Mallampati score
 - 1.11.2.2 Thyromental distance
 - 1.11.2.3 Upper lip bite test
 - 1.11.2.4 Range of motion of neck
 - 1.11.2.5 Neck circumference
 - 1.11.2.6 Mandible, mouth opening
 - 1.11.2.7 Other predictors of airway difficulty
 - 1.11.2.7.1 Dentition
 - 1.11.2.7.2 Tongue

- 1.11.2.7.3 Gender
- 1.11.2.7.4 Age
- 1.11.2.7.5 Body habitus/obesity
- 1.11.2.7.6 Facial hair
- 1.11.2.7.7 Medical conditions, tumours, trauma, pregnancy

- 1.11.2.8 Investigations
 - 1.11.2.8.1 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:
 - 1.11.2.8.1.1 Pulmonary function testing (vitalometry)
 - 1.11.2.8.1.2 Blood gas testing
 - 1.11.2.8.1.3 Flow-volume loops

G) Communicator Competencies

- 1.12 Demonstrate appropriate communication skills regarding the patient airway, evaluation and planning
 - 1.12.1 Provide clear communication of pre-operative findings/concerns/plans to the patient
 - 1.12.2 Provide accurate written documentation of pre-operative assessment and patient discussion for colleagues
 - 1.12.3 Provide accurate written documentation of intra-operative airway findings
 - 1.12.4 Identify the patient with a difficult airway and be able to:
 - 1.12.4.1 Write a "Difficult Airway Letter"
 - 1.12.4.2 Communicate this finding with the patient and family, and other physicians including the family physician
 - 1.12.4.3 Recommend wearing a MedicAlert bracelet

H) Airway Management Techniques

- 1.13 Demonstrate knowledge and expertise 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
 - 1.13.1.10 Cases in which muscle relaxants are required
 - 1.13.1.11 Surgery around head and neck
 - 1.13.1.12 Airway procedures
 - 1.13.1.13 Bronchoscopy, biopsies, therapeutic procedures
- 1.13.2 Route 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 intubation
 - 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
 - 1.13.2.5 Technique/considerations using standard endotracheal tube
- 1.13.3 Intubation
- 1.13.3.1 Demonstrate knowledge and expertise in managing normal and difficult airways using direct laryngoscopy and intubation, 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 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, airways

- 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 Fiberoptic laryngoscopes
 - 1.13.3.1.3.1.2 Rigid fiberoptic laryngoscopes
 - 1.13.3.1.3.1.3 Shikani, Bullard, etc.
 - 1.13.3.1.3.1.4 Flexible fiberoptic laryngoscopes
 - 1.13.3.1.3.1.5 Video laryngoscopes
 - 1.13.3.1.3.1.6 Glidescope, McGrath laryngoscope, etc.

- 1.13.3.1.4 Adjuncts to facilitate endotracheal tube placement
 - 1.13.3.1.4.1 Gum elastic bougie
 - 1.13.3.1.4.2 Stylets
 - 1.13.3.1.4.3 Malleable
 - 1.13.3.1.4.4 Lighted (e.g. Trachlight, Tubestat)
 - 1.13.3.1.4.5 Manoeuvres to facilitate visualization
 - 1.13.3.1.4.6 Optimal patient positioning
 - 1.13.3.1.4.7 BURP (backward upward rightward position)
 - 1.13.3.1.4.8 OELM (optimal external laryngeal manipulation)

- 1.13.3.1.5 Confirmation of intubation
 - 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 Management of extubation

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

- 1.13.4.1.1 Airway toilet, suctioning
- 1.13.4.1.2 Awake extubation criteria
- 1.13.4.1.3 Deep extubation technique
- 1.13.4.1.4 Post-extubation stridor
- 1.13.4.1.5 Extubation of the patient with a difficult airway

1.13.5 Supraglottic devices

1.13.5.1 Demonstrate knowledge and proficiency in airway management using supraglottic devices, including but not limited to:

- 1.13.5.1.1 Indications and contraindications of different supraglottic devices
- 1.13.5.1.2 Elective use as alternative to endotracheal intubation
- 1.13.5.1.3 Laryngeal mask airway (LMA)
- 1.13.5.1.4 LMA – ProSeal
- 1.13.5.1.5 LMA – Classic
- 1.13.5.1.6 Emerging alternatives
- 1.13.5.1.7 Conduit for endotracheal intubation
- 1.13.5.1.8 Use of specific types of LMA as a conduit for endotracheal intubation
- 1.13.5.1.9 Emergent use in difficult airway algorithms
- 1.13.5.1.10 CVCI (Cannot Ventilate, Cannot Intubate) situation

1.13.6 Complications of airway management

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

- 1.13.6.1.1 Errors of endotracheal tube placement
- 1.13.6.1.2 Endobronchial intubation
- 1.13.6.1.3 Overinsertion
- 1.13.6.1.4 Patient repositioning, neck flexion
- 1.13.6.1.5 Esophageal intubation
- 1.13.6.1.6 Airway trauma

- 1.13.6.1.7 Dental trauma
- 1.13.6.1.8 Soft tissue trauma
- 1.13.6.1.9 Post-extubation stridor
- 1.13.6.1.10 Nasal trauma for nasal intubation
- 1.13.6.1.11 Aspiration
- 1.13.6.1.12 Prevention
- 1.13.6.1.13 Fasting guidelines
- 1.13.6.1.14 Anti-reflux pre-treatment strategies
- 1.13.6.1.15 Role of cricoid pressure
- 1.13.6.1.16 Management
- 1.13.6.1.17 Current guidelines, role of bronchoscopy, lavage, antibiotics, other

I) The Difficult Airway

1.14 Demonstrate advanced knowledge and skills 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. The anesthesiologist must also demonstrate appropriate communication, management and technical skills in doing so

1.14.1 General Considerations

1.14.1.1 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:

- 1.14.1.1.1 Predicted versus unpredicted difficult airway
- 1.14.1.1.2 Awake versus asleep strategy
- 1.14.1.1.3 Failed intubation strategy
- 1.14.1.1.4 Cannot ventilate, cannot intubate strategy
- 1.14.1.1.5 Calling for assistance
- 1.14.1.1.6 Special considerations in the pediatric and obstetric populations

1.14.2 Further classification of difficult airways into descriptive categories:

- 1.14.2.1 Difficult mask ventilation
- 1.14.2.2 Difficult laryngoscopy
- 1.14.2.3 Difficult intubation
- 1.14.2.4 Difficult ventilation

1.14.3 Predicted Difficult Airway

1.14.3.1 Demonstrate knowledge and proficiency in formulating an approach to the recognized difficult airway. The anesthesiologist must understand and be able to weigh alternative strategies

1.14.3.1.1 Formulation of a management plan:

1.14.3.1.1.1 Intubation versus alternatives

1.14.3.1.1.2 Supraglottic devices

1.14.3.1.1.3 Regional anesthesia

1.14.3.1.1.4 Awake versus asleep intubation

1.14.3.1.1.5 Fiberoptic versus videolaryngoscopic techniques

1.14.3.1.1.6 Other devices

1.14.3.1.1.7 Lighted stylet

1.14.3.1.1.8 Other approaches:

1.14.3.1.1.8.1 Retrograde wire or catheter-assisted intubation

1.14.3.1.1.8.2 Patient preparation for awake intubation

1.14.3.1.1.8.3 Psychological, communication of plan/concerns

1.14.3.1.1.8.4 Pharmacological

1.14.3.1.1.8.5 Anti-sialogogue

1.14.3.1.1.8.6 Anxiolytic

1.14.3.1.1.8.7 Strategies for uncooperative patients

1.14.3.1.1.8.8 Airway topicalization techniques

1.14.3.1.1.8.9 Local anesthetic pharmacology

1.14.3.1.1.8.10 Nerve block techniques

1.14.3.1.1.8.11 Aerosolized, spray, contact, injection

1.14.4 Unpredicted Difficult Airway

1.14.4.1 Demonstrate an ability to deal with unexpected 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

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

1.14.5 The Surgical Airway

1.14.5.1 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:

- 1.14.5.1.1 Mini-tracheostomy
- 1.14.5.1.2 Cricothyrotomy
- 1.14.5.1.3 Jet ventilation
- 1.14.5.1.4 Contraindications to surgical airway techniques

1.14.6 Extubation of the Difficult Airway Patient

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

- 1.14.6.1.1 The patient with a wired jaw
- 1.14.6.1.2 The patient with airway edema
- 1.14.6.1.3 Extubation over an introducer
- 1.14.6.1.4 Assessment for readiness for extubation

2 Ambulatory Anesthesiology

A) Ambulatory Anesthesiology Settings

- 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 Identify and evaluate any pre-existing comorbid conditions
 - 2.3.4.1 Provisions for pre-operative screening through record review, interview & examination and directed consultations to reduce late cancellations as well as morbidity & mortality
 - 2.3.4.2 American Society of Anesthesiologists (ASA) Status and appropriateness for ambulatory care
 - 2.3.4.3 Body Mass Index (BMI) stratification
 - 2.3.4.4 Anesthetics for pediatric cases in non-hospital facilities
 - 2.3.4.5 Hormone Replacement Therapy (HRT)/Birth Control Pill (BCP) discontinuation
 - 2.3.5 Select eligible patients for ambulatory anesthesia based on:
 - 2.3.5.1 Type of surgery
 - 2.3.5.2 Duration of surgery
 - 2.3.5.3 Potential for blood transfusions
 - 2.3.5.4 Potential severity of perioperative complications
 - 2.3.5.5 Post-operative care
 - 2.3.6 Special considerations for pediatric patients
 - 2.3.6.1 Former premature patients
 - 2.3.6.2 Comorbid conditions including obstructive sleep apnea
 - 2.3.6.3 Patients with upper respiratory tract infections
 - 2.3.6.4 Airway challenges

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
 - 2.4.3 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 Otolaryngology
 - 2.6.1.2 Vascular surgery
 - 2.6.1.3 General surgery

- 2.6.1.4 Orthopaedic surgery
- 2.6.1.5 Urologic surgery
- 2.6.1.6 Gynaecologic surgery
- 2.6.1.7 Plastic/cosmetic surgery
- 2.6.1.8 Dental surgery
- 2.6.1.9 Ophthalmology
- 2.6.1.10 Diagnostic imaging

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 See Complications
 - 2.8.2 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 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 Harlequin syndrome
 - 3.2.3 Explain the function of the autonomic nervous system in visceral pain
 - 3.2.3.1 Throat
 - 3.2.3.2 Lungs
 - 3.2.3.3 Heart uterus
 - 3.2.3.4 Small and large bowel
 - 3.2.3.5 Pancreas
 - 3.2.3.6 Vagina
 - 3.2.3.7 Testicles
 - 3.2.3.8 Celiac ganglion block

- 3.2.4 Explain the effect of stellate ganglion block on upper limb blood circulation and sympathetic lumbar ganglion block on lower limb blood circulation
- 3.2.5 Explain Marey's law
- 3.2.6 Explain the Bainbridge reflex
- 3.2.7 Explain the Valsalva manoeuvre
- 3.2.8 Explain the Bezold-Jarsich reflex

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 α and β -agonists, both direct and indirect and explain their clinical effect
 - 3.3.4 Explain the effects of α and β -blockers
 - 3.3.5 Explain the effects of calcium channel blockers on the blood vessels
 - 3.3.6 Explain the effects of α_2 -blockers in regard to pain
 - 3.3.7 Explain the effects of antihypertensive drugs on the autonomic nervous system, including drugs affecting the renin-angiotensin system
 - 3.3.8 Explain the effects of antidepressant drugs on the autonomic nervous system, including Monoamine Oxidase Inhibitors (MAOIs) and tricyclic antidepressants
 - 3.3.9 Explain the relation between antiemetic drugs and the autonomic nervous system
 - 3.3.10 Explain the relation between tocolytic drugs and the autonomic nervous system
 - 3.3.11 Describe the effects of anticholinergic and adrenergic drugs on a transplanted heart
 - 3.3.12 Describe the effects of epinephrine injection in the presence of volatile anesthetics

D) Autonomic Dysfunction

- 3.4 Demonstrate an understanding of the pathophysiology of the autonomic nervous system with respect to the following conditions:
 - 3.4.1 Explain pheochromocytoma effects
 - 3.4.2 Explain autonomic dysreflexia
 - 3.4.3 Describe assessment of diabetic autonomic neuropathy

- 3.4.4 Describe autonomic changes with aging
- 3.4.5 Explain the oculocardiac reflex
- 3.4.6 Describe the effects of aging on the autonomic nervous system
- 3.4.7 Describe the surgical stress syndrome

4 Cardiovascular Anesthesia

A) General Objectives

- 4.1 Upon completion of this training, the Anesthesiologist shall demonstrate knowledge and proficiency in all the objectives listed below in plain text and shall demonstrate knowledge of the principles of the objectives listed as italicized items, but not be expected to perform these objectives
- 4.2 *The subspecialist in cardiovascular anesthesia shall demonstrate knowledge and proficiency in all the objectives listed below in plain text plus additional specific objectives listed as italicized items*

B) Cardiac anesthesia

- 4.3 Demonstrate knowledge with respect to the following:
 - 4.3.1 Basic Science
 - 4.3.1.1 Coronary anatomy and physiology
 - 4.3.1.1.1 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
 - 4.3.1.1.2 Describe the normal structure of coronary arteries and the determinants of arteriolar tone
 - 4.3.1.1.3 Describe the determinants of coronary artery blood flow, myocardial oxygen supply and myocardial oxygen demand, including differences between the right and left ventricles
 - 4.3.1.1.4 Describe the pathogenesis of myocardial ischemia, including the pathology of atherosclerotic heart disease, dynamic stenosis, collateral circulation and coronary steal
 - 4.3.1.1.5 Describe the pathogenesis of perioperative ischemia and infarction, including similarities and differences from Myocardial Infarction (MI) in the ambulatory (non-surgical) setting
 - 4.3.1.2 Cardiac physiology
 - 4.3.1.2.1 Describe the phases of the cardiac cycle and relate these to the electrocardiogram
 - 4.3.1.2.2 Discuss the determinants of cardiac output (heart rate and stroke volume), including those variables which influence stroke volume (preload, afterload, contractility)
 - 4.3.1.2.3 Describe commonly used indices of systolic function, such as dP/dt, Ejection Fraction (EF), and End Systolic Pressure Volume Relationship (ESPVR); pressure volume loops
 - 4.3.1.2.4 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
- 4.3.1.2.5 Describe the differences between the function of the left and right ventricle, and the interaction between the two
- 4.3.1.2.6 Describe the normal anatomy, structure and function of the four heart valves
- 4.3.1.2.7 Describe the pericardium anatomy and understand the physiologic consequences of diseases of the pericardium
- 4.3.1.3 Electrophysiology
 - 4.3.1.3.1 Describe the normal anatomy of the cardiac conduction system
 - 4.3.1.3.2 Describe the phases of cellular action potentials, including the major associated ion currents
 - 4.3.1.3.3 Describe the automaticity of the cardiac conduction system, understanding the differences between the SA node, AV node, Bundle of His and Purkinje fibres
 - 4.3.1.3.4 Describe excitation-contraction coupling, and how electrical activation of the myocyte leads to contraction and relaxation
- 4.3.1.4 Neurohumoral regulation of the heart
 - 4.3.1.4.1 Describe the sympathetic and parasympathetic innervation of the heart
 - 4.3.1.4.2 Describe the interaction of the sympathetic nervous system (SNS) and parasympathetic nervous system (PSNS) with cardiac variables, including heart rate, contractility, relaxation as well and venous and arteriolar tone
 - 4.3.1.4.3 Describe the major receptor mechanisms involved with the autonomic innervation of the heart, including Acetyl Choline, α and β receptors, as well as their stimulants and actions
 - 4.3.1.4.4 Describe the major hormonal systems which regulate cardiac function, including the rennin-angiotensin system, natriuretic peptides, vasopressin and catecholamines
 - 4.3.1.4.5 Describe major cardiac reflex systems, such as the:
 - 4.3.1.4.5.1 Baroreceptor reflex
 - 4.3.1.4.5.2 Chemoreceptor reflex
 - 4.3.1.4.5.3 Bezold-Jarisch reflex
 - 4.3.1.4.5.4 Vagal manoeuvres
 - 4.3.1.4.5.5 Cushing's reflex

- 4.3.1.5 Vascular anatomy and physiology
 - 4.3.1.5.1 Describe the anatomy of the pulmonary vasculature
 - 4.3.1.5.2 Describe the regulation of pulmonary artery tone, including autonomic and humoral mechanisms
 - 4.3.1.5.3 Describe the impact of pulmonary vascular resistance on the function of the right ventricle
 - 4.3.1.5.4 Describe the anatomy of the aorta, including major branches
 - 4.3.1.5.5 Describe the vascular supply of the major organs and the four limbs
 - 4.3.1.5.6 Describe the autonomic and humoral control of vascular smooth muscle, and how these systems regulate arterial and venous tone

- 4.3.1.6 Embryology (see also pediatric anesthesia section)
 - 4.3.1.6.1 Demonstrate a basic understanding of cardiac embryology
 - 4.3.1.6.2 Demonstrate awareness of how this relates to major congenital cardiac diseases, such as:
 - 4.3.1.6.2.1 Patent ductus arteriosus
 - 4.3.1.6.2.2 Coarctation of the aorta
 - 4.3.1.6.2.3 Major abnormalities of the great vessels, such as transposition
 - 4.3.1.6.2.4 Major valvular abnormalities, such as Ebstein’s anomaly, pulmonary atresia, and Tetralogy of Fallot
 - 4.3.1.6.2.5 Hypoplastic heart syndromes
 - 4.3.1.6.2.6 Atrial Septal Defect (ASD)
 - 4.3.1.6.2.7 Ventricular Septal Defect (VSD)
 - 4.3.1.6.3 Describe normal fetal circulation and understand the differences between adult and fetal circulation
 - 4.3.1.6.4 Describe the normal transition from fetal to adult circulation, especially as it relates to the immediate post-natal period

- 4.3.1.7 Demonstrate an ability to apply the aforementioned principles in management with respect to the immediate assessment and management, and pharmacology and perioperative monitoring

- 4.3.2 Clinical assessment
 - 4.3.2.1 Demonstrate the ability to:
 - 4.3.2.1.1 Take a focused cardiac history

- 4.3.2.1.2 Complete a focused physical examination of the cardiovascular system
 - 4.3.2.1.3 Interpret relevant laboratory data
 - 4.3.2.1.4 Interpret the summary reports of advanced cardiac investigations such as:
 - 4.3.2.1.4.1 Vascular studies such as the ankle-brachial index and carotid Doppler studies
 - 4.3.2.1.4.2 Holter monitors Myocardial
 - 4.3.2.1.4.3 stress tests Myocardial
 - 4.3.2.1.4.4 perfusion studies
 - 4.3.2.1.4.5 Left – and – right-sided cardiac catheterization studies
 - 4.3.2.1.4.6 Static echocardiography reports
 - 4.3.2.1.5 Relate the above to relevant perioperative assessment
 - 4.3.2.1.6 Compile the above to arrive at relevant anesthetic considerations and risks
- 4.3.3 Pathophysiology
- 4.3.3.1 Demonstrate an 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:
 - 4.3.3.1.1 Medically optimized pre-existing cardiac disease
 - 4.3.3.1.1.1 Anti-anginals
 - 4.3.3.1.1.2 Anti-hypertensives
 - 4.3.3.1.1.3 Anti-dysrhythmics
 - 4.3.3.1.1.4 Diuretics
 - 4.3.3.1.2 Thoracic Aortic Disease (atheroma, aneurysms, dissections)
 - 4.3.3.1.3 Coronary Artery Disease - See Critical Care (Sections 6.10, 6.11)
 - 4.3.3.1.3.1 Acute myocardial ischemia
 - 4.3.3.1.3.2 Myocardial infarction
 - 4.3.3.1.3.3 Complications of myocardial infarction such as dysrhythmia, VSD, Congestive Heart Failure (CHF), Mitral Regurgitation (MR), Left Ventricular aneurysm, pseudoaneurysm
 - 4.3.3.1.3.4 Management in the face of recent thrombolytic and anti-

- platelet therapy
- 4.3.3.1.3.5 The implications of recent Percutaneous Coronary Intervention (PCI) and coronary stent placement
- 4.3.3.1.4 Valvular heart disease
 - 4.3.3.1.4.1 Aortic Stenosis (AS)
 - 4.3.3.1.4.2 Aortic Regurgitation (AR)
 - 4.3.3.1.4.3 Mitral Stenosis (MS)
 - 4.3.3.1.4.4 Mitral Regurgitation (MR)
 - 4.3.3.1.4.5 Pulmonary Stenosis (PS)
 - 4.3.3.1.4.6 Tricuspid Regurgitation (TR)
- 4.3.3.1.5 Cardiac tamponade
- 4.3.3.1.6 Constrictive pericarditis
- 4.3.3.1.7 Cardiomyopathies
 - 4.3.3.1.7.1 Dilated
 - 4.3.3.1.7.2 Restrictive
 - 4.3.3.1.7.3 Obstructive (Hypertrophic Obstructive Cardiomyopathy (HOCM) with or without Systolic Anterior Motion (SAM), Dynamic left ventricular obstruction in the elderly)
- 4.3.3.1.8 Cardiogenic shock
 - 4.3.3.1.8.1 Right sided congestive heart failure (CHF), pulmonary hypertension
 - 4.3.3.1.8.2 Left sided CHF from diastolic and/or systolic dysfunction
- 4.3.3.1.9 Aberrant conduction including: Wolf Parkinson White (WPW), dysrhythmia, ablation procedures (procedures in the Electrophysiology (EP) lab
- 4.3.3.1.10 Pacemaker and Automatic Implantable Cardioverter Defibrillator (AICD) insertion
- 4.3.3.1.11 *Valve replacement or repair surgery*
- 4.3.3.1.12 *Mitral valve assessment for repair*
- 4.3.3.1.13 *Cardiac tumors*
- 4.3.3.1.14 *Urgent and non-urgent cardiac re-operation*
- 4.3.3.1.15 *Cardiac transplant*
- 4.3.3.1.16 Heparin induced thrombocytopenia

- 4.3.3.1.17 Heparin resistance
 - 4.3.3.1.18 Sudden acute and sub-acute ventricular and supra-ventricular arrhythmia
 - 4.3.3.1.19 *Adult Congenital Heart Disease*
 - 4.3.3.1.20 *Acute Pulmonary emboli and chronic thrombo-embolic pulmonary hypertension*
 - 4.3.3.1.21 *Endocarditis*
- 4.3.4 Perioperative management of Cardiac Surgery
- 4.3.4.1 Demonstrate knowledge of special issues related to Cardiac Surgery and Anesthesiology
 - 4.3.4.2 Demonstrate knowledge of the indications for elective and emergent coronary artery bypass graft (CABG) surgery
 - 4.3.4.3 Demonstrate knowledge of the indications for intra-aortic balloon pump (IABP)
 - 4.3.4.4 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
 - 4.3.4.5 Demonstrate knowledge of antifibrinolytics and their role in blood conservation
 - 4.3.4.6 Demonstrate knowledge of Cardiopulmonary Bypass CPB and its physiologic effects and complications
 - 4.3.4.7 Methods of blood conservation in cardiac and non-cardiac surgery including cell savers
 - 4.3.4.8 Heparin-induced thrombocytopenia HIT and new/novel anticoagulants (e.g. recombinant Hirudin, Argatroban, bivalirudin)
 - 4.3.4.9 Anesthesia for procedures in the cath lab (eg: Atrial fibrillation ablation, Patent foramen ovale (PFO) closure, percutaneous valve replacement)
 - 4.3.4.10 Patient-prosthesis mismatch (PPM) after valve replacement
 - 4.3.4.11 Protamine reactions
 - 4.3.4.12 *Circulatory arrest*
 - 4.3.4.13 *Cardiovascular Intensive Care Unit (ICU) care*
 - 4.3.4.14 *Fast-track cardiac anesthesia and surgery*
 - 4.3.4.15 *Cardioplegia*
 - 4.3.4.16 *Left and right ventricular assist devices, Bi-VAD and artificial heart*
 - 4.3.4.17 *Heart and heart-lung transplantation*
 - 4.3.4.18 *Temporary pacemaker utilization post cardiac surgery*

- 4.3.4.19 *Ischemic preconditioning and volatile anesthetic preconditioning*
- 4.3.4.20 *Resource utilization and cost effectiveness techniques in cardiac anesthesia, surgery and Cardiovascular (CV) intensive care*

- 4.3.5 Pharmacology
 - 4.3.5.1 Demonstrate knowledge with respect to mechanism of action, pharmacokinetics and pharmacodynamics, indications, contraindications, side effects, complications, dose, antidote, interactions, and anesthetic implications of:
 - 4.3.5.1.1 Sympathomimetics, α - and β - adrenergic antagonists
 - 4.3.5.1.2 Phosphodiesterase inhibitors
 - 4.3.5.1.3 Calcium sensitizing agents (levosimendan)
 - 4.3.5.1.4 Peripheral vasodilators, including the nitrates;
 - 4.3.5.1.5 Calcium-channel blockers
 - 4.3.5.1.6 Diuretics
 - 4.3.5.1.7 Other anti-hypertensive agents
 - 4.3.5.1.8 Other anti-dysrhythmic drugs, including digitalis
 - 4.3.5.1.9 Prostaglandins
 - 4.3.5.1.10 Nitric Oxide
 - 4.3.5.1.11 Anti-fibrinolytic agents
 - 4.3.5.1.12 Anti-platelet agents
 - 4.3.5.1.13 Thrombolytics
 - 4.3.5.1.14 Heparin and non-heparin anticoagulants
 - 4.3.5.1.15 Protamine
 - 4.3.5.1.16 Drugs for pulmonary hypertension
 - 4.3.5.1.17 Use of epidurals and spinal cord stimulation in myocardial ischemia

 - 4.3.5.2 Demonstrate knowledge with respect to effects on the cardiovascular system for the following agents:
 - 4.3.5.2.1 IV induction agents
 - 4.3.5.2.2 Sedatives
 - 4.3.5.2.3 Opioids
 - 4.3.5.2.4 Volatile anesthetics
 - 4.3.5.2.5 Nitrous oxide
 - 4.3.5.2.6 Local anesthetics

- 4.3.5.2.7 Neuromuscular blocking agents
- 4.3.5.2.8 Anti-cholinesterases and cholinergic agonists
- 4.3.5.2.9 Anti-cholinergic agents
- 4.3.5.2.10 NSAIDs and Cox-2 inhibitors

- 4.3.5.3 Demonstrate knowledge with respect to the current indications for and recommendations regarding pharmacologic agents to minimize perioperative ischemic complications (e.g. ASA, β -blockers, statins, etc.)

- 4.3.6 Monitoring
 - 4.3.6.1 Demonstrate an ability to:
 - 4.3.6.1.1 Interpret a 12-lead ECG for ischemia, infarction and arrhythmia. Recognize the limitations of ECG monitoring, and be aware of the sensitivity/specificity of ECG as ischemia monitor
 - 4.3.6.1.2 Describe the common placements of intra-operative ECG monitoring leads. Understand the limitations of 3- and 5-lead systems as compared to 12-lead ECG for diagnosing ischemia and arrhythmia. Be familiar with alternative lead placements and their indications. Be aware of the common artifacts present on intra-operative ECG monitors
 - 4.3.6.1.3 Demonstrate principals of non-invasive and invasive BP monitoring and its pitfalls
 - 4.3.6.1.4 Discuss resonant frequency, damping, etc.
 - 4.3.6.1.5 Secure large-bore peripheral intravenous, arterial (radial, brachial and femoral) and central venous (internal jugular, subclavian and femoral) access
 - 4.3.6.1.6 Set up and insert a Pulmonary Artery (PA) catheter. Be able to assess right-sided catheterization variables, including central venous pressure (CVP), pulmonary artery pressure (PAP), pulmonary capillary wedge pressure (PCWP) and cardiac output (CO). Be able to interpret mixed-venous blood gases, and determine whole-body oxygen delivery and consumption. Understand the indications, limitations and complications of pulmonary artery (PA) catheters in critical care settings
 - 4.3.6.1.7 Discuss non-invasive methods of estimating CO and limitations
 - 4.3.6.1.8 Demonstrate an understanding of the laboratory monitoring of the acid-base, oxygen carrying, coagulation and inflammatory components of the hematologic system
 - 4.3.6.1.9 Demonstrate an understanding of Thromboelastogram monitoring

- 4.3.6.1.10 Transesophageal Echocardiogram (TEE)
 - 4.3.6.1.10.1 Describe the indications and contraindications of perioperative TEE in the cardiac and non-cardiac surgical settings
 - 4.3.6.1.10.2 Demonstrate an understanding of the sensitivity and specificity of TEE in the early detection of myocardial dysfunction, volume assessment, venous air embolism, valvular dysfunction and anatomical abnormalities
 - 4.3.6.1.10.3 *Achieve National Board of Echocardiography Certification in the performance and interpretation of perioperative transesophageal echocardiography*

C) Vascular Anesthesia

- 4.4 Demonstrate an understanding of the anatomy and physiology relevant to the management of patients presenting for vascular surgery, including but not limited to:
 - 4.4.1 Anatomy, Physiology and Pathophysiology
 - 4.4.1.1 Demonstrate knowledge of the basic sciences as applicable to Anesthesiology, including vascular anatomy, and pertinent physiology
 - 4.4.1.2 The anatomy and physiology of spinal blood supply
 - 4.4.1.3 Describe the physiologic consequences of aortic cross clamping
 - 4.4.1.3.1 Thoracic
 - 4.4.1.3.2 Abdominal supraceliac
 - 4.4.1.3.3 Abdominal infrarenal
 - 4.4.1.4 The pathology of atherosclerotic disease
 - 4.4.1.5 The major diseases of the aorta:
 - 4.4.1.5.1 Aortic aneurysm
 - 4.4.1.5.2 Aortic dissection
 - 4.4.1.5.3 Aortic occlusive disease
 - 4.4.1.5.4 Embolic disease and ischemic limb
 - 4.4.1.5.5 Connective tissue disease
 - 4.4.1.5.6 Aortitis
 - 4.4.1.5.7 Aortic injury after blunt trauma
 - 4.4.1.6 The anesthesiologist must demonstrate an ability to apply the aforementioned knowledge in management with respect to patient assessment and management, pharmacology and perioperative

monitoring

4.4.2 Clinical Assessment

4.4.2.1 Demonstrate an understanding of:

- 4.4.2.1.1 A comprehensive preoperative assessment
- 4.4.2.1.2 The presence of coexisting diseases particularly related to Coronary Artery Disease (as per cardiac considerations) the implications of vascular disease on end organs e.g. kidneys, CNS
- 4.4.2.1.3 The clinical skills necessary to general internal medicine and intensive care including the ability to investigate, diagnose, and manage appropriately factors that influence a patient's medical and surgical care
- 4.4.2.1.4 Recognize that prior to provision of anesthetic care specific medical intervention and modification of risk factors may be required

4.4.3 Clinical Management of Vascular Surgery

4.4.3.1 Demonstrate an understanding of the following considerations: The

- 4.4.3.1.1 differences of clamping at various levels of the aorta
- 4.4.3.1.2 Management of patients and the hemodynamic effects of aortic cross clamping
- 4.4.3.1.3 Intra-operative support
- 4.4.3.1.4 Manage the following cases on the descending aorta:
 - 4.4.3.1.4.1 Thoracic aneurysm repair
 - 4.4.3.1.4.2 Abdominal aneurysm repair
 - 4.4.3.1.4.3 Aortic dissection
 - 4.4.3.1.4.4 Renal protection and supra-celiac clamps
 - 4.4.3.1.4.5 Spinal cord protection during thoracic aortic surgery
 - 4.4.3.1.4.6 Repair of the ruptured aneurysm
- 4.4.3.1.5 Peripheral vascular surgery
- 4.4.3.1.6 Carotid endarterectomy
- 4.4.3.1.7 Amputation
- 4.4.3.1.8 Post-operative management of adult patients for aortic, peripheral vascular and carotid procedures

- 4.4.3.1.9 Demonstrate competence in all technical procedures commonly employed in vascular anesthetic procedures, including
 - 4.4.3.1.9.1 Airway management
 - 4.4.3.1.9.2 Cardiovascular resuscitation
 - 4.4.3.1.9.3 Patient monitoring and life support
 - 4.4.3.1.9.4 General, and regional anesthetic techniques
 - 4.4.3.1.9.5 Analgesic techniques
 - 4.4.3.1.9.6 Postoperative care

- 4.4.3.1.10 Manage massive transfusions and its inherent complications
- 4.4.3.1.11 Demonstrate knowledge in the use of spinal drainage for thoracic aneurysm repair
 - 4.4.3.1.11.1 Indications
 - 4.4.3.1.11.2 Contraindications
 - 4.4.3.1.11.3 Methodology
 - 4.4.3.1.11.4 Monitoring
 - 4.4.3.1.11.5 Complications

- 4.4.3.1.12 *Manage diseases of the ascending aorta and aortic arch*

- 4.4.4 Pharmacology - See Cardiac Anesthesia (Section 4.1.5)
- 4.4.5 Monitoring
 - 4.4.5.1 Demonstrate an understanding of monitoring standards for vascular surgery, including but not limited to:
 - 4.4.5.1.1 Monitoring brain function during Carotid Endarterectomy
 - 4.4.5.1.2 Monitoring spinal cord during thoracic aortic surgery
 - 4.4.5.1.3 Activated Clotting Time (ACT)
 - 4.4.5.1.4 Invasive monitoring
 - 4.4.5.1.5 Special issues related to vascular anesthesia

- 4.4.6 Pain Management
 - 4.4.6.1 Demonstrate knowledge of the principles of management of patients with postoperative pain following abdominal and peripheral vascular procedures, including but not limited to:
 - 4.4.6.1.1 Epidural analgesia
 - 4.4.6.1.2 Risks of neuraxial anesthesia with antiplatelet agents,

intraoperative heparinization and other alterations in coagulation status

- 4.4.6.1.3 Patients with chronic pain due to chronic vascular insufficiency
- 4.4.6.1.4 Phantom limb pain- advantages and disadvantages of regional versus general anesthesia for Carotid endarterectomy (CEA)

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
 - 5.1.3 Prevent potential complications
 - 5.1.4 Manage potential 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) Complications of Anesthesia in General

- 5.2 Awareness under anesthesia
- 5.3 Allergy and anaphylaxis
- 5.4 Extravasation of drugs and fluids
- 5.5 Drug interactions
- 5.6 Bacteremia
- 5.7 Hyper-/hypotension
- 5.8 Tachy-/bradycardia
- 5.9 Hyper-/hypocarbica
- 5.10 Hypoxemia
- 5.11 Hyper-/hypothermia
- 5.12 Raised airway pressure
- 5.13 Cardiac arrest and ACLS protocols
- 5.14 Intraoperative fires/burns

B) Complications of Regional Anesthesia - See Regional Anesthesia (Section 27.5)

C) Complications of Medication Administration

- 5.15 Demonstrate an understanding of the complications related to administration of anesthetics and other drugs:
- 5.15.1 Inhalation Anesthetics - See Volatile Agents (Section 34.6)
 - 5.15.2 Intravenous Induction Agents and Sedatives - See Pharmacology (Section

- 23.6)
- 5.15.3 Narcotics/Opioids - See Pharmacology (Section 23.7)
- 5.15.4 Antiemetics and Anticholinergics - See Pharmacology (Section 23.8)
- 5.15.5 Neuromuscular Blocking Agents - See Neuromuscular Junction (Section 17.2)
- 5.15.6 Reversal Agents (CNS and Neuromuscular) - See Neuromuscular junction (Section 17.4)
- 5.15.7 Local Anesthetic Agents - See Regional Anesthesia (Section 27.5)
- 5.15.8 Non-anesthetic drugs commonly used in the OR
 - 5.15.8.1 Vasoactive drugs
 - 5.15.8.2 Electrolyte solutions
 - 5.15.8.3 Bronchodilators
 - 5.15.8.4 Anticonvulsants
 - 5.15.8.5 Corticosteroids
 - 5.15.8.6 Antibiotics
 - 5.15.8.7 Antifibrinolytics
 - 5.15.8.8 Anticoagulants and their reversal agents

D) Allergy - See Immunology (Section 13.4)

E) Fluid Management

- 5.16 Demonstrate an understanding of the complications related to fluid and blood product administration including:
 - 5.16.1 Fluid [See Critical Care (Section 6.4)]
 - 5.16.2 Blood products [See Hematology (Section 11.6)]

F) Airway [See Airway (Sections 1.2.2., 1.3.2., 1.8.4)]

G) Monitoring - See Monitoring and Equipment (Section 15.13)

- 5.17 Failure to secure access
- 5.18 Arterial/venous trauma including tears, fistula formation
- 5.19 Arterial occlusion
- 5.20 Pneumo-/hemothorax

H) Patient Positioning

- 5.21 Complications relating to changing positions

- 5.22 Pressure: nerves and eyes, vascular structures, skin
- 5.23 Stretching: nerves, particularly brachial plexus
- 5.24 Management of emergencies in prone position
- 5.25 Venous air embolism
- 5.26 Inadequate organ perfusion

I) Type of surgery

- 5.27 Laparoscopic
- 5.28 Thoracic
- 5.29 Neuro
- 5.30 Vascular (e.g. spinal cord ischemia with Abdominal Aortic Aneurysm (AAA))
- 5.31 Orthopedics (e.g. fat embolism, hypotension from reaction to cement with arthroplasty)

J) Ventilation - See Critical Care (Section 6.3)

- 5.32 Conventional
- 5.33 Non-conventional
- 5.34 Non-invasive

K) Occupational Hazards for Anesthesiologists and other OR personnel

- 5.35 Demonstrate an understanding of the potential risks to themselves and others when dealing with high risk patients and situations in the operating room, including but not limited to:
 - 5.35.1 Needle stick
 - 5.35.2 Infections – needle, airborne, contact
 - 5.35.3 Inhalation of agents
 - 5.35.4 Violent patient – Assault – physical, verbal
 - 5.35.5 Lifting patients – back and other injuries
 - 5.35.6 Post Traumatic Stress Disorder (PTSD) after adverse events
 - 5.35.7 Fatigue
 - 5.35.8 Substance abuse

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) Monitoring - See Monitoring (Section 15.13)

B) Airway management - See Airway (Section 1)

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

C) Mechanical ventilation

- 6.2 Demonstrate an understanding of the various models of mechanical ventilation used in critical care, their 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 Controlled mechanical ventilation (CMV)
 - 6.2.3.2 Synchronized intermittent mandatory ventilation (SIMV)
 - 6.2.3.3 Pressure support ventilation
 - 6.2.3.4 Pressure control ventilation
 - 6.2.3.5 Non-invasive positive pressure ventilation
 - 6.2.3.6 High frequency oscillation
 - 6.2.4 Ventilator induced lung injury and it's prevention and Adult Respiratory Distress Syndrome (ARDS) net protocol
 - 6.2.5 Managing patient-ventilator dyssynchrony
 - 6.2.6 Weaning from mechanical ventilation
 - 6.2.7 Monitoring ventilatory therapy
 - 6.2.7.1 Arterial and venous blood gases
 - 6.2.7.2 Pulse oximetry
 - 6.2.7.3 Ventilator graphics

- 6.2.8 Sedation and paralysis for mechanical ventilation
 - 6.2.8.1 Pharmacology of common sedative and analgesic agents
 - 6.2.8.2 Indications for neuromuscular blockade and pharmacology of neuromuscular blocking agents
 - 6.2.8.3 Complications of prolonged mechanical ventilation and neuromuscular blockade + Myopathy of critical illness

D) Management of fluid, electrolyte and acid-base disorders

- 6.3 Demonstrate an understanding of fluid and electrolyte disturbances encountered in critical care management 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
 - 6.3.3 Management of electrolyte abnormalities
 - 6.3.3.1 Hyponatremia
 - 6.3.3.2 Hypernatremia
 - 6.3.3.3 Hypokalemia
 - 6.3.3.4 Hyperkalemia
 - 6.3.3.5 Hypocalcemia
 - 6.3.3.6 Hypomagnesemia
 - 6.3.3.7 Hypo and hyperphosphatemia
 - 6.3.4 Classification of metabolic acidosis

E) Nutrition

- 6.4 Demonstrate an understanding, but not in depth knowledge, 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

F) Transfusion therapy - See Hematology (Section 11)

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

G) Hemodynamic management of shock

- 6.6 Demonstrate an understanding of the various forms of shock and the management thereof:
 - 6.6.1 Pathophysiology of shock
 - 6.6.2 Hypovolemic shock
 - 6.6.3 Septic shock
 - 6.6.4 Cardiogenic shock
 - 6.6.5 Obstructive shock
 - 6.6.5.1 Pulmonary embolism
 - 6.6.5.2 Pericardial tamponade
 - 6.6.5.3 Tension pneumothrax
 - 6.6.5.4 Air embolism
 - 6.6.5.5 Amniotic fluid embolism
 - 6.6.6 Distributive shock
 - 6.6.6.1 Spinal shock
 - 6.6.6.2 Anaphylactic shock
 - 6.6.6.3 Systemic inflammatory response system (SIRS)
 - 6.6.7 Fluid therapy
 - 6.6.8 Pharmacology of and critical indications for vasopressors and inotropic therapy

H) 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 Pharmacology of antihypertensive agents
 - 6.7.2 Diagnosis and management of hypertensive crisis

I) Respiratory Failure

- 6.8 Demonstrate an approach to the management of critically ill patients in respiratory failure, including but not limited to:
 - 6.8.1 Differential diagnosis of respiratory failure
 - 6.8.2 Acute Respiratory Distress Syndrome (ARDS)
 - 6.8.3 Hospital acquired pneumonia
 - 6.8.4 Chronic obstructive pulmonary disease
 - 6.8.5 Ventilator associated pneumonia
 - 6.8.6 Severe community acquired pneumonia
 - 6.8.7 Management of acute asthma
 - 6.8.8 Pulmonary hypertension
 - 6.8.9 Thoracentesis
 - 6.8.10 Chest tube insertion and management

J) Acute Coronary Syndromes (ACS)

- 6.9 Demonstrate an understanding of the diagnosis and management of acute coronary syndromes, including but not limited to:
 - 6.9.1 Pharmacologic management of ACS
 - 6.9.2 Percutaneous coronary angioplasty and stenting
 - 6.9.3 Coronary artery bypass grafting
 - 6.9.4 Management of cardiac failure
 - 6.9.4.1 Pharmacology
 - 6.9.4.2 Supportive care
 - 6.9.4.3 Intra-aortic balloon pump
 - 6.9.5 Complications of myocardial infarction
 - 6.9.5.1 Acute mitral regurgitation
 - 6.9.5.2 Ventricular septal defect
 - 6.9.5.3 Ventricular free wall rupture
 - 6.9.5.4 Ventricular aneurysm

K) Management of arrhythmias and cardiac arrest

- 6.10 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:
 - 6.10.1 ACLS guidelines for the management of:
 - 6.10.1.1 Ventricular tachycardia (VT), (including polymorphic VT), and ventricular fibrillation
 - 6.10.1.2 Asystole
 - 6.10.1.3 Atrial flutter and fibrillation
 - 6.10.1.4 Other supraventricular tachycardias
 - 6.10.1.5 Symptomatic bradycardia
 - 6.10.1.6 AV block
 - 6.10.1.7 Wolff – Parkinson – White syndrome
 - 6.10.2 Principles of safe cardioversion and defibrillation
 - 6.10.3 Transthoracic and transvenous pacing
 - 6.10.4 Management of the pacemaker dependent patient, patient with an automatic implantable cardiac defibrillator (AICD)
 - 6.10.5 Management of a patient with an AICD
 - 6.10.6 Pharmacology of antiarrhythmic therapy

L) Infectious diseases - See Infectious Disease (Sections 14.2, 14.6)

- 6.11 Demonstrate an approach to the diagnosis and management of infectious diseases in the critically ill patient

M) Neurocritical care

- 6.12 Demonstrate knowledge of issues encountered with neurocritical care unit patients, including but not limited to:
 - 6.12.1 Management of severe head trauma and raised intracranial pressure (ICP)
 - 6.12.2 Management of cerebrovascular accident due to ischemic stroke
 - 6.12.3 Intracranial hemorrhage
 - 6.12.4 Subarachnoid hemorrhage
 - 6.12.5 Status epilepticus
 - 6.12.6 Differential diagnosis and management of decreased level of consciousness and coma
 - 6.12.7 Management of agitation and delirium

- 6.12.8 Guillain – Barre syndrome
- 6.12.9 Spinal shock

N) Pulmonary embolism and thromboembolic disease

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

O) Acute and Chronic Renal Failure - See Renal/ Urologic (Section 29.3)

- 6.16 Demonstrate knowledge of the management of the critically ill patient with renal failure, including but not limited to:
 - 6.16.1 Management of the critically ill patient with chronic renal failure
 - 6.16.2 Differential diagnosis and management of acute renal failure
 - 6.16.3 Management of rhabdomyolysis
 - 6.16.4 Management of hyperkalemia
 - 6.16.5 Hepatorenal syndrome
 - 6.16.6 Principles of hemodialysis and continuous renal replacement therapy: acute vs. chronic
 - 6.16.7 Hemodialysis, use in poisoning

P) Management of Acute and Chronic Hepatic Failure - See Hepatobiliary (Section 12.3)

- 6.17 Demonstrate knowledge of the management of the critically ill patient with hepatic failure, including but not limited to:
 - 6.17.1 Differential diagnosis and management of acute and fulminant hepatic failure
 - 6.17.2 Indications for urgent liver transplantation
 - 6.17.3 Management of complications of hepatic failure
 - 6.17.3.1 Cerebral edema
 - 6.17.3.2 Hepatic encephalopathy
 - 6.17.3.3 Coagulopathy
 - 6.17.3.4 Ascites
 - 6.17.3.5 Spontaneous bacterial peritonitis

Q) Gastrointestinal Emergencies

- 6.18 Demonstrate knowledge of the management of the critically ill patient presenting with gastrointestinal emergencies, including but not limited to:
 - 6.18.1 Differential diagnosis and management of upper and lower gastrointestinal bleeding
 - 6.18.2 Differential diagnosis and management of peritonitis
 - 6.18.3 Prevention and management of aspiration
 - 6.18.4 Disorders of bowel mobility
 - 6.18.5 Prevention of stress ulceration
 - 6.18.6 Management of acute pancreatitis
 - 6.18.7 Intestinal ischemia
 - 6.18.8 Acute megacolon
 - 6.18.9 Abdominal compartment syndrome

R) Endocrine Emergencies

- 6.19 Demonstrate knowledge of the management of the critically ill patient presenting with endocrine emergencies, including but not limited to:
 - 6.19.1 Diabetic knowledge Hyperosmolar
 - 6.19.2 nonketotic coma Hyperthyroidism and
 - 6.19.3 Thyroid storm Hypothyroidism and
 - 6.19.4 myxedema coma Hypercalcemia
 - 6.19.5 Adrenal insufficiency
 - 6.19.6 Diabetes insipidus
 - 6.19.7 Syndrome of inappropriate antidiuretic hormone (ADH)
 - 6.19.8

S) Management of Poisoning and Drug-Related Complications

- 6.20 Demonstrate knowledge of the management of patients after poisonings, drug overdoses and exposure to agents used in bioterrorism, including but not limited to:
 - 6.20.1 Evaluation and supportive care of the patient with suspected poisoning
 - 6.20.2 Salicylates
 - 6.20.3 Methanol/ethylene glycol/isopropyl alcohol
 - 6.20.4 Sedative agents
 - 6.20.4.1 Barbiturates

- 6.20.4.2 Benzodiazepines

- 6.20.5 Antipsychotic agents
 - 6.20.5.1 Phenothiazines
 - 6.20.5.2 Lithium

- 6.20.6 Antidepressants
 - 6.20.6.1 Monoamine oxidase inhibitors
 - 6.20.6.2 Tricyclic antidepressants

- 6.20.7 Acetaminophen
- 6.20.8 Narcotics
- 6.20.9 Beta blockers
- 6.20.10 Calcium channel blockers
- 6.20.11 Digitalis
- 6.20.12 Carbon monoxide
- 6.20.13 Organophosphate poisoning
- 6.20.14 Cyanide

T) Drug Related Syndromes

- 6.21 Diagnose and manage idiosyncratic drug reactions, including but not limited to:
 - 6.21.1 Serotonin syndrome
 - 6.21.2 Malignant hyperthermia (MH)
 - 6.21.3 Neuroleptic malignant syndrome

U) Critical care of the trauma patient

- 6.22 Demonstrate in depth knowledge of the management of the trauma patient, including but not limited to:
 - 6.22.1 Principles of Advanced Trauma Life Support (ATLS)
 - 6.22.1.1 Primary survey
 - 6.22.1.2 Secondary survey
 - 6.22.1.3 Tertiary survey

 - 6.22.2 Supportive care
 - 6.22.2.1 Management of hypovolemia

- 6.22.2.2 Management of hypothermia
- 6.22.2.3 Management of coagulopathy
- 6.22.2.4 Management of abdominal compartment syndrome

- 6.22.3 Evaluation and management of:
 - 6.22.3.1 Blunt trauma
 - 6.22.3.2 Penetrating trauma
 - 6.22.3.3 Crush injury
 - 6.22.3.4 Thoracic trauma
 - 6.22.3.5 Abdominal trauma

- 6.22.4 Evaluation and management of neurologic trauma
 - 6.22.4.1 Head injury and raised intracranial pressure
 - 6.22.4.2 Spinal cord injury and spinal shock
 - 6.22.4.3 Determination of brain death
 - 6.22.4.4 Management of the brain dead organ donor

- 6.22.5 Burns
- 6.22.6 Airway management of the trauma patient

V) Obstetrical Critical Care - See Obstetrics 18.10

- 6.23 Demonstrate knowledge of obstetrical conditions requiring critical care management, including but not limited to:
 - 6.23.1 Pre-eclampsia/eclampsia
 - 6.23.2 HELLP syndrome
 - 6.23.3 Respiratory critical care of the pregnant patient
 - 6.23.3.1 Pneumonia
 - 6.23.3.2 ARDS
 - 6.23.3.3 Asthma
 - 6.23.3.4 Respiratory failure
 - 6.23.4 Postpartum hemorrhage
 - 6.23.4.1 Amniotic fluid embolism
 - 6.23.4.2 Abruptio placenta
 - 6.23.4.3 Disseminated intravascular coagulation

- 6.23.4.4 Uterine rupture
- 6.23.5 Management of cardiac arrest in pregnancy
- 6.23.6 Thromboembolic disease in pregnancy
- 6.23.7 Postpartum care of the parturient with cardiovascular disease
 - 6.23.7.1 Acute coronary syndrome
 - 6.23.7.2 Valvular heart disease
 - 6.23.7.3 Postpartum cardiomyopathy

W) Postoperative Care

- 6.24 Demonstrate knowledge of the management of patients requiring critical care admission after major surgical procedures, including but not limited to:
 - 6.24.1 Cardiac surgery
 - 6.24.2 Thoracic surgery
 - 6.24.3 Vascular surgery
 - 6.24.3.1 Abdominal aortic aneurysm
 - 6.24.3.2 Revascularization of the lower limb
 - 6.24.3.3 Carotid endarterectomy
 - 6.24.4 Solid organ transplant
 - 6.24.5 Major abdominal surgery
 - 6.24.5.1 Hepatic resection
 - 6.24.5.2 Pancreatectomy
 - 6.24.5.3 Esophagectomy
 - 6.24.5.4 Bowel resection
 - 6.24.6 Fluid and electrolyte management after major surgery

X) Ethical principles of Critical Care management

- 6.25 Demonstrate knowledge of ethical concerns related to management of critically ill patients, including but not limited to:
 - 6.25.1 Patient confidentiality and privacy legislation
 - 6.25.2 Patient autonomy
 - 6.25.3 Principles of informed consent and decision making
 - 6.25.4 Next of kin designation

- 6.25.5 End of life decision making
- 6.25.6 Organ procurement for transplantation
- 6.25.7 Management and review of adverse events
- 6.25.8 Communication with families in crisis
- 6.25.9 Cultural aspects of Critical Care

Y) Principles of crisis management and team leadership

- 6.26 Demonstrate knowledge of crisis resource management and team leadership in critical situations, including but not limited to:
 - 6.26.1 Leadership
 - 6.26.2 Resource assessment and allocation
 - 6.26.3 Situational awareness
 - 6.26.4 Communication and collaboration during a crisis

7 Ear, Nose and Throat Surgery

See also Airway (Section 1)

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 Airway 1.1
 - 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
 - 7.1.3.6 Use of nitrous oxide and muscle relaxants
 - 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
 - 7.1.4.1.6 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

- 7.1.4.3 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

- 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

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
 - 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

- 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

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 Safety considerations
 - 7.4.2.1 Protection of patient and personnel
 - 7.4.2.1.1 Eye protection
 - 7.4.2.1.2 Skin protection

- 7.4.2.2 Airway fires
 - 7.4.2.2.1 Prevention strategies
 - 7.4.2.2.1.1 Surgeon techniques
 - 7.4.2.2.1.2 Gas mix
 - 7.4.2.2.1.3 ETT modifications
- 7.4.2.3 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 Procedural considerations
 - 7.5.2.1 Induction and maintenance technique
 - 7.5.2.2 ETT, NTT, LMA
 - 7.5.2.3 Deep extubation vs. awake extubation
 - 7.5.2.4 Airway toilet
 - 7.5.2.5 Re-operation for bleeding after adenotonsillectomy
 - 7.5.2.5.1 Chronology of bleeding
 - 7.5.2.5.2 Coagulopathy
 - 7.5.2.5.3 Full stomach
 - 7.5.2.5.4 Airway difficulty
 - 7.5.2.5.5 Hemodynamic stability, blood loss
 - 7.5.2.6 Role of NSAIDs
 - 7.5.2.7 Postoperative nausea and vomiting and the use of antiemetic agents

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 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 tracheostomy

7.7.1.2.1 For pulmonary toilet

7.7.1.2.1.1 Prolonged orotracheal intubation

7.7.1.2.2 During major head and neck cancer surgery

7.7.1.2.3 Chronic ventilatory failure

7.7.2 Anesthetic options for emergency tracheostomy

7.7.2.1 Awake tracheostomy under local anesthetic

7.7.2.2 General anesthetic

7.7.2.2.1 Awake fiberoptic intubation

7.7.2.3 Management of loss of tracheostomy with fresh stoma

7.7.3 Trans-tracheal intubation

7.7.3.1 Patient with pre-existing tracheal stoma

H) Surgery for Obstructive Sleep Apnea

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

7.8.1 Diagnosis of obstructive sleep apnea

7.8.1.1 Presumptive indicators in patient history and physical exam

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 Ongoing need for CPAP or BiPAP mask

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 Nitrous oxide, muscle relaxants
 - 7.9.1.4 Positioning
 - 7.9.1.5 Post-operative nausea and vomiting

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
 - 8.1.3 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

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 receiving corticosteroid therapy presenting for anesthesia and surgery

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

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

F) Anterior Pituitary Dysfunction: Panhypopituitarism and Acromegaly

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

G) Carcinoid Syndrome

- 8.11 List the clinical manifestations of carcinoid syndrome and the anesthetic considerations arising from them

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 major ethical theories, perspectives and principles
 - 9.1.1 Theories: deontological, teleological
 - 9.1.2 Perspectives: duty, virtue, principles, utilitarian/consequentialist, feminist, communitarian
 - 9.1.3 Principles
 - 9.1.4 Georgetown four: beneficence, non-maleficence, respect for persons, (autonomy,) justice
 - 9.1.5 Demonstrate knowledge that there are others: truth-telling, promise-keeping

- 9.2 Recognize that there are ethical components in decisions doctors need to make every day; ethics is not just found in the “hard choices”
- 9.3 Demands for inappropriate care/ineffective therapy
 - 9.3.1 Describe the concept of “futility”; when it may apply, its hazards
 - 9.3.2 Who decides goals of care?

- 9.4 End of Life Care
- 9.5 With-holding vs. withdrawing care (no ethical difference)
- 9.6 The concept of brain death and its diagnosis
 - 9.6.1 Organ donation
 - 9.6.2 DCD: Donation after Cardiac Death

- 9.7 Demonstrate an understanding of the ethical basis and use of the principle of informed choice
 - 9.7.1 Consent/Refusal
 - 9.7.2 Jehovah’s Witnesses

- 9.8 Describe how to assess capacity, know the regulations and principles governing Substitute Decision Makers (for relevant province)
- 9.9 Describe the effect of difference in value systems
 - 9.9.1 Religious, cultural, ethnic
 - 9.9.2 Have ways to deal with difference

9.10 Recognize and respect Diversity

- 9.10.1 Gender, religious, cultural, ethnic, sexual, age, disability (mental & physical)

9.11 Respect privacy & confidentiality and know the difference

- 9.11.1 Occasions when confidentiality is commonly at risk
- 9.11.2 Occasions when confidentiality is legitimately breached
- 9.11.3 Statutory reporting, harm to self & others

9.12 Truth Telling

- 9.12.1 Disclosure of diagnosis/Breaking bad news
- 9.12.2 Disclosure of error

9.13 The patient with a DNR order coming to the OR

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 in the Geriatric Patient

10.1 Demonstrate knowledge of the following 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 Preoperative Evaluation/Assessment of the Geriatric Patient

B) Perioperative management

10.2 Evaluate and prepare the geriatric patient for anesthesia

10.2.1 Comorbidities and the Geriatric Patient

10.2.1.1 Elicit appropriate history and perform physical examination of the elderly patient to identify existing comorbid conditions

10.2.1.2 Obtain appropriate investigations and consultation for optimizing elderly patient prior to surgery

10.2.1.3 Demonstrate knowledge of pre-existing comorbidities of body systems and the impact they have in the safe anesthesia management of the elderly patient

10.2.2 Preoperative Testing

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

C) Pharmacology and the Geriatric Patient

10.3 Pharmacodynamics

- 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 Pharmacokinetics

- 10.4.1 Describe changes in the pharmacodynamics, pharmacokinetics, 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 Volatile agents including nitrous oxide
 - 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

10.5.2 Regional Anesthesia in the Geriatric Patient - See Regional (Section 27)

10.5.2.1 Describe the alterations in anatomy, physiology, pharmacology and complications specific to the geriatric patient of 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) Perioperative Complications in the Geriatric Patient

10.6 Demonstrate an understanding of the potential complications related to anesthetizing geriatric patients and be able to discuss the:

- Contributing risk factors
- Strategies to minimize risk of complications
- Investigation and management

Of the following conditions:

- 10.6.1 Post operative cognitive dysfunction/Post operative delirium
- 10.6.2 Cardiovascular complications
- 10.6.3 Respiratory complications
- 10.6.4 Hepatic complications
- 10.6.5 Renal complications

F) Post Operative Pain Management in the Geriatric Patient

10.7 Provide effective pain management in geriatric patients

- 10.7.1 Discuss the importance of post operative pain management in this patient population
- 10.7.2 Discuss risk, benefits and complications of various routes, agents and modalities for delivery of agents for post operative pain management

G) Post Operative Recovery and the Geriatric Patient

10.8 Anticipate and manage postoperative recovery of geriatric patients.

10.8.1 Discuss age-related impediments to recovery of preoperative function and independence

10.8.2 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 (euvoletic) anemia
- 11.3 Impaired oxygen delivery
- 11.4 Clinical and laboratory indicators of shock
- 11.5 Understand the concepts of VO_2 for tissue metabolic processes, DO_2 , oxygen, extraction ratio, DO_2 crit (critical threshold of oxygen delivery)
- 11.6 Be able to calculate arterial oxygen content

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

(*In collaboration with a haematologist. In emergency situations, there may not be sufficient time for this collaboration to occur, in which case the consultant anesthesiologist will be expected to manage such patients independently)

B) Hemoglobinopathies

- 11.7 Methemoglobin, including precipitation by some pharmacologic agents (nitric oxide, nitroglycerine, nitroprusside), and pharmacology of methylene blue
- 11.8 Sulfhemoglobin
- 11.9 Carboxyhemoglobin
- 11.10 Anemias
 - 11.10.1 Acute blood loss: predict increased risk of acute blood loss, clinical signs of acute blood loss, perioperative management, strategies to minimize blood loss
 - 11.10.2 Management of the patient who refuses transfusions of blood products
 - 11.10.3 Chronic blood loss/anemia secondary to deficiency of iron, B12, folic acid
 - 11.10.4 Anemia of chronic disease, anemia of chronic renal failure, aplastic anemia, anemia associated with liver failure
 - 11.10.5 Hemolytic anemias, including but not limited to:
 - 11.10.5.1 Congenital spherocytosis
 - 11.10.5.2 G6PD deficiency
 - 11.10.5.3 Immune haemolytic anemias (e.g. Drug-induced, hypersplenism)

- 11.10.5.4 Sickle cell disease, including prevention, end organ complications and pain management
- 11.10.5.5 Mechanical etiologies (e.g. Mechanical heart valve)
- 11.10.5.6 Thalassemia

11.10.6 Polycythemia

- 11.10.6.1 Primary polycythemias
- 11.10.6.2 Secondary to hypoxemia

C) Physiology of Normal Hemostasis

- 11.11 Role of vasculature
- 11.12 Platelets (adhesion, activation, aggregation, and various factors involved with platelet function)
- 11.13 Protein coagulation factors
- 11.14 Physiologic mechanisms to limit the coagulation: Antithrombin, Tissue Factor Pathway Inhibitor, Protein C and Protein S, and the fibrinolytic system
- 11.15 Alterations seen in the normal postoperative period (and the effect on postoperative DVT), normal pregnancy, the newborn, trauma, sepsis, shock and cancer
- 11.16 Laboratory to assess the coagulation system
- 11.17 Laboratory monitoring of the various pharmacological agents
- 11.18 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)

D) Pharmacology: Anticoagulants/Antifibrinolytics

- 11.19 Pharmacodynamics (mechanism of action)
- 11.20 Pharmacokinetics (dose, clinical duration of action, etc.)
- 11.21 Clinical pharmacology (indications, side effects, complications and contraindications)
- 11.22 Describe the impact on INR, PTT, TT, fibrinogen level, fibrin degradation products.
- 11.23 Perioperative use of:
 - 11.23.1 Protamine
 - 11.23.2 Vitamin K
 - 11.23.3 Desmopressin (DDAVP)
 - 11.23.4 Recombinant activated Factor VII (rFVIIa)

- 11.24 Perioperative management of anticoagulant or antiplatelet agents, including but not limited to:
- 11.24.1 Coumadin
 - 11.24.2 Heparin (both unfractionated and low molecular weight)
 - 11.24.3 Agents used as alternatives to patients who have a history of heparin induced thrombocytopenia
 - 11.24.4 Platelet inhibitors such as cyclooxygenase inhibitors (e.g. ASA, NSAIDS)
 - 11.24.5 ADP inhibitors (e.g. Clopidogrel, ticlid)
 - 11.24.6 Glycoprotein IIB IIIA inhibitors (e.g. Abciximab)
 - 11.24.7 Phosphodiesterase inhibitors (e.g. Persantine)
 - 11.24.8 Anti-fibrinolytic agents (e.g. aminocaproic acid, tranexamic acid, aprotinin)

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

(*In collaboration with a haematologist. In emergency situations, there may not be sufficient time for this collaboration to occur, in which case the consultant anesthesiologist will be expected to manage such patients independently)

E) Disorders of Coagulation

11.25 Congenital "bleeders"

- 11.25.1 Hemophilia A*
- 11.25.2 Hemophilia B*
- 11.25.3 Von Willebrand's disease *

11.26 Congenital "clotters"

- 11.26.1 Protein C deficiency *
- 11.26.2 Protein S deficiency *
- 11.26.3 Antithrombin deficiency *
- 11.26.4 Other thrombophilias *

11.27 Acquired "bleeders"

- 11.27.1 Effects of anticoagulant drugs or antiplatelet drugs
- 11.27.2 Dilutional thrombocytopenia or dilution of procoagulants

- 11.27.3 DIC
- 11.27.4 Liver disease
- 11.27.5 Massive blood transfusion (see transfusion medicine)
- 11.27.6 Hypothermia
- 11.27.7 Thrombocytopenia due to PIH, drug-induced, ITP, etc.
- 11.27.8 Effects of extracorporeal circulation
- 11.27.9 Sepsis

11.28 Acquired “clotters”

- 11.28.1 Heparin-induced thrombocytopenia *
- 11.28.2 TTP *
- 11.28.3 Antiphospholipid Antibody Syndrome *

11.29 Hematologic Emergencies

- 11.29.1 New diagnosis of acute leukemia (blast crisis) especially acute promyelocytic leukemia
- 11.29.2 TTP
- 11.29.3 Hyperviscosity syndrome
- 11.29.4 Acute thrombosis
- 11.29.5 Acquired hemophilia

F) Blood Products

11.30 Regarding the following blood products:

- RBC
- Frozen Plasma (FP)
- Prothrombin Complex Concentration (PCC) (Octaplex)
- Platelets
- Cryoprecipitate

The competent anesthesiologist will demonstrate knowledge of the following:

- 11.30.1 Indications
- 11.30.2 Physiology
- 11.30.3 Risks
- 11.30.4 Benefits

- 11.30.5 Management of complications, including but not limited to:
 - 11.30.5.1 Febrile reactions
 - 11.30.5.2 Allergic reactions
 - 11.30.5.3 Volume overload
 - 11.30.5.4 Transfusion-related acute lung injury (TRALI)
 - 11.30.5.5 Acute and delayed haemolytic reactions
 - 11.30.5.6 Sepsis Coagulopathy
 - 11.30.5.7 Electrolyte disturbances
 - 11.30.5.8 Hypothermia
 - 11.30.5.9 Transfusion-associated graft vs. host disease (TA-GVHD)
 - 11.30.5.10 Immune-related effects
 - 11.30.5.11 Transfusion-transmitted diseases (hepatitis B and C, HIV etc.)
 - 11.30.5.12 Effect of age of stored RBC's
 - 11.30.5.13 Effect on 2-3 DPG
 - 11.30.5.14

- 11.30.6 Associated administration, including but not limited to:
 - 11.30.6.1 Informed consent
 - 11.30.6.2 Identification and verification of both the patient and the blood product
 - 11.30.6.3 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)
 - 11.30.6.4 Documentation

G) Blood banking

- 11.31 Demonstrate a working knowledge of blood bank procedures
 - 11.31.1 Clerical procedures
 - 11.31.2 Serologic procedures
 - 11.31.2.1 Uncrossmatched (emergency release) RBC's
 - 11.31.2.2 Type-specific uncrossmatched RBC's
 - 11.31.2.3 Computer assisted and serological crossmatches
 - 11.31.2.4 Type and screen
 - 11.31.2.5 Frozen plasma
 - 11.31.2.6 Platelets

- 11.31.2.7 Cryoprecipitate
- 11.31.2.8 Antibody investigation

H) Reduction of use of Homologous Blood Products:

- 11.32 Demonstrate a working knowledge of:
 - 11.32.1 Methods used to reduce blood loss
 - 11.32.1.1 Patient position
 - 11.32.1.2 Controlled hypotension (including the physiology, indications, contraindications, and technique, including the pharmacologic agent(s) used)
 - 11.32.1.3 Regional anesthesia
 - 11.32.1.4 Pharmacologic agents (e.g. antifibrinolytic agents, role of recombinant activated Factor VII (rFVIIa))
 - 11.32.2 Alternatives to blood products and their risks and benefits
 - 11.32.3 Use of crystalloids
 - 11.32.4 Use of colloids
 - 11.32.4.1 Physiologic effects of colloids in comparison to crystalloids
 - 11.32.4.2 Understand the crystalloid/colloid controversy
 - 11.32.4.3 Compare starch vs. albumen
 - 11.32.5 Management the patient (preoperative discussion, intraoperative and postoperative management) who refuses blood products for religious or other reasons
 - 11.32.6 Calculate "allowable blood loss"
 - 11.32.7 Demonstrate a working knowledge of:
 - 11.32.7.1 Preoperative autologous donation (PAD)
 - 11.32.7.2 Directed donation
 - 11.32.7.3 Haemoglobin-based oxygen carriers, and perfluorocarbon emulsions
 - 11.32.7.4 Erythropoietin therapy
 - 11.32.7.5 Acute normovolemic hemodilution
 - 11.32.7.6 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

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:
 - 12.5.2.1 Changes in hepatic blood flow
 - 12.5.2.2 Ability to biotransform (intrinsic clearance)
 - 12.5.2.3 Changes in binding of drugs; biotransformation
 - 12.5.2.4 Bile excretion
 - 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
 - 12.6.4.1 Types
 - 12.6.4.2 Transmission
 - 12.6.4.3 Course
 - 12.6.4.4 Prevention
 - 12.6.4.5 Hazards to healthcare providers
- 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 for preoperative prediction of surgical risk
 - 12.6.6.3 Complications (systemic review)
 - 12.6.6.4 Anesthetic management
- 12.6.7 Anesthetic management for acute or chronic alcoholism
- 12.6.8 Anesthetic management for a patient with a previous liver transplant

D) Anesthesia for Hepatobiliary Procedures

- 12.7 Demonstrate knowledge and understanding of anesthesia and 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 during hepatobiliary procedures. This will help the anesthesiologist optimize preoperative preparation, intra-operative anesthetic management and post-anesthetic care of these patients
- 12.8 Demonstrate knowledge of the considerations of, and to independently provide anesthetic care for patients presenting for, the following procedures:
 - 12.8.1 Cholecystectomy: open and laparoscopic
 - 12.8.2 Endoscopic biliary tract procedures
 - 12.8.3 Pancreatic resection

- 12.8.4 Biliary duct reconstruction
- 12.8.5 Whipples' procedure
- 12.8.6 Liver resections
- 12.8.7 Liver donation
- 12.8.8 T.I.P.S. procedure
- 12.8.9 *Liver transplant*

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, roles of T-lymphocytes (helper T-lymphocytes, suppressor T-lymphocytes, cytotoxic T-lymphocytes)
 - 13.1.2 Cell-mediated immunity and its role in rejection of transplanted organs
 - 13.1.3 Autoimmune diseases
 - 13.1.4 Humoral immunity, role of B-lymphocytes, plasma cells, types of antibodies, antigens, allergens and IgE antibodies
 - 13.1.5 The complement system, the two pathways of activation (classic or immunologic pathway and alternative or non-immunologic pathway), their roles in antigen-antibody activation, autoimmune diseases, and bacterial infections, and the production of C2a and C5a
 - 13.1.6 The four types of hypersensitivity (allergic) responses (type I to type IV reactions)

B) Immunological Diseases

- 13.2 The anesthesiologist shall, in collaboration with the appropriate consultant (time permitting), manage the patient with the following disorders presenting for surgical or obstetric management:
 - 13.2.1 Hereditary angioedema in C1 esterase inhibitor protein deficiency
 - 13.2.2 Congenital and acquired immunodeficiency states
 - 13.2.3 HIV/ AIDS
 - 13.2.4 Selective IgA deficiency and anaphylaxis associated with blood transfusions
 - 13.2.5 Cold autoimmune diseases: (e.g. cryoglobulinemia, cold Hemagglutinin disease, paroxysmal cold hemoglobinuria)
 - 13.2.6 Amyloidosis

C) Autoimmune disease

- 13.3 The anesthesiologist shall, in collaboration with the appropriate consultant (time permitting), 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 Ankylosing spondylitis
 - 13.3.2.4 Systemic lupus erythematosus
 - 13.3.2.5 Scleroderma
 - 13.3.2.6 IgA deficiency
 - 13.3.2.7 Sarcoidosis

D) Pre-existing Allergies

- 13.4 For the following conditions, the specialist anesthesiologist shall demonstrate an understanding of:
 - Pathophysiology
 - Clinical manifestations
 - Investigation
 - Management
- 13.4.1 Protamine allergy
- 13.4.2 Latex allergy
- 13.4.3 Metabisulfite allergy
- 13.4.4 Volatile agent allergic hepatitis
- 13.4.5 Transfusion reaction
- 13.4.6 Intravenous contrast media allergy
- 13.4.7 Food allergies associated with drug or medical substance allergies
 - 13.4.7.1 Eggs/ propofol
 - 13.4.7.2 Banana/ kiwi /latex
 - 13.4.7.3 Fish/ protamine
 - 13.4.7.4 Shellfish/ iodine prep

- 13.4.8 Drug reactions, distinguished from non-allergic adverse drug side effect (drug toxicity from a drug level above a therapeutic range, drug-drug interaction, idiosyncratic non-allergic drug effect (e.g. genetic deficiency of an enzyme)
 - 13.4.8.1 Anaphylaxis
 - 13.4.8.2 Drug-induced release of histamine (anaphylactoid)
 - 13.4.8.3 Activation of the complement system

E) Transplantation: (See Transplantation 33.9)

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 and multisystemic implications of the connective tissue disorders. The anesthesiologist must demonstrate an understanding of the anesthetic considerations of the following diseases:
 - 13.6.1 Epidermolysis bullosa
 - 13.6.2 Sclerodermia
 - 13.6.3 Systemic lupus erythematosus
 - 13.6.4 Rheumatoid arthritis
 - 13.6.5 Ankylosing spondylitis
 - 13.6.6 Marfan 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 Mechanism of transmission of selected infectious diseases; tuberculosis, MRSA, C difficile, viral hepatitis
 - 14.1.2 Isolation measures
 - 14.1.2.1 Universal precautions
 - 14.1.2.2 Droplet precautions
 - 14.1.2.3 Airborne precautions
 - 14.1.3 Effect of tracheal intubation on the development of infectious complications
 - 14.1.4 Aseptic technique
 - 14.1.5 Management of needle stick injuries

B) Infectious Syndromes

- 14.2 Demonstrate knowledge regarding infectious syndromes, including but not limited to:
 - 14.2.1 Infections syndromes leading to uni or multi-systemic decompensation, including the differential diagnosis and treatment modalities
 - 14.2.2 Participate in the treatment of a patient in septic shock
 - 14.2.3 Infection in the immunocompromised host
 - 14.2.4 Pathophysiology of sepsis and multiorgan failure
 - 14.2.5 Infection in solid organ and marrow transplant patients
 - 14.2.6 Community acquired infection
 - 14.2.6.1 Community acquired pneumonia
 - 14.2.6.2 Meningitis and encephalitis
 - 14.2.6.3 Genitor-urinary sepsis
 - 14.2.6.4 Intra-abdominal sepsis
 - 14.2.6.4.1 Perforated viscus
 - 14.2.6.4.2 Cholecystitis and ascending cholangitis
 - 14.2.6.4.3 Pancreatitis
 - 14.2.6.4.4 Spontaneous bacterial peritonitis

- 14.2.6.5 Soft tissue infection – severe cellulitis and necrotizing fasciitis
- 14.2.6.6 Head and neck infection
 - 14.2.6.6.1 Epiglottitis
 - 14.2.6.6.2 Ludwig’s angina
- 14.2.6.7 Bacterial endocarditis

- 14.2.7 Prevention and management of nosocomial infection
 - 14.2.7.1 Line-related bloodstream infection
 - 14.2.7.2 Clostridia difficile colitis
 - 14.2.7.3 Hospital acquired pneumonia

- 14.2.8 Clostridial myonecrosis
- 14.2.9 Tetanus
- 14.2.10 Toxic shock syndrome
- 14.2.11 Infections with group A streptococci
- 14.2.12 Herpes zoster (See pain management objectives Section 21)

C) Patients with Immunodeficiency Syndromes

- 14.3 Demonstrate knowledge of the problems related to, and anesthetic considerations of, immunodeficiency syndromes, including but not limited to:
 - 14.3.1 AIDS
 - 14.3.2 Chemotherapy
 - 14.3.3 Transplantation

D) Antibiotic Prophylaxis

- 14.4 Demonstrate knowledge of the rationale behind surgical antibiotic prophylaxis for wound infection. 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

E) Upper Respiratory Tract Infections

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

F) Pharmacology

- 14.6 Pharmacology, spectrum, and complications of antibacterial, antiviral and antifungal therapy
- 14.7 Major anti-infectious agents
 - 14.7.1 Indications
 - 14.7.2 Complications related to their use (toxicity, superinfection)
 - 14.7.3 Microbiological techniques used to make adjustment to therapy (dosage, culture)
- 14.8 Explain the role of the different treatment modalities for the management of a patient with septic shock (support treatment, antibiotics, surgery, protein C, activated, etc.)

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:

A) Monitoring

15.1 Pressure Measurement

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

15.1.1.1 Principles of Measurement

15.1.1.1.1 Define the various units (joules, kilopascals) commonly used in Anesthesiology

15.1.1.1.2 Describe how most anesthesia monitors measure force (Newton's 2nd Law)

15.1.1.2 Static Pressure Measurement

15.1.1.2.1 Describe the principle of measuring static columns of fluid (CVP)

15.1.1.2.2 Define 1 atmosphere of pressure

15.1.1.3 Dynamic Pressure Management

15.1.1.3.1 Demonstrate knowledge of how modern pressure transducers work

15.1.1.3.2 Describe the effects of compliance in these systems

15.1.1.3.3 Describe the characteristics of the pressure versus time waveform in clinical practice

15.1.1.4 Signal-Processed Pressure Monitor

15.1.1.4.1 Use a non-invasive blood pressure (NIBP) monitor properly

15.1.1.4.2 Describe how a NIBP cuff works (how systolic, MAP and diastolic pressure are determined)

15.1.1.4.3 Describe the different false readings associated with NIBP

15.2 Flow Measurement

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

15.2.1.1 Principles of Flow

15.2.1.1.1 Describe the differences between flow and velocity

- 15.2.1.1.2 Describe the relationship between pressure and flow
- 15.2.1.1.3 Describe the different forces that can act on fluids (gravity, pressure gradient, and viscous force/friction)
- 15.2.1.1.4 Demonstrate knowledge of the Bernoulli equation and its relevance in Anesthesiology
- 15.2.1.1.5 Demonstrate knowledge of the relevance of the Reynolds number in Anesthesiology

15.2.1.2 Mass/Volume Flow Meters

- 15.2.1.2.1 Describe how cardiac output is measure using thermodilution and the potential errors associated with it

15.2.1.3 Velocity/Flow Measurements

- 15.2.1.3.1 Describe how pilot tubes are used in anesthetic monitors
- 15.2.1.3.2 Describe how a venture tube works and its relationship to the Bernoulli equation

15.2.1.4 Balance-of-Pressure Flow Meters

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

15.3 Sound Measurement

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

15.3.1.1 Principles of Sound

- 15.3.1.1.1 Describe how Doppler ultrasound works
- 15.3.1.1.2 Describe what sound waves are and how they travel

15.3.1.2 Passive – Stethoscope

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

15.3.1.3 Active – Echo, Doppler

- 15.3.1.3.1 Demonstrate knowledge of the principles and physics of TEE
- 15.3.1.3.2 Demonstrate knowledge of the principles and physics of Doppler

- 15.3.1.3.3 Describe the principles and features of ultrasound and its use in vascular access and nerve localization

15.4 Electricity

- 15.4.1 Demonstrate knowledge of the principles of electricity use in monitoring and the principles of electrical safety, including but not limited to:
 - 15.4.1.1 Describe the differences between AC and DC current
 - 15.4.1.2 Demonstrate knowledge of micro and macroshock
 - 15.4.1.3 Demonstrate knowledge of the principles behind electrical isolation in the operating room
 - 15.4.1.4 Demonstrate knowledge of passive electrical examination
 - 15.4.1.4.1 EKG – describe how the EKG senses electrical impulses and the problems processing these signals
 - 15.4.1.4.2 EEG – know that the signal strength is 1/10th of that in an EKG
 - 15.4.1.4.3 BIS (and other monitors of depth of anesthesia)
 - 15.4.1.4.3.1 Know how a BIS monitor works
 - 15.4.1.4.3.2 Know how to interpret the BIS index
 - 15.4.1.4.3.3 Know how the various BIS levels correlate clinically
 - 15.4.1.5 Active Electrical Examination
 - 15.4.1.5.1 Somatosensory Evoked Potentials (SSEPs)
 - 15.4.1.5.1.1 Know how SSEPs are measured
 - 15.4.1.5.1.2 Know the clinical uses of SSEPs in the OR
 - 15.4.1.5.1.3 Know how different anesthetic agents affect measurement of SSEPs
 - 15.4.1.5.2 Motor Evoked Potentials (MEPs)
 - 15.4.1.5.2.1 Know the uses and limitations of MEPs
 - 15.4.1.5.2.2 Know how different anesthetic agents effect measurement of MEPs

15.5 Measurement Utilizing Light

- 15.5.1 Demonstrate knowledge of the principles of light transmission and its' utility in various forms of monitoring, including but not limited to:
 - 15.5.1.1 Principles of light
 - 15.5.1.1.1 Demonstrate knowledge of the difference between sound and electromagnetic waves (i.e. different speeds, different propagation waves)

- 15.5.1.1.2 Define the Beer-Lambert Law and know how it relates to various anesthetic monitors
- 15.5.1.1.3 Demonstrate knowledge of how the different Light Monitors work – Capnometer (mainstream and sidestream), Agent Analyzer Capnometer
 - 15.5.1.1.3.1 Describe how the Capnometer works
 - 15.5.1.1.3.2 Know the different wavelengths of light measured
 - 15.5.1.1.3.3 Describe the different phases in a CO₂ waveform and identify clinical correlations in various waveforms

15.5.1.2 Pulse Oximeters function

- 15.5.1.2.1 Describe the four different species of haemoglobin measured
- 15.5.1.2.2 Demonstrate knowledge of how fractional haemoglobin saturation is determined
- 15.5.1.2.3 Describe how the Beer-Lambert equation relates to the pulse oximeter

15.5.1.3 Raman Scattering

- 15.5.1.3.1 Describe how Raman scattering works
- 15.5.1.3.2 Describe the difference between Raman scattering and absorption based gas analysis

15.6 Temperature Measurement

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

15.6.1.1 Principles of Temperature

- 15.6.1.1.1 Define specific heat and a calorie

15.6.1.2 Temperature Monitors

- 15.6.1.2.1 Describe the three techniques for measuring temperature
- 15.6.1.2.2 Describe the three electrical techniques for measuring temperature:
 - 15.6.1.2.2.1 Resistance Thermometer
 - 15.6.1.2.2.2 Thermistor
 - 15.6.1.2.2.3 Thermocouple

15.7 Neuromuscular Monitors

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

15.7.1.1 Describe how a peripheral nerve stimulator works

15.7.1.2 Describe the different patterns of nerve stimulation

15.7.1.2.1 Single twitch

15.7.1.2.2 Train of Four (TOF)

15.7.1.2.3 Tetanic

15.7.1.2.4 Post Tetanic

15.7.1.2.5 Double burst stimulation (DBS)

15.8 Cardiovascular Monitors

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

15.8.1.1 Electrocardiography

15.8.1.2 Monitoring arterial blood pressure

15.8.1.2.1 Non-invasive blood pressure monitoring

15.8.1.2.2 Invasive arterial blood pressure monitoring

15.8.1.2.2.1 Sites of cannulation

15.8.1.2.2.2 Indications, contraindications

15.8.1.2.2.3 Complications

15.8.1.2.2.4 Insertion technique

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

15.8.1.3 Monitoring central venous pressure

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

15.8.1.3.2 Complications and principles of safe insertion technique

15.8.1.3.3 Sites of cannulation

15.8.1.3.4 Ultrasound guided insertion technique

15.8.1.3.5 Physiology of central venous pressure monitoring and sources of error

15.8.1.3.6 Waveform analysis

- 15.8.1.4 Pulmonary artery catheter insertion and monitoring
 - 15.8.1.4.1 Indications and contraindications
 - 15.8.1.4.2 Insertion technique
 - 15.8.1.4.3 Sources of error and principles of trouble shooting
 - 15.8.1.4.4 Principles of monitoring cardiac output, pulmonary artery pressure, pulmonary artery occlusion pressure and calculation of work indices and vascular resistance
 - 15.8.1.4.5 Waveform analysis
 - 15.8.1.4.6 Estimation of fluid responsiveness: Systolic pressure variation and transthoracic thermodilution
 - 15.8.1.4.7 Continuous mixed venous oximetry
- 15.8.1.5 Echocardiography
 - 15.8.1.5.1 Indications for, strengths and limitations of transthoracic and transesophageal echocardiography

B) Equipment

15.9 Inhaled Anesthetic Delivery Systems

- 15.9.1 Demonstrate knowledge of the principles behind the functionality of vaporizers and gas delivery systems
 - 15.9.1.1 Gas delivery systems
 - 15.9.1.1.1 Storage and delivery of anesthetic gases via pipelines and cylinders
 - 15.9.1.1.2 Anesthesia breathing circuits
 - 15.9.1.2 Gas laws
 - 15.9.1.2.1 Boyle's law, Charles' Law, Henry's Law, Graham's law of diffusion, Dalton's law of partial pressures
 - 15.9.1.2.2 Partial pressure
 - 15.9.1.2.3 Blood / gas solubility
 - 15.9.1.3 Anesthetic Machine
 - 15.9.1.3.1 Demonstrate in depth knowledge of the anesthetic machines:
 - 15.9.1.3.1.1 Demonstrate knowledge about the safety features of the anesthetic machine
 - 15.9.1.3.1.2 Describe the CSA/ASA standards for anesthetic machines

- 15.9.1.3.1.3 Pipeline and Cylinder gas supply
- 15.9.1.3.1.4 Pressure failure mechanisms
- 15.9.1.3.1.5 Flow meter and proportioning systems
- 15.9.1.3.1.6 Breathing circuits
 - 15.9.1.3.1.6.1 Bain
 - 15.9.1.3.1.6.2 Circle
- 15.9.1.3.1.7 Vaporizers
- 15.9.1.3.1.8 CO₂ absorption
- 15.9.1.3.1.9 Anesthesia ventilators
- 15.9.1.3.1.10 Scavenger systems
- 15.9.1.3.1.11 Low-flow anesthesia
- 15.9.1.3.1.12 Perform a complete pre-use check of the machine

15.10 Equipment Cleaning and Sterilization

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

15.11 Lasers

- 15.11.1 Demonstrate knowledge of the principles of the physics of laser use
 - 15.11.1.1 Describe the three ways that laser light is different than ordinary light
 - 15.11.1.1.1 Monochromatic
 - 15.11.1.1.2 Coherent
 - 15.11.1.1.3 Collimated
 - 15.11.1.2 Describe the essential components in a laser
 - 15.11.1.3 Demonstrate knowledge about the different lasers available in the OR
 - 15.11.1.3.1 CO₂
 - 15.11.1.3.2 Argon
 - 15.11.1.3.3 Krypton
 - 15.11.1.3.4 Holmium
 - 15.11.1.3.5 Nd:YAG
 - 15.11.1.4 Describe the potential hazards of lasers in the OR and how to

protect against them

15.11.1.5 Describe the Airway Fire Protocol

15.12 Ultrasound Machines

15.12.1 Demonstrate knowledge of the principles of ultrasound technology

15.12.1.1 Ultrasound Principles

15.12.1.1.1 Describe the principles of US

15.12.1.1.2 Describe how M-mode and Two-dimensional Echocardiography work

15.12.1.2 TEE

15.12.1.2.1 Describe the design and the basic waveforms seen with a TEE

15.12.1.2.2 List the indications, limitations and complications of use

15.12.1.3 Regional Ultrasound

15.12.1.3.1 Describe the basic structures seen with ultrasound and identify nerves

16 Neurology/ Neurosurgical Anesthesiology

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

A) Basic Science

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

16.1.1 Anatomy

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

16.1.2 Physiology

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

16.1.3 Pharmacology

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

B) Neurological diseases

- 16.2 Demonstrate the ability to independently provide anesthesia care for:
 - 16.2.1 Patients with increased intracranial pressure at risk of herniation
 - 16.2.1.1 Supratentorial tumors
 - 16.2.1.2 Posterior fossa tumors

 - 16.2.2 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

 - 16.2.4 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
 - 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

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

 - 16.3.1.2 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 Ventriculoperitoneal or 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

16.3.1.7.1 Laminectomy/Discectomy/Decompression

16.3.1.7.2 Spinal instrumentation/fusion

16.3.1.7.3 Spinal cord tumour resection

16.3.1.8 *Pediatric Neurosurgery*

16.3.1.8.1 *Surgery for meningomyelocele*

16.3.1.8.2 *Craniectomy for craniosynostosis*

16.3.1.8.3 *Untethering of spinal cord*

16.4 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

16.4.2 Management of fluid therapy in the neurosurgical patient

16.4.3 Patients requiring intraoperative neurological monitoring

16.4.3.1 Electroencephalography, including bispectral analysis

16.4.3.2 Somatosensory Evoked Potentials

16.4.3.3 Motor evoked potentials

16.4.3.4 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 how a postjunctional receptor works
- 17.1.7 Explain the effects of the prejunctional receptor on nerve transmission
- 17.1.8 Explain the quantal theory at the neuromuscular junction
- 17.1.9 Describe the action potential across nerve membrane, including sodium and calcium channels

B) Pharmacology of Muscle Relaxants

17.2 Demonstrate an ability to:

- 17.2.1 Explain the action of neuromuscular relaxants, nondepolarizing and depolarizing, on prejunctional and postjunctional receptors
- 17.2.2 Explain a desensitization block
- 17.2.3 Explain how certain drugs can affect neuromuscular relaxants effects
 - 17.2.3.1 Volatile agents
 - 17.2.3.2 Antibiotics
 - 17.2.3.3 Calcium
 - 17.2.3.4 Local anesthetics
 - 17.2.3.5 Antiepileptics
 - 17.2.3.6 Diuretics
 - 17.2.3.7 Channel blocks and other effects

- 17.2.4 Pharmacology of succinylcholine
 - 17.2.4.1 Pharmacokinetics and pharmacodynamics
 - 17.2.4.2 Indications
 - 17.2.4.3 Contraindications
 - 17.2.4.4 Butyrylcholinesterase activity and reversal of succinylcholine
 - 17.2.4.5 Drug interactions and adverse effects

- 17.2.5 Pharmacology of non-depolarizing neuromuscular blocking agents
 - 17.2.5.1 Pharmacokinetics and pharmacodynamics
 - 17.2.5.2 Potency
 - 17.2.5.3 Metabolism and elimination Clinical
 - 17.2.5.4 management and dosage Drug
 - 17.2.5.5 interactions and adverse effects
 - 17.2.5.6 Indications
 - 17.2.5.7 Contraindications

C) Prejunctional, Immature and Extrajunctional Receptors

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

D) Neuromuscular Reversal

- 17.6 Demonstrate in depth knowledge of the reversal of neuromuscular blockade
 - 17.6.1 Explain how antagonists of neuromuscular block works
 - 17.6.1.1 Neostigmine
 - 17.6.1.2 Pyridostigmine
 - 17.6.1.3 Edrophonium
 - 17.6.1.4 Suggamadex®

- 17.6.2 Explain the role of anticholinergic drugs in neuromuscular reversal
 - 17.6.2.1 Atropine
 - 17.6.2.2 Glycopyrrolate
- 17.6.3 Describe the effects of neuromuscular relaxants on the autonomic nervous system
- 17.6.4 Explain the influence of neuromuscular diseases on neuromuscular relaxants effects
- 17.6.5 Explain the influence of age, obesity on neuromuscular relaxants effects
- 17.6.6 Describe the determinants of speed and adequacy of reversal of neuromuscular blockers
- 17.6.7 Describe the side effects of anticholinesterase agents

E) Monitoring Neuromuscular Blockade

- 17.7 Demonstrate the ability to monitor blockade of the neuromuscular junction
 - 17.7.1 Peripheral nerve stimulation – patterns used
 - 17.7.2 Assessment of complete/adequate reversal
 - 17.7.3 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

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 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 Resuscitation of the newborn – NRP protocol
- 18.3.4 Predict the likelihood of need for resuscitation
- 18.3.5 Recognize the neonate needing resuscitation
- 18.3.6 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 Magnesium sulphate
 - 18.4.8.7 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 - See also Regional anesthesia (27.1, 27.5)

18.6.1 Demonstrate knowledge and discuss the following:

- Indications
- Contraindications
- Mechanism of action
- Pharmacokinetics/ pharmacodynamics
- Maternal Side effects
- Fetal effects
- Effects on Uterine blood flow
- Complications
- Management of complications

For the following 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 Spinal-single shot
- 18.6.1.6 Combined spinal/ epidural
- 18.6.1.7 Continuous spinal catheter technique
- 18.6.1.8 Epidural Local anesthetics
- 18.6.1.9 Pudendal and paracervical blocks

F) Anesthesia for Obstetrical surgery

18.7 Demonstrate knowledge and discuss:

- Indications
- Contraindications
- Mechanism of action
- Pharmacokinetics/ pharmacodynamics
- Maternal Side effects
- Fetal effects
- Effects on Uterine blood flow
- Complications
- Management of complications

For the following 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 endotracheal anesthesia
- 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 of:
 - 18.8.1 The management of maternal ante – or postpartum hemorrhage
 - 18.8.1.1 Uterine rupture Abruption
 - 18.8.1.2 or atony Placenta previa
 - 18.8.1.3 or accrete
 - 18.8.1.4 Retained placenta

 - 18.8.2 The treatment for maternal embolic events
 - 18.8.3 Amniotic fluid
 - 18.8.3.1 Air
 - 18.8.3.2 Thrombus

18.8.4 Management of fetal emergencies – prolapsed vasa previa

18.8.5 Management of intra-uterine fetal death

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

18.9 Demonstrate knowledge of:

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

For 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 – 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 Mild

18.9.1.4.2 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 The anesthetic considerations for morbidly obese parturient

18.9.2.2 The use of regional anesthesia in morbidly obese patients

18.9.2.3 The management of general anesthesia in obese patients

- 18.9.3 Respiratory disease knowledge
 - 18.9.3.1 Asthma
 - 18.9.3.2 ARDS

- 18.9.4 Cardiac disease knowledge
 - 18.9.4.1 Demonstrate an understanding of when invasive monitors are needed for delivery and postpartum care
 - 18.9.4.2 Demonstrate an understanding of the pathophysiology and management of parturients with:
 - 18.9.4.2.1 Congenital heart disease
 - 18.9.4.2.1.1 Left to right shunt
 - 18.9.4.2.1.2 Right to left shunts (Tetralogy of Fallot)
 - 18.9.4.2.1.3 Pulmonary hypertension (Eisenmenger's Syndrome)
 - 18.9.4.2.1.4 Coarctation of aorta
 - 18.9.4.3 Idiopathic Hypertrophic Subaortic Sclerosis IHSS/ Hypertrophic Obstructive Cardiomyopathy (HOCM)
 - 18.9.4.4 Ischemic heart disease
 - 18.9.4.5 Valvular heart disease
 - 18.9.4.5.1 Aortic stenosis
 - 18.9.4.5.2 Aortic insufficiency
 - 18.9.4.5.3 Mitral stenosis
 - 18.9.4.5.4 Mitral regurgitation

 - 18.9.4.6 Peripartum cardiomyopathy

- 18.9.5 Endocrine disease
 - 18.9.5.1 Demonstrate knowledge of diabetes mellitus
 - 18.9.5.2 Demonstrate knowledge of thyroid disease
 - 18.9.5.2.1 Hyperthyroidism
 - 18.9.5.2.2 Hypothyroidism

 - 18.9.5.3 Describe the impact of these conditions on the pregnancy and vice versa
 - 18.9.5.4 Pheochromocytoma

- 18.9.5.5 Manage glucose control in the parturient during caesarean or vaginal delivery

- 18.9.6 Hematologic and coagulation disorders
 - 18.9.6.1 Demonstrate knowledge of anemias
 - 18.9.6.2 Demonstrate knowledge of coagulation disorders
 - 18.9.6.3 Demonstrate knowledge of the guidelines concerning regional anesthesia and anticoagulation

- 18.9.7 Miscellaneous disorders
 - 18.9.7.1 Renal disease Liver
 - 18.9.7.2 disease Musculoskeletal
 - 18.9.7.3 disorders Scoliosis
 - 18.9.7.4 Rheumatoid arthritis
 - 18.9.7.5 Spina bifida cystica
 - 18.9.7.6 Autoimmune disorders
 - 18.9.7.7 Prior back surgery including Harrington rod placement
 - 18.9.7.8

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

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 determinants that predispose patients, and intraoperative management of the OCR

19.1.2 Describe the determinants of intra-ocular pressure (IOP) and 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 the 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 mydriatics, miotics, and 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 systemic medications

19.2.3 Effects of Anesthesia on IOP or 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 Identify the drugs used to provide sedation and the side effects and complications associated with those drugs

19.2.4.2 Topical anesthesia

- 19.2.4.2.1 Describe the local anesthetics commonly used to provide topical anesthesia to the eye

19.2.4.3 Regional anesthesia

- 19.2.4.3.1 Describe retrobulbar and peri-bulbar blocks. Know the indications and contra-indications for these blocks
- 19.2.4.3.2 Describe the complications including globe perforation, optic nerve damage, hemorrhage and total spinal associated with these blocks and the management thereof

19.2.4.4 General anesthesia

- 19.2.4.4.1 Describe the issues surrounding limited access to the airway, the importance of smooth induction and emergence
- 19.2.4.4.2 Demonstrate an understanding of the significance of Ketamine, nitrous oxide, and succinylcholine on the eye

19.2.5 Post Operative Nausea and Vomiting Prophylaxis

- 19.2.5.1 Appreciate the importance of PONV prophylaxis in eye 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 Blephoroplasty
 - 19.3.6.2 Dacrocystorhinostomy (DCR)
 - 19.3.6.3 Ptosis repair
 - 19.3.6.4 Orbital reconstruction

- 19.3.7 Corneal transplant
- 19.3.8 Removal of foreign body
- 19.3.9 Conjunctival – pterygium
- 19.3.10 Laser surgery
- 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
- 20.3 Associated chronic pain
- 20.4 Use of anti-coagulants
- 20.5 Local, Regional or General
- 20.6 Positioning
- 20.7 Tourniquet
- 20.8 Cement – Methyl methacrylate
- 20.9 Fat embolism, PE
- 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

B) Limb Fractures

- 20.15 Provide anesthetic care for patients with fractures taking into account the following concerns:
 - 20.15.1 Urgent vs. emergent Open
 - 20.15.2 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 anesthetic care for patients presenting for joint replacement taking into account the following concerns:
 - 20.16.1 Age, Co-morbidities
 - 20.16.1.1 RA
 - 20.16.1.2 OA
 - 20.16.1.3 AS
 - 20.16.2 Chronic pain
 - 20.16.3 Positioning
 - 20.16.3.1 Beach chair
 - 20.16.3.2 Lateral
 - 20.16.4 Tourniquet
 - 20.16.5 Cement
 - 20.16.6 Blood loss
 - 20.16.7 Post op pain, regional techniques
 - 20.16.8 Rehabilitation, mobilization, physiotherapy
 - 20.16.9 Anti-coagulation

D) Tendon/Ligament Reconstruction

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

E) Spine

- 20.18 Principles of Anesthesiology for spinal decompression/ stabilization surgery
 - 20.18.1 Demonstrate an understanding of the concerns related to spinal surgery with respect to:
 - 20.18.1.1 Spinal cord anatomy and physiology
 - 20.18.1.2 Stable vs. Unstable
 - 20.18.1.3 Emergency vs. Elective
 - 20.18.1.4 Instrumentation
 - 20.18.1.5 Spinal shock
 - 20.18.1.6 Spinal cord compromise
 - 20.18.1.6.1 Protection

- 20.18.1.6.2 Precautions
- 20.18.1.6.3 Awake positioning

- 20.18.1.7 Spinal cord monitoring
 - 20.18.1.7.1 SSEP
 - 20.18.1.7.2 Wake up tests

- 20.18.1.8 Post operative neurological assessment
- 20.18.1.9 Considerations of dural tear
- 20.18.1.10 Prolonged OR
- 20.18.1.11 Post-operative respiratory function
- 20.18.1.12 Implications of surgery on different levels of the spine:
 - 20.18.1.12.1 C-spine
 - 20.18.1.12.1.1 Unstable vs. stable c-spine Anterior
 - 20.18.1.12.1.2 and posterior approach Airway
 - 20.18.1.12.1.3 management, Shared airway Lack of
 - 20.18.1.12.1.4 access
 - 20.18.1.12.1.5 Awake positioning

 - 20.18.1.12.2 T-spine
 - 20.18.1.12.2.1 One lung ventilation
 - 20.18.1.12.2.2 Blood loss
 - 20.18.1.12.2.3 Embolism
 - 20.18.1.12.2.4 Autonomic hyper-reflexia

 - 20.18.1.12.3 L-spine
 - 20.18.1.12.3.1 Implications of prone position
 - 20.18.1.12.3.2 Disc/laminectomy
 - 20.18.1.12.3.3 Spine decompression +/- fusion
 - 20.18.1.12.3.4 Implications of bone graft/coral graft

20.19 Scoliosis Surgery

20.19.1 Provide anesthetic care for patients presenting for scoliosis surgery with respect to:

20.19.1.1 Pre-op assessment

20.19.1.1.1 Pediatric vs. adult

20.19.1.1.2 Co-morbidities (MS, CP etc.)

20.19.1.2 Respiratory function

20.19.1.3 Cardiovascular function

20.19.1.4 Anesthetic management

20.19.1.5 Prone positioning

20.19.1.6 Blood loss

20.19.1.7 VAE

20.20 Spinal Cord Tumours

20.20.1 Demonstrate an understanding of the concerns related to spinal cord tumours with respect to:

20.20.1.1 Blood loss

20.20.1.2 Neurological compromise

20.20.1.3 Primary vs. metastases – radiation, chemotherapy etc.

F) Pelvic Surgery

20.21 Demonstrate an understanding of the concerns related to pelvic surgery with respect to:

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 Demonstrate an understanding of the concerns related to ambulatory surgery with respect to:

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

20.23 Demonstrate an understanding of the concerns related to pediatric patients with respect to:

- 20.23.1 Considerations of pediatric patients
- 20.23.2 Emergent vs. elective
- 20.23.3 Co-morbid conditions
- 20.23.4 Congenital conditions
- 20.23.5 Prolonged surgery
- 20.23.6 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 gross anatomic pathways at the peripheral, spinal, brainstem, thalamic and cortical levels that are involved in the perception of pain

21.1.1.2 Pain Transduction

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 systems affected by the stress response, and the overall impact on each of those systems

21.1.1.3.2 Describe the extent to which the stress response is modified by analgesia, 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

21.1.1.4 Neuropsychological

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

21.2.1.3 Pain Rating Scales

- 21.2.1.3.1 Describe the visual analog scale (VAS), numeric, verbal and FACES rating scales, including their relative advantages and disadvantages, and apply them in clinical practice

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 benefits and limitations

- 21.3.1.1.2 Advocate 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

- 21.3.1.1.5 Discuss the advantages, disadvantages, indications, contraindications and complications of the regional techniques listed in the above section as they apply to acute pain management

21.3.1.2 Systemic Pharmacological Interventions

21.3.1.3 General Analgesic Pharmacology

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

21.3.1.3.2 Discuss the use of intrathecal/epidural administration of opioids and adjuncts

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

21.3.1.4 Patient-Controlled Analgesia PCA

21.3.1.4.1 Describe the pharmacokinetic rationale behind Patient Controlled Analgesia (PCA)

21.3.1.4.2 List and manage the potential risks for PCA

21.3.1.4.3 Devise appropriate management protocols for PCA

21.3.1.4.4 Prescribe PCA appropriately

21.3.1.4.5 Utilize different routes for PCA-intravenous, subcutaneous, Epidural, oral

21.3.1.4.6 Describe the agents which may be used for PCA

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 NMDA Antagonists
 - 21.4.1.5.1 Contrast the pharmacokinetic and pharmacodynamics characteristics of NMDA antagonists
 - 21.4.1.5.2 Describe the mechanism of action of NMDA antagonists
 - 21.4.1.5.3 Develop protocols and policies to govern the administration of NMDA antagonists in the perioperative setting
- 21.4.1.6 Anticonvulsants
 - 21.4.1.6.1 Describe the indications, contraindications, advantages and disadvantages of anticonvulsants in acute pain management
 - 21.4.1.6.2 Describe the analgesic mechanism of action and anticonvulsants
 - 21.4.1.6.3 Develop protocols and policies to govern the administration of anticonvulsants in the perioperative setting
- 21.4.1.7 Alpha-Agonists
 - 21.4.1.7.1 Describe the mechanism of action of alpha-agonists
 - 21.4.1.7.2 Develop protocols and policies to govern the administration of Alpha-agonists in the perioperative setting
- 21.4.1.8 Antidepressants
 - 21.4.1.8.1 Describe the mechanisms of action of Antidepressants with

respect to acute pain management

21.4.1.8.2 Develop protocols and policies to govern the administration of antidepressants in the perioperative setting

21.4.1.9 Tramadol

21.4.1.9.1 Identify and minimize related complications and side effects

21.4.1.9.2 Describe the mechanism of action of Tramadol

21.4.1.10 Cannabinoids

21.4.1.10.1 Describe the indications, contraindications, advantages and disadvantages of cannabinoids including issues specific to all relevant routes of administration

21.4.1.10.2 Describe the types of cannabinoids available (THC/synthetic THC analogue/THC/CBD & marijuana)

21.4.1.10.3 List the systemic effects of cannabinoids including variations specific to particular routes of administration

21.4.1.10.4 Identify and minimize related complications and side effects

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

21.4.1.10.6 Develop protocols and policies to govern the administration of cannabinoids in the perioperative setting

21.5 Non-Pharmacologic Interventions

21.5.1 Demonstrate an understanding and ability to use/prescribe non-pharmacologic interventions for the management of acute pain

21.5.1.1 Recognize the importance of non-pharmacologic factors in analgesia

21.5.1.2 Support allied health professional in provision of non-pharmacologic interventions

21.5.1.3 Trans-cutaneous electrical nerve stimulation (TENS)

21.5.1.3.1 Explains the theoretical mechanism of TENS in analgesia

21.5.1.3.2 Discuss the efficacy of TENS in acute pain management

21.5.1.3.3 Coordinate access to TENS as a non-pharmacologic adjunct in appropriate situations

21.6 Outcomes of 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 patient outcomes, and the mechanisms for such contribution
- 21.6.1.1.2 Design analgesia plans that optimize recovery for patients
- 21.6.1.1.3 Advocate with other disciplines to implement appropriate multimodal recovery plans

21.6.1.2 Addiction, Tolerance and Substance Abuse

- 21.6.1.2.1 Identify and distinguish between tolerance, dependence and addiction
- 21.6.1.2.2 Identify the special physiological, psychological, pharmacokinetic and pharmacodynamics issues in the tolerant or abusing patient
- 21.6.1.2.3 Recognize addictive behaviour and warning signs of substance abuse
- 21.6.1.2.4 Educate allied health and other medical professional to the risks and appropriate management of tolerance and addiction in relation to acute analgesic therapy
- 21.6.1.2.5 Describe the biopsychosocial aspects of substance abuse and its interaction with analgesic therapy
- 21.6.1.2.6 Generate an appropriate acute pain plan in cooperation with the patient setting realistic analgesic and functional goals
- 21.6.1.2.7 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 the development and management of chronic pain, including but not limited to:

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 gross anatomic pathways at the peripheral, spinal, brainstem, thalamic and cortical levels that are involved in the perception of pain

21.7.1.2 Pain Transduction

- 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, spinal, brainstem, thalamic and cortical levels that are involved in the perception of pain

21.7.1.3 Neuroendocrine Stress Response

- 21.7.1.3.1 Describe the systems affected by the stress response, and the overall impact on each of those systems
- 21.7.1.3.2 Describe the specific changes within each of the affected systems that lead to the overall functional impact on those systems
- 21.7.1.3.3 Describe the extent to which the stress response is modified by analgesia, the theoretical effect such modification on surgical outcomes, and the extent to which the modification of stress response has been shown to affect outcomes

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 Rating Scales

- 21.8.1.2.1 Describe the VAS, numeric, verbal and FACES rating scales, including their relative advantages and disadvantages, and apply them in clinical practice

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*

21.9.2 Tolerance, Addiction and Substance Abuse

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

21.10 Analgesic Interventions

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

21.10.1.1 Multimodal and Regional Analgesia

- 21.10.1.1.1 Describe the multimodal approach to analgesia, including its benefits and limitations
- 21.10.1.1.2 Advocate with other disciplines to create effective policies for multimodal therapies
- 21.10.1.1.3 Describe the relative merits of different co-analgesics
- 21.10.1.1.4 Select an appropriate co-analgesic regimen to improve analgesia and minimize risk or side effects in a spectrum of patients
- 21.10.1.1.5 Identify common impediments to analgesia and modify therapy appropriately
- 21.10.1.1.6 Discuss the advantages, disadvantages, indications,

contraindications and complications of the regional techniques as they apply to chronic pain management

- 21.10.1.1.7 Identify and manage complications and adverse effects of regional analgesic techniques in an ambulatory chronic pain population

21.10.1.2 Pharmacologic Interventions

21.10.1.2.1 General Analgesic Pharmacology

- 21.10.1.2.1.1 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
- 21.10.1.2.1.2 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
- 21.10.1.2.1.3 Identify patients with special pharmacokinetic and dynamic characteristics and modify therapy appropriately
- 21.10.1.2.1.4 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

21.10.1.2.2 PCA

- 21.10.1.2.2.1 Describe the pharmacokinetic rationale behind PCA
- 21.10.1.2.2.2 List and manage the potential risks of PCA
- 21.10.1.2.2.3 Devise appropriate management protocols for PCA
- 21.10.1.2.2.4 Prescribe PCA appropriately
- 21.10.1.2.2.5 Diagnose and address common complications
- 21.10.1.2.2.6 Utilize different routes for PCA-IV, SC, Epidural, oral
- 21.10.1.2.2.7 Utilize different agents or combinations for PCA, and provide a rationale based on advantages and disadvantages

21.11 Analgesic agents

21.11.1 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

21.11.1.1 Topical Analgesics

- 21.11.1.1.1 Identify appropriate situations and agents for topical analgesia
- 21.11.1.1.2 Discuss the relative advantages and disadvantages of this route with specific reference to the agent and the situation
- 21.11.1.1.3 Prescribe topical opioids appropriately
- 21.11.1.1.4 Describe the indications, contraindications and rationale for the use of other topical analgesics
- 21.11.1.1.5 Describe the use of topical agents to a patient

21.11.1.2 Opioids

- 21.11.1.2.1 Describe the mechanism of action of opioids
- 21.11.1.2.2 Describe the types of opioid receptors with reference to their functions and distribution in the body
- 21.11.1.2.3 Develop protocols and policies to govern the administration of opioids in the perioperative setting
- 21.11.1.2.4 Intrathecal/epidural route
- 21.11.1.2.5 Mechanisms to avoid/reverse opioid tolerance (opioid rotation; use of antagonists etc.)
- 21.11.1.2.6 Detoxification protocols (slow vs. rapid detox)
- 21.11.1.2.7 Discuss opioid conversions – equipotency; iv:po conversions
- 21.11.1.2.8 Methadone

21.11.1.3 NSAIDs

- 21.11.1.3.1 Describe the mechanism of action of NSAIDs
- 21.11.1.3.2 Develop protocols and policies to govern the administration of NSAIDs in the chronic pain setting
- 21.11.1.3.3 NSAIDs vs. Cox-2

21.11.1.4 Acetaminophen

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

21.11.1.5 NMDA Antagonists

- 21.11.1.5.1 Describe the mechanism of action of NMDA antagonists
- 21.11.1.5.2 Describe the role of excitatory amino acids in pain and sensitization
- 21.11.1.5.3 Develop protocols and policies to govern the administration of NMDA antagonists in the chronic pain setting
- 21.11.1.5.4 Methadone in chronic pain – titration protocol; mechanism of action; conversion; ways of administering; methadone license

21.11.1.6 Anticonvulsants

- 21.11.1.6.1 Describe the analgesic mechanism of action of anticonvulsants
- 21.11.1.6.2 Develop protocols and policies to govern the administration of anticonvulsants in the perioperative setting
- 21.11.1.6.3 IV lidocaine therapy

21.11.1.7 Alpha-agonists

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

21.11.1.8 Antidepressants

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

21.11.1.9 Tramadol

- 21.11.1.9.1 Identify and minimize related complications and side effects
- 21.11.1.9.2 Describe the mechanism of action of Tramadol

21.11.1.10 Cannabinoids

- 21.11.1.10.1 Describe the indications, contraindications, advantages and

disadvantages of cannabinoids including issues specific to all relevant routes of administration

- 21.11.1.10.2 List the systemic effects of cannabinoids including variations specific to particular routes of administration
- 21.11.1.10.3 Identify and minimize related complications and side effects
- 21.11.1.10.4 Describe the mechanism of action of cannabinoids with respect to analgesia
- 21.11.1.10.5 Develop protocols and policies to govern the administration of cannabinoids in the perioperative setting

21.12 Non-Pharmacologic Interventions

- 21.12.1 Demonstrate knowledge and ability to use/prescribe non-pharmacologic interventions for the management of acute pain
- 21.12.2 Recognize the importance of non-pharmacologic factors in analgesia
- 21.12.3 Support allied health professional in provision of non-pharmacologic interventions TENS and acupuncture
- 21.12.4 Explain the theoretical mechanism of TENS in analgesia
- 21.12.5 Discuss the efficacy of TENS in chronic pain management
- 21.12.6 Coordinate access to TENS as a non-pharmacologic adjunct in appropriate situations
 - 21.12.6.1 Other Non-Pharmacologic Interventions
 - 21.12.6.1.1 Use of Biofeedback
 - 21.12.6.1.2 Chiropractic interventions
 - 21.12.6.1.3 Massage
 - 21.12.6.1.4 Physiotherapy – ultrasound/interferential/TENS etc.
 - 21.12.6.2 Spinal Cord and Peripheral Nerve Stimulation
 - 21.12.6.2.1 Identify clinical situations in which stimulation may be of benefit
 - 21.12.6.2.2 Describe the purported mechanism of action of stimulation
 - 21.12.6.2.3 Coordinate access to stimulation for appropriate patients
 - 21.12.6.2.4 Discuss the relative advantages, disadvantages, indications and contraindications of stimulation for chronic pain
 - 21.12.6.2.5 Identify complications of implanted stimulators
 - 21.12.6.2.6 *Demonstrate an understanding of the use of Intrathecal pumps/spinal & epidural catheters*
 - 21.12.6.2.7 *Common drugs – opioids/baclofen/LA/clonidine/ketamine*
 - 21.12.6.2.8 *How to titrate/wean po/iv drugs in this situation*

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 Protein binding
- 22.2.1.1.3 Pharmacokinetics/Pharmacodynamics
- 22.2.1.1.4 Metabolism
- 22.2.1.1.5 Clearance
- 22.2.1.1.6 Excretion
- 22.2.1.1.7 Toxicity
- 22.2.1.1.8

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, former preterm infants, children and adolescents presenting for common surgical procedures
 - 22.7.2 Children with cardiovascular diseases
 - 22.7.2.1 ASD, VSD, PDA
 - 22.7.2.2 Postoperative repaired simple lesions
 - 22.7.2.3 Cardiomyopathies
 - 22.7.2.4 Heart transplant recipients
 - 22.7.2.5 Demonstrate an understanding of the anesthetic management of very premature infants
 - 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 TB

- 22.7.7 Patients with Endocrine/metabolic diseases
 - 22.7.7.1 Diabetes
 - 22.7.7.2 Thyroid diseases
 - 22.7.7.3 Mucopolysaccharidoses
 - 22.7.7.4 Obesity
 - 22.7.7.5 *Mitochondrial diseases*

- 22.7.8 Patients with Hematologic diseases/malignancies
 - 22.7.8.1 Anemias including Sickle cell disease, Thalasemia
 - 22.7.8.2 Bleeding disorders: hemophilia, Von Willebrand’s disease
 - 22.7.8.3 Others: ITP, leukemia
 - 22.7.8.4 Malignancies
 - 22.7.8.5 Mediastinal masses

22.7.9 Psychological

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

22.7.10 Children with more common syndromes

- 22.7.10.1 Down's syndrome
- 22.7.10.2 Mental retardation
- 22.7.10.3 Malignant hyperthermia syndrome
- 22.7.10.4 *Pierre Robin Sequence, Crouzon syndrome, Goldenhar syndrome, Treacher Collins syndrome etc.*
- 22.7.10.5 *Epidermolysis Bullosa*

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 (bleeding tonsil)
- 22.8.3.2 Myringotomy
- 22.8.3.3 Mastoidectomy

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

- 22.8.4 Orthopedic Surgery
 - 22.8.4.1 Fracture reduction
 - 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 V-P shunt insertion, revision
 - 22.8.6.2 Tumour resection
 - 22.8.6.3 Drainage of extra/subdural hematoma
 - 22.8.6.4 Raised ICP
 - 22.8.6.5 *Myelomeningocele repair*

- 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
 - 22.8.7.6 *Renal transplant*

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 Cardiac Surgery

- 22.8.9.1 Pacemaker insertion
- 22.8.9.2 *Cardiac catheterization*
- 22.8.9.3 *Coarctation repair*
- 22.8.9.4 *PDA ligation*

22.8.10 Dental Surgery

- 22.8.10.1 Dental extractions/restorations
- 22.8.10.2 Orthognathic surgery

22.8.11 Remote Locations

- 22.8.11.1 MRI/CT
- 22.8.11.2 Interventional radiology procedures
- 22.8.11.3 Medical procedures: e.g. Bone marrow aspiration/biopsy, LP, gastroscopy, colonoscopy, joint injections

22.8.12 Demonstrate an understanding of the principles of anesthetic management for:

- 22.8.12.1 Tracheo-esophageal fistula repair
- 22.8.12.2 Omphalocele
- 22.8.12.3 Gastroschisis
- 22.8.12.4 Necrotizing enterocolitis
- 22.8.12.5 Congenital diaphragmatic hernia
- 22.8.12.6 Thoracic surgery, including the need for lung isolation
- 22.8.12.7 Neonatal airway surgery
- 22.8.12.8 Laryngeal/tracheal reconstruction
- 22.8.12.9 Airway papillomas

22.8.13 Perioperative/PACU issues

22.8.13.1 Demonstrate the ability to evaluate and manage common problems which may arise perioperatively:

22.8.13.1.1 Criteria for day surgery, especially for exprematures

22.8.13.1.2 Un-cooperative patient

22.8.13.1.3 Delirium

22.8.13.1.4 Post extubation stridor

22.8.13.1.5 Pain

22.8.13.1.6 Nausea and vomiting

22.8.13.1.7 Laryngospasm

22.8.13.1.8 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 Sublingual
 - 23.10.1.2 Transcutaneous
 - 23.10.1.3 Intramuscular
 - 23.10.1.4

- 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 I reactions) and conjugation (phase II)
 - 23.12.1.5 Describe the impact of various factors affecting biotransformation
 - 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 and sedatives

- 23.22.1.1 Propofol
- 23.22.1.2 Pentothal
- 23.22.1.3 Ketamine
- 23.22.1.4 Etomidate
- 23.22.1.5 Midazolam

23.22.2 Narcotics/Opioids and adjuncts - See also Pain 23.1.3. 21.4

- 23.22.2.1 Fentanyl
- 23.22.2.2 Remifentanyl
- 23.22.2.3 Sufentanyl
- 23.22.2.4 Alfentanyl
- 23.22.2.5 Morphine
- 23.22.2.6 Hydromorphone
- 23.22.2.7 Meperidine

- 23.22.3 Muscle relaxants - See Neuromuscular Junction 17B
- 23.22.4 Reversal agents - See Neuromuscular Junction 17 D
- 23.22.5 Antiemetics - See Post Anesthesia Care Unit 25 C
- 23.22.6 Volatiles - See Volatiles 34
- 23.22.7 Vasopressors and inotropes - See Autonomic Nervous System 3 D,
Cardiovascular 4.3.5

- 23.22.8 Miscellaneous
 - 23.22.8.1 Intravenous lidocaine
 - 23.22.8.2 Naloxone
 - 23.22.8.3 Flumazenil

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 of burns including thermal, chemical and electrical burns

24.1.1.2 Describe the initial assessment and resuscitation of the burn patient

24.1.1.3 Describe the anesthetic considerations of the burn patient presenting for plastic procedures

24.1.1.3.1 Skin flaps

24.1.1.3.2 Split thickness 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

24.1.2 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

B) Anesthesia for Limb Replantation

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

24.2.1 The general and regional anesthetic options for limb replantation

24.2.2 Manoeuvres 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

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 The factors that influence flap perfusion including 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 for flap preservation
- 24.3.5 The post operative 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 amstopexy
 - 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) Minor Hand Procedures

- 24.5 The Anesthesiologist must demonstrate an understanding of the anesthetic concerns for patients undergoing hand surgery including:
 - 24.5.1 The anesthetic options for minor hand procedures
 - 24.5.2 The advantages/disadvantages and complications of the various anesthetic techniques
 - 24.5.2.1 Local infiltration
 - 24.5.2.2 IV block
 - 24.5.2.3 Peripheral nerve block
 - 24.5.2.4 General anesthesia

F) Craniofacial

24.6 Adult Craniofacial

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

24.6.1.1 Facial reconstructive surgery

24.6.1.2 Maxillo-facial trauma

24.7 Pediatric Craniofacial

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

24.7.1.1 Cleft lip/palate surgery

24.7.1.2 Ear reconstruction

25 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

25.1 Demonstrate knowledge of the physical and staffing requirements of the PACU, including but not limited to:

- 25.1.1 Space
- 25.1.2 Personnel
- 25.1.3 Equipment
- 25.1.4 Monitoring
- 25.1.5 Medications, IV fluids

B) Patient Management

25.2 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:

- 25.2.1 Fluid and electrolyte management
 - 25.2.1.1 Goals of resuscitation
 - 25.2.1.2 Accurate measures of preload
 - 25.2.1.3 Fluid responsiveness
- 25.2.2 Pain management: indications/contraindications of multimodal approach including local anesthetics, regional and neuroaxial blocks, opioids, NSAIDS and adjuncts including acetaminophen, gabapentin, Ketamine and tricyclic antidepressants
- 25.2.3 Antiemetics
- 25.2.4 Monitoring guidelines
- 25.2.5 Discharge criteria

C) Complications

25.3 Identify and manage common problems in the PACU, including but not limited to:

- 25.3.1 Respiratory complications
 - 25.3.1.1 Chronic obstructive pulmonary disease (COPD)
 - 25.3.1.2 Aspiration

- 25.3.1.3 Negative pressure pulmonary edema
- 25.3.2 Hypoxemia and hypoventilation
 - 25.3.2.1 Assessment of ventilation
 - 25.3.2.2 Recognition and diagnosis
 - 25.3.2.3 Oxygen delivery systems including BIPAP and CPAP
- 25.3.3 Recognition and treatment of upper airway obstruction, stridor, aspiration, obstructive sleep apnea
- 25.3.4 Hypotension and Hypertension
 - 25.3.4.1 Diagnosis and management
 - 25.3.4.2 Shock
- 25.3.5 Cardiac complications
 - 25.3.5.1 Myocardial ischemia/chest pain
 - 25.3.5.2 Brady-/tachycardia
 - 25.3.5.3 Dysrhythmias
 - 25.3.5.4 Cardiogenic shock
 - 25.3.5.5 Pulmonary edema
- 25.3.6 Anaphylaxis
- 25.3.7 Inadequate analgesia
 - 25.3.7.1 Blocks and neuraxial anesthesia
 - 25.3.7.2 Opiates
 - 25.3.7.3 Non-opiates
 - 25.3.7.4 Challenges in pain management
- 25.3.8 Oliguria/Polyuria
 - 25.3.8.1 Assessment of Volume Status
 - 25.3.8.2 Differential diagnosis
- 25.3.9 Post-Operative Mental Status Changes
 - 25.3.9.1 Delirium
 - 25.3.9.2 Differential diagnosis
 - 25.3.9.3 Delayed Emergence

- 25.3.9.4 Decreased level of consciousness, Acute cerebrovascular accident (CVA)

- 25.3.10 Fluid and Electrolyte Abnormalities
 - 25.3.10.1 Acid base
 - 25.3.10.2 Trans-urethral prostatectomy (TURP) Syndrome, Hysteroscopy syndrome
 - 25.3.10.3 Hypo- and Hyper-calcemia, kalemia, natremia, magnesemia, glycemia

- 25.3.11 Nausea and Vomiting
 - 25.3.11.1 Risk factors
 - 25.3.11.2 Pharmacology

- 25.3.12 Hyperthermia, Hypothermia & Shivering
 - 25.3.12.1 Postoperative fever
 - 25.3.12.2 Malignant Hyperthermia
 - 25.3.12.3 Hypothermia

- 25.3.13 Neurological
 - 25.3.13.1 Residual Neuromuscular Blockade
 - 25.3.13.2 Prolonged regional blocks and peripheral nerve blocks
 - 25.3.13.3 Peripheral Neuropathies

26 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 the following considerations regarding systemic illness

A) Cardiovascular

26.1 Hypertension

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

26.2 Pulmonary Hypertension

- 26.2.1 Identify patients with pulmonary hypertension by history, physical exam and laboratory/imaging findings
- 26.2.2 Identify the impact of the proposed anesthesia and surgery on the underlying disease
- 26.2.3 Coordinate further investigations and consultations necessary to safely and expeditiously perform the necessary surgery

26.3 Cardiomyopathy

- 26.3.1 Identify right and left ventricular dysfunction by use of history, physical and laboratory findings/imaging
- 26.3.2 Identify appropriate preoperative management of ventricular dysfunction
- 26.3.3 Utilize consultants appropriate to optimize ventricular dysfunction

26.4 Valvular Disease

- 26.4.1 Utilize history and physical examination to identify cardiac murmurs
- 26.4.2 Identify patients that require a preoperative echocardiogram to evaluate the severity of stenotic and regurgitation lesions of aortic, mitral, pulmonic and tricuspid valves
- 26.4.3 Identify risk factors for bacterial endocarditis
- 26.4.4 Prescribe appropriate prophylaxis for endocarditis

26.5 Congenital Heart Disease

- 26.5.1 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
- 26.5.2 Describe the physiology and design appropriate management plans for R-L, L-R and bidirectional shunts
- 26.5.3 Prescribe appropriate prophylaxis for endocarditis

26.6 Pacemakers/Implantable Cardioverter/Defibrillator

- 26.6.1 Identify indications for preoperative pacemaker/ ICD insertion or intraoperative pacing
- 26.6.2 Coordinate consultation for perioperative pacing
- 26.6.3 Identify the type of pacemaker/ICD and verify function
- 26.6.4 Coordinate appropriate perioperative assessment and programming of a pacemaker/ICD

26.7 Arrhythmia

- 26.7.1 Identify the presence, type and severity of abnormal rhythms, using history, physical and EKG
- 26.7.2 Identify rhythm abnormalities requiring preoperative therapeutic or prophylactic therapy
- 26.7.3 Prescribe appropriate therapeutic or suppressive therapy
- 26.7.4 Utilize consultants effectively to coordinate appropriate pharmacologic or electrophysiologic therapy

26.8 Conduction Abnormalities

- 26.8.1 Identify the presence, severity and type of abnormalities of conduction
- 26.8.2 Identify and manage reversible contributors to abnormal conduction

26.9 Peripheral Vascular Disease

- 26.9.1 Identify the presence, severity and physiologic impact of peripheral vascular disease
- 26.9.2 Predict the impact of carotid disease on intraoperative risk
- 26.9.3 Identify the important preoperative variables that affect outcome in major vascular surgery, and provide a plan to optimize them

26.10 Patient with heart transplantation

26.11 Cardiac tamponade and constrictive pericarditis

26.12 Superior vena cava syndrome

26.13 Cardiac risk assessment

- 26.13.1 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
- 26.13.2 Identify patients with clinical risk factors who would benefit from further preoperative testing, balancing the potential risks and the urgency of the surgical indication

26.14 Cardiac risk reduction

- 26.14.1 Utilize pharmacologic therapy to reduce perioperative cardiac risk
- 26.14.2 Describe the risks and benefits of beta-blockers, alpha-2 agonists, statins, and anti-platelet therapy for the reduction of perioperative cardiac risk
- 26.14.3 Identify indications for preoperative surgical or interventional management for cardiac risk reduction
- 26.14.4 Utilize appropriate consultation to coordinate preoperative cardiac risk reduction
- 26.14.5 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

26.15 Cardiovascular testing

- 26.15.1 Interpret and use the results of the following to assess risk and appropriately modify perioperative management
 - 26.15.1.1 ECG
- 26.15.2 Use the results of the following to assess risk and appropriately modify perioperative management
 - 26.15.2.1 Echocardiography
 - 26.15.2.2 Stress testing, dobutamine stress echocardiography
 - 26.15.2.3 Perfusion imaging
 - 26.15.2.4 Coronary angiography
 - 26.15.2.5 Ventriculography

B) Respiratory

26.16 Airway assessment

- 26.16.1 Predict difficulty with laryngoscopy and intubation by use of history and physical findings

- 26.16.2 Predict difficulty with manual ventilation by use of history and physical findings
- 26.16.3 Use investigations including xray, computed tomography and pulmonary function studies to identify and/or quantify airway management concerns
- 26.16.4 Identify, grade the severity and list the implications of special airway situations including
 - 26.16.4.1 Airway obstruction – intra and extrathoracic
 - 26.16.4.2 Mediastinal mass
 - 26.16.4.3 Bronchopleural fistula
 - 26.16.4.4 Tracheo-esophageal fistula
 - 26.16.4.5 Tracheal stenosis
 - 26.16.4.6 Anatomic/structural abnormalities congenital and acquired
 - 26.16.4.7 Difficult airway and cognitive impairment
 - 26.16.4.8 Patient scheduled for tracheotomy
- 26.16.5 Prescribe appropriate preoperative therapy to facilitate difficult airway management
- 26.16.6 Coordinate the availability of special equipment, support and logistical preparation for special airway situations
- 26.16.7 Provide pertinent information to prepare the patient with awake intubation or possibility of dental damage
- 26.16.8 Manage side effects and complications of intubation e.g. Dental damage
- 26.17 Respiratory risk assessment
 - 26.17.1 Identify, grade the severity and estimate the impact on risk of perioperative complications of COPD, Asthma
 - 26.17.2 Restrictive defect
 - 26.17.3 Bullous lung disease/Bronchopleural fistula CO₂ retention
 - 26.17.4 Obstructive +/- or central sleep apnea
 - 26.17.5 Recurrent aspiration
 - 26.17.6 ARDS
 - 26.17.7 CF/bronchiectasis
 - 26.17.8 Infection (pneumonia, upper respiratory tract infection, empyema)
 - 26.17.9 Pneumothorax/Chest tube

26.18 Reduction of respiratory risk

- 26.18.1 Identify patients with contagious pulmonary infection, coordinate special precautions for perioperative period
 - 26.18.1.1 Identify and coordinate the availability of special intraoperative interventions to manage patients with any of the above problems
 - 26.18.1.2 Provide appropriate preoperative therapy to reduce the severity of the above problems
 - 26.18.1.3 Smoking cessation
 - 26.18.1.4 Utilize consultants effectively to assist in assessing perioperative respiratory problems and reducing risk
 - 26.18.1.5 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
 - 26.18.1.6 Identify patients that would benefit from postoperative monitoring in an enhanced or intensive care unit

26.19 Assessment for lung resection

- 26.19.1 Estimate the impact of the proposed procedure on perioperative outcome using history, physical and laboratory information
- 26.19.2 Estimate the extent of resection that an individual patient is expected to tolerate utilizing PFTs, ABG, and VO₂ max testing

26.20 Pulmonary testing

- 26.20.1 Order appropriate lung function testing to assist with perioperative decision making
- 26.20.2 Interpret and use the results of the following to assess risk and appropriately modify perioperative management
 - 26.20.2.1 Flow and volume studies
 - 26.20.2.2 Diffusion measurement
 - 26.20.2.3 Arterial blood gases
 - 26.20.2.4 XRays of chest, neck, airway
 - 26.20.2.5 CT of airway/lungs
- 26.20.3 Integrate the results of the following to assess risk and appropriately modify perioperative management
 - 26.20.3.1 Sleep studies
 - 26.20.3.2 Exercise studies
 - 26.20.3.3 Ventilation/perfusion scan

26.20.3.4 CT chest

C) Neurological

26.21 Intracranial mass

- 26.21.1 Assess the implications for perioperative outcome and anesthetic management of intracranial mass lesions based on location, size, and proposed procedure
- 26.21.2 Manage reversible contributions to increase ICP
- 26.21.3 Identify and assess the severity of increased ICP

26.22 Seizure disorder

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

26.23 Cognitive impairment

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

26.24 Neurovascular

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

26.25 Peripheral Neuropathy

- 26.25.1 Identify common causes of perioperative neuropathy

- 26.25.2 Utilize appropriate consultation to diagnose peripheral neuropathy
- 26.25.3 Discuss the relevance of peripheral neuropathy to choice of anesthetic

26.26 Spinal cord

- 26.26.1 Assess the severity and anesthetic implications of spinal cord impingement and threats to spinal cord perfusion
- 26.26.2 Assess the physiologic effects and anesthetic implications of pre-existing spinal cord injury. Assess the risk and anesthetic implication of autonomic hyperreflexia
- 26.26.3 Movement disorders
- 26.26.4 Identify movement disorders significant for anesthetic management
- 26.26.5 Utilize appropriate consultation to diagnose and stabilize movement disorders preoperatively
- 26.26.6 Identify anesthetic implications of movement disorders, including drug interactions
- 26.26.7 Identify anesthetic implications of pharmacotherapy for movement disorders and its withdrawal

26.27 Myopathies

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

26.28 Neuromuscular

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

26.29 Psychiatric

- 26.29.1 Identify patients taking antidepressant medication and be aware of the anesthetic considerations and potential drug interactions especially with monoamine oxidase inhibitors/SSRIs
- 26.29.2 Assess patient suitability for ECT and identify patient at increased risk for morbidity from ECT

26.30 Neurologic investigations

26.30.1 Interpret and use the results of the following to assess risk and appropriately modify perioperative management

26.30.1.1 CT head, spine

26.30.1.2 Xray c-spine

26.30.1.3 MRI Transcranial Doppler Imaging, Carotid Doppler, Angiography

26.30.1.4 EEG

26.30.1.5 EMG

D) Gastrointestinal

26.31 Identify risk factors for preoperative reflux and provide appropriate prophylaxis

26.32 Use information from consultants to characterize, grade the severity and assess the physiologic and anesthetic implications of hepatic dysfunction

26.33 Identify the presence and type of infectious hepatitis and assess the infectious risk

26.34 Identify the physiologic effects, comorbidities, metastatic spread, and anesthetic implications of GI malignancies, Carcinoid syndrome, paraneoplastic syndrome, thrombosis

26.35 Assess the anesthetic implications of chemotherapy used and coordinate laboratory/investigation for their systemic effects

26.36 Use the results of the following to assess risk and appropriately modify perioperative management

26.36.1 Abdominal imaging

26.36.2 Liver function testing

E) Musculoskeletal

26.37 Grade the severity, mechanical and anesthetic implications and other system involvement of:

26.37.1 Rheumatoid arthritis

26.37.2 Osteoarthritis

26.37.3 Ankylosing spondylitis

26.37.4 Osteogenesis imperfecta

26.37.5 Osteoporosis bone metastasis, dermatomyosites

26.38 Assess the anesthetic implications of pharmacology for the above and recommend appropriate perioperative management

26.39 Interpret and use the results of the following to assess risk and appropriately modify perioperative management

26.39.1 CT C-spine

26.39.2 Xray C T and L-spine

F) Dermatologic

26.40 Grade the severity, mechanical and anesthetic implications and other system involvement of:

26.40.1 Bullous diseases

26.40.2 Psoriasis

26.40.3 Scleroderma

26.40.4 Assess the anesthetic implications of burn injury

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

G) Hematologic

26.42 Identify abnormalities of hemostasis on preoperative history

26.43 Specify hematologic disease (von Willebrand, hemophilia etc.)

26.44 Interpret results of screening tests for hemostasis

26.45 Utilize laboratory testing to characterize hypercoagulable disorders including:

26.45.1 Protein C, S, antithrombin III deficiencies

26.45.2 Homocysteinuria

26.45.3 Heparin induced thrombocytopenia

26.45.4 DIC V Leiden Factor

26.46 Utilize appropriate consultation to characterize the type and severity of other abnormalities of hemostasis, and provide preoperative optimization

26.47 Identify indications for thromboprophylaxis

26.48 Modify pre-existing anticoagulant/antiplatelet therapy to balance risks of intraoperative bleeding and thrombotic complications

26.49 Identify, diagnose and treat preoperative anemia using history physical and laboratory information

26.50 Utilize consultation appropriately to evaluate and treat uncommon causes of anemia bone marrow transplantation, patient with hematologic cancer hemoglobin disorders (thalassemia, IgA deficit, sickle cell disease, porphyria, etc.)

26.51 Identify and utilize consultation to characterize and treat thrombocytopenia

- 26.52 Quantify expected blood loss and coordinate a plan to reduce the likelihood of allogeneic transfusion
- 26.53 Explain to patients the indications, risks and benefits of methods of optimizing preoperative haemoglobin and preoperative autologous donation
- 26.54 Interpret and use the results of the following to assess risk and appropriately modify perioperative management
 - 26.54.1 CBC
 - 26.54.2 Anemia investigations excluding bone marrow
 - 26.54.3 Hemoglobin electrophoresis
- 26.55 Use the results of the following to assess risk and appropriately modify perioperative management
 - 26.55.1 Bone marrow biopsy
 - 26.55.2 Platelet function testing
 - 26.55.3 Coagulation testing and factor levels
 - 26.55.4 Thromboelastography

H) Endocrine/Metabolic - See Endocrinology 8

I) Transplanted Organ - See Transplantation 33

27 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

27.1 Demonstrate knowledge of the pharmacology of the local anesthetic with respect to:

27.1.1 Mechanism of Action

- 27.1.1.1 Explain the effects of sodium channel blockade on the action potential
- 27.1.1.2 Explain how local anesthetic blocks the sodium channel
- 27.1.1.3 Explain the mechanism of factors facilitating and hindering local anesthetic effect at the sodium channel

27.1.2 Toxicity

- 27.1.2.1 Identify the manifestations of systemic toxicity
- 27.1.2.2 Demonstrate knowledge of the different forms of local anesthetic (LA) toxicity – cardiac toxicity, direct neurotoxicity; methaemoglobinaemia; allergy
- 27.1.2.3 Identify and provide appropriate management of local anesthetic toxicity
- 27.1.2.4 Describe the mechanisms of LA neurologic and cardiac toxicity
- 27.1.2.5 Demonstrate knowledge of factors influencing the development of CNS & CVS toxicity (e.g. speed of injection; site of injection; maximal doses; LA potency; hypercarbia; use of vasoconstrictors; cardiac/liver disease)

27.1.3 Kinetics

- 27.1.3.1 Describe drug, patient and technical factors contributing to speed of onset of local anesthetics
- 27.1.3.2 Describe the drug, patient and technical factors contributing to recovery from LA
- 27.1.3.3 Describe the determinants of serum LA concentration, its measurement, and the role of protein binding

27.1.4 Structure Activity Relationships

- 27.1.4.1 Describe the molecular structure of LA, and the resultant effects on kinetics and dynamics
- 27.1.4.2 Describe the differences between amide & ester local anesthetics

with examples of each. Understand the physicochemical properties of potency; protein binding; pKa & pH

27.1.4.3 Describe the relationship between LA & differential blockade

27.1.5 Adjuvants

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

27.1.5.1.1 Epinephrine

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

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

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

27.1.5.1.1.4 Describe the mechanisms of the above effects

27.1.5.1.2 Bicarbonate

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

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

27.1.5.1.3 Opioids

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

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

27.1.5.1.4 Alpha-agonists

27.1.5.1.4.1 Discuss the rationale for and against and clinical utility of addition of alpha-agonists to local anesthetics for peripheral regional blockade

27.1.5.1.4.2 Describe the mechanisms, doses, clinical effects and adverse effects of alpha-agonists in neuraxial blockade

27.1.5.1.5 NMDA Antagonists

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

B) Physiology

27.2 Describe the following physiologic principles relevant to regional anesthesia

27.2.1 Nerve Conduction

- 27.2.1.1 Describe the structural classification of nerve types and the relevance to local anesthetic action
- 27.2.1.2 Explain the generation of nerve action potential, refractory period and recovery
- 27.2.1.3 Describe the structure of nerves

27.2.2 Effects of Neuraxial Blockade

- 27.2.2.1 Describe the cardiorespiratory effects of neuraxial blockade
- 27.2.2.2 Describe the differences and similarities between spinal and epidural blockade with respect to mechanism of action, effects of adjuvants and cardiorespiratory physiology
- 27.2.2.3 Describe the effects of neuraxial blockade on coagulation
- 27.2.2.4 Describe the effects of neuraxial blockade on the neurohumoral stress response
- 27.2.2.5 Describe the effects of neuraxial blockade on postoperative respiratory effects of surgery
- 27.2.2.6 Describe the effects of neuraxial blockade on intraoperative blood loss (controlled hypotension)
- 27.2.2.7 Identify factors influencing spread of spinal/epidural anesthesia

27.2.3 The Neuroendocrine Stress Response

- 27.2.3.1 Describe the systems affected by the stress response, and the overall impact on each of those systems
- 27.2.3.2 Describe the specific changes within each of the affected systems that leads to the overall functional impact on those systems
- 27.2.3.3 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

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

27.3.1 Nerve Stimulation

- 27.3.1.1 Describe the rationale for the use of stimulations for locating nerves
- 27.3.1.2 Discuss the advantages, disadvantages and limitations of nerve stimulation as a means of locating nerves
- 27.3.1.3 List and explain the characteristics of the ideal nerve stimulator
- 27.3.1.4 Describe the response characteristics of different nerve fibers to stimulation
- 27.3.1.5 Use stimulation to safely and effectively perform regional blocks
- 27.3.1.6 Different types of needles – insulated vs. non-insulated needles

27.3.2 Ultrasound

- 27.3.2.1 Describe the relative advantages, disadvantages and limitations of ultrasound as a method of locating nerves
- 27.3.2.2 Describe the basic physics principles of ultrasound and their clinical relevance in identifying different anatomic structures
- 27.3.2.3 Choose the appropriate ultrasound probe and machine settings to properly identify the desired structure
- 27.3.2.4 List and explain the characteristics of the ideal ultrasound machine
- 27.3.2.5 Identify the ultrasonographic anatomy relevant to nerve localization
- 27.3.2.6 Use ultrasound to safely and effectively perform regional blocks
- 27.3.2.7 Static vs. dynamic use of ultrasound
- 27.3.2.8 In-plane vs. Out-of-plane techniques

D) Clinical Application of Regional Anesthesia

27.4 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:

27.4.1 Anesthetic Planning

- 27.4.1.1 Generate and implement an anesthetic plan including appropriate options, contingency plans and expectations
- 27.4.1.2 Select an appropriate regional anesthetic technique(s) for anesthetic care

- 27.4.1.3 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
- 27.4.1.4 Discuss regional PLUS GA vs. GA vs. regional
- 27.4.1.5 Discuss the use of regional techniques pre vs. post induction of general anesthesia
- 27.4.1.6 Regional techniques in pediatric anesthesia

- 27.4.2 Nerve Localization
 - 27.4.2.1 Describe anatomic landmarks for performance of blocks
 - 27.4.2.2 Utilize nerve stimulation for identification of plexuses and peripheral nerves for regional anesthetic techniques within his/her scope of practice
 - 27.4.2.3 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

- 27.5 Demonstrate knowledge of the limitations of regional anesthesia including contraindications and complications
 - 27.5.1 Contraindications to Regional Anesthesia
 - 27.5.1.1 Identify and, where appropriate, manage relative and absolute contraindications to regional anesthetics

 - 27.5.2 Anticoagulation and Regional Anesthesia
 - 27.5.2.1 Develop an approach to regional anesthesia in the patient with abnormal coagulation parameters
 - 27.5.2.2 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
 - 27.5.2.3 Assess the appropriate timing of regional anesthetic procedures relative to anticoagulation therapy
 - 27.5.2.4 Modify the anticoagulation, anesthetic plan or both appropriately in order to minimize overall risk and improve outcome
 - 27.5.2.5 Interact with surgeons and administrators to create policies governing the interaction of anticoagulation and anesthetic/analgesic management

27.5.3 Complications of Regional Anesthesia

27.5.3.1 Describe the complications of regional anesthesia and the risk factor, presentation, diagnosis and treatment of:

- 27.5.3.1.1 Failed block
- 27.5.3.1.2 Intravascular injection of local anesthetic
- 27.5.3.1.3 Overdose
- 27.5.3.1.4 Epidural hematoma & abscess
- 27.5.3.1.5 Anterior spinal artery syndrome
- 27.5.3.1.6 Post Dural Puncture Headache (PDPH)
- 27.5.3.1.7 Post-operative neuropathy
- 27.5.3.1.8 Inadvertent spinal/subdural block

F) Spectrum of Anesthesia Techniques

27.6 Demonstrate knowledge of the spectrum of regional anesthetic techniques and perform those relevant to the anesthesiologist's level of training

27.7 Demonstrate knowledge of basic surface anatomy & palpable landmarks and the dermatomal & peripheral nerve distribution as applicable to each specific block

27.8 Describe site-specific equipment; indications; contraindications & drug selection for each block

27.8.1 Neuraxial Blocks

27.8.1.1 Spinal – single shot midline and paramedian

27.8.1.2 Epidural

27.8.1.2.1 T1-4

27.8.1.2.2 T4-8

27.8.1.2.3 T8-L-5

27.8.1.2.4 Caudal

27.8.2 Upper Extremity Blocks

27.8.2.1 Interscalene

27.8.2.2 Supraclavicular

27.8.2.3 Infraclavicular

27.8.2.4 Axillary

27.8.2.5 At the elbow

27.8.2.5.1 Median nerve

27.8.2.5.2 Musculocutaneous nerve

27.8.2.5.3 Radial nerve

27.8.2.6 At the wrist and hand

27.8.2.6.1 Ulnar nerve

27.8.2.6.2 Median nerve

27.8.3 Radial Nerve

27.8.3.1 Digital nerves

27.8.4 Lower Extremity Blocks

27.8.4.1 Lumbar plexus

27.8.4.2 Femoral nerve block/3 – in – 1 block

27.8.5 Sciatic block

27.8.5.1 Popliteal

27.8.5.2 Ankle block

27.8.6 All Limbs – IVRA (Bier block)

27.8.7 Trunk Blocks

27.8.7.1 Parvertebral block

27.8.7.2 Intercostal nerve block

27.8.7.3 Ilioinguinal/iliohypogastric

27.8.7.4 Penile block

27.8.8 Head and Neck Blocks

27.8.8.1 Supraorbital nerve block

27.8.8.2 Mental nerve block

27.8.8.3 Mandibular never block

27.8.8.4 Occipital nerve block

27.8.8.5 Superficial cervical plexus

27.8.8.6 Retrobulbar & peribulbar blocks

27.8.9 Airway Blocks

27.8.10 Topicalization

27.8.10.1 Superior laryngeal

27.8.10.2 Lingual nerve

27.8.10.3 Transtracheal block

28 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, Cardiac Catheterization Laboratories, Image Guided therapy suites and endoscopy suites

A) Physical Requirements

- 28.1 Demonstrate an understanding of the physical requirements for provision of anesthesia in remote locations:
 - 28.1.1 The anesthetizing location must conform to electrical code and excess anesthetic gas scavenging
 - 28.1.2 Medical gas pipelines must meet the same standards as a regular operating room
 - 28.1.3 The anesthetic machine must conform to CAS standards
 - 28.1.4 Standard CAS monitors are required
 - 28.1.5 Standard emergency drugs and equipment must be readily available
 - 28.1.6 Anesthetic machines, monitoring and scavenging are the same as would be expected in a regular operating room, including resuscitation equipment etc.

B) Personnel

- 28.2 Demonstrate an understanding of the personnel required to provide safe anesthesia
 - 28.2.1 Appropriate ancillary help must be available to the anesthesiologist

C) The Nature of the Remote Locations

- 28.3 Demonstrate an understanding of the unique considerations for each location, including the fact that these are frequently distant from the main operating room
 - 28.3.1 Interventional Radiology
 - 28.3.1.1 Radiation exposure: Patients and staff
 - 28.3.1.2 Anesthetic considerations
 - 28.3.1.2.1 Limited access to patient
 - 28.3.1.2.2 Movement of radiological equipment
 - 28.3.1.2.3 Temperature management
 - 28.3.1.3 Contract media complications
 - 28.3.1.3.1 Anaphylaxis

- 28.3.1.3.2 Interaction with Metformin
- 28.3.1.3.3 Renal failure

- 28.3.1.4 Temperature regulation
- 28.3.1.5 Variety of procedures and their implications
 - 28.3.1.5.1 Biopsies
 - 28.3.1.5.2 Angiography
 - 28.3.1.5.3 AAA stent graft
 - 28.3.1.5.4 Carotid artery stent
 - 28.3.1.5.5 Kyphoplasty/vertebroplasty
 - 28.3.1.5.6 TIPS (transjugular intrahepatic portosystemic shunt)
 - 28.3.1.5.7 Cerebral Aneurysm / AV malformation coiling
 - 28.3.1.5.8 Radiofrequency ablation
 - 28.3.1.5.9 E.G. vascular access procedures, biopsies, drain insertion angiography

- 28.3.2 MRI
 - 28.3.2.1 Implications of magnetic field
 - 28.3.2.2 Patient selection
 - 28.3.2.3 MRI compatible anesthesia equipment and monitors
 - 28.3.2.4 Management of resuscitation
 - 28.3.2.5 Noise
 - 28.3.2.6 Management of patient claustrophobia

- 28.3.3 Cardiac Catheterization Laboratory
 - 28.3.3.1 Considerations as per Interventional Radiology
 - 28.3.3.2 Specific considerations for cardiac patients
 - 28.3.3.2.1 Pediatric congenital heart disease
 - 28.3.3.2.2 Adult valvular heart disease
 - 28.3.3.2.3 Coronary artery disease
 - 28.3.3.2.4 Cardiomyopathies
 - 28.3.3.2.5 Dysrhythmias – pacemakers and ICD's

 - 28.3.3.3 Type of procedure: diagnostic vs. therapeutic
 - 28.3.3.3.1 AICD

28.3.3.3.2 Electrophysiologic Studies

28.3.4 Endoscopy Suites

28.3.4.1 Implications of bowel preparation on hydration and electrolytes

28.3.4.2 Shared airway e.g. upper endoscopy

D) Electroconvulsive Therapy

28.4 Indications

28.5 Contraindications

28.6 Complications and management

28.6.1 Bradycardia

28.6.2 Tachycardia

28.6.3 Hypertension

28.6.4 Failure of seizure

E) Post Procedure Disposition

28.7 Demonstrate knowledge with respect to postanesthetic care of these patients

28.7.1 Location

28.7.1.1 Local vs. OR PACU

28.7.2 Discharge planning

28.7.3 Anticipation of complications

28.7.4 Lack of Anesthesiology personnel available to deal with emergencies

29 Renal / Urologic

Prevention of perioperative morbidity and mortality depends in part upon an understanding of renal physiology and pharmacology and the effects of alterations in renal function on the excretion of drugs administered during and after surgery. Therefore, the anesthesiologist must demonstrate knowledge and understanding of Anesthesiology and the renal system.

A) Basic Science

- 29.1 Demonstrate knowledge of the anatomy and physiology of the renal excretory system
 - 29.1.1 Functional Anatomy of the Kidneys, Ureters, and Bladder
 - 29.1.1.1 Description of the nephron
 - 29.1.1.2 Description of the renal circulation and its regulation
 - 29.1.2 Physiology of Urine Formation
 - 29.1.2.1 Sodium filtration and reabsorption
 - 29.1.2.2 Water filtration and reabsorption
 - 29.1.2.3 Physiologic control of glomerular filtration and solute reabsorption
 - 29.1.3 Neurohumoral Regulation of Renal Function
 - 29.1.3.1 Aldosterone Antidiuretic
 - 29.1.3.2 hormone Atrial
 - 29.1.3.3 natriuretic peptide
 - 29.1.3.4 Prostaglandins
 - 29.1.4 Neuroendocrine Response to Stress of Trauma and Surgery
 - 29.1.5 Effects of Anesthesia on Renal Function
 - 29.1.6 Evaluation and Interpretation of Renal Function Tests
 - 29.1.6.1 BUN, creatinine, ratio, clearance
 - 29.1.6.2 Urinalysis: Na, osmolarity, proteinuria, hematuria, urine sediment
 - 29.1.7 Pharmacology of the Renal System
 - 29.1.7.1 Potential nephrotoxic agents
 - 29.1.7.2 Renal excretion of anesthetic drugs
 - 29.1.7.3 Pharmacology and classification of diuretics

B) Renal Protection

- 29.2 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

C) Pathology

- 29.3 Demonstrate knowledge of pathologies related to the renal system:

29.3.1 Chronic Renal Failure

- 29.3.1.1 Clinical characteristics / the uremic syndrome
- 29.3.1.2 Dialysis treatment: indications, types, physiologic effects and complications
- 29.3.1.3 Anesthetic management of the patient with chronic renal failure:
 - 29.3.1.3.1 Preoperative evaluation / optimization
 - 29.3.1.3.2 Monitoring
 - 29.3.1.3.3 Selection of anesthetic agents

29.3.2 Acute Renal Failure

- 29.3.2.1 Pathophysiology of oliguria
 - 29.3.2.1.1 Types
 - 29.3.2.1.2 Diagnostic tests
 - 29.3.2.1.3 Management

29.3.3 Hepatorenal Syndrome

- 29.3.3.1 Pathophysiology
- 29.3.3.2 Treatment
- 29.3.3.3 Response to liver transplant

D) Anesthesia for Urologic Procedures

- 29.4 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 will help the anesthesiologist optimize preoperative preparation, intraoperative anesthetic management and postanesthetic care of these patients
- 29.5 Demonstrate understanding of the considerations of, and to independently provide anesthetic care for patients presenting for the following procedures:
- 29.5.1 Transurethral Resection of the Prostate
 - 29.5.1.1 List the complications of TURP

- 29.5.1.2 Describe the TURP syndrome and its treatment

- 29.5.2 Prostatectomy: Open and Laparoscopic Lithotripsy
 - 29.5.2.1 Percutaneous ultrasonic lithotripsy
 - 29.5.2.2 Extracorporeal shock wave lithotripsy (ESWL)

- 29.5.3 Endourologic Procedures
 - 29.5.3.1 Urethral
 - 29.5.3.2 Bladder
 - 29.5.3.3 Ureteral

- 29.5.4 Nephrectomy
- 29.5.5 Renal Transplant

30 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

30.1 Anatomy of respiratory tract

- 30.1.1 Anatomy of the airway and upper airway muscles
- 30.1.2 Anatomy of the Tracheobronchial tree
- 30.1.3 Functional histology and anatomy of the alveolus
- 30.1.4 Pulmonary and bronchial circulation
- 30.1.5 Pulmonary lymphatics

30.2 Pulmonary physiology

30.2.1 Pulmonary mechanics: Elastic forces and lung volumes

- 30.2.1.1 Elastic recoil of the lungs and chest wall
- 30.2.1.2 Surface tension, surfactant, and its effects on lung mechanics
- 30.2.1.3 Alveolar, intrapleural and transmural pressures and their relationship
- 30.2.1.4 Hysteresis
- 30.2.1.5 Lung and chest wall compliance and elastance
- 30.2.1.6 Static compliance versus dynamic compliance
- 30.2.1.7 Lung volumes, Functional Residual Capacity (FRC)
- 30.2.1.8 Physiologic changes with aging
- 30.2.1.9 Principles of measurement of lung volumes, lung compliance

30.2.2 Pulmonary mechanics: Respiratory system resistance

- 30.2.2.1 Principles of gas flow and resistance: laminar flow, turbulent flow, flow through and orifice, Reynolds number
- 30.2.2.2 Respiratory system resistance
- 30.2.2.3 Gas trapping
- 30.2.2.4 Airway closure, closing capacity and closing volumes
- 30.2.2.5 Flow-related airway collapse
- 30.2.2.6 Neuromuscular control of airway diameter
- 30.2.2.7 Pharmacology affecting airway resistance
- 30.2.2.8 Measurement of airway resistance and closing capacity

30.2.3 Control of breathing

- 30.2.3.1 Central nervous system control of respiratory drive
- 30.2.3.2 Peripheral receptors and respiratory drive
- 30.2.3.3 Lung reflexes
- 30.2.3.4 Carbon dioxide and respiratory control
- 30.2.3.5 Oxygen, respiratory control and the response to hypoxia
- 30.2.3.6 Effects of drugs on respiratory drive
- 30.2.3.7 Methods of assessing control of breathing and sensitivity to hypoxia

30.2.4 Pulmonary ventilation

- 30.2.4.1 Functional anatomy of the muscles of respiration
- 30.2.4.2 Postural effects on respiratory muscle function
- 30.2.4.3 Work of breathing
- 30.2.4.4 Work against resistance
- 30.2.4.5 Work against elastic recoil
- 30.2.4.6 Measurement of ventilation
- 30.2.4.7 Neuronal control of respiratory muscle function
- 30.2.4.8 Respiratory muscle fatigue

30.2.5 Pulmonary circulation

- 30.2.5.1 Pulmonary blood flow and blood volume
- 30.2.5.2 Pulmonary vascular pressures
- 30.2.5.3 Pulmonary vascular resistance
- 30.2.5.4 Control of vascular tone – cellular mechanisms and neural control
- 30.2.5.5 Control of vascular tone – pharmacology
- 30.2.5.6 Effects of hypoxia and hypoxic pulmonary vasoconstriction
- 30.2.5.7 Effects of lung volume
- 30.2.5.8 Effect of lung inflation on pulmonary blood flow, pulmonary vascular resistance, and cardiac output
- 30.2.5.9 Principles of measurement of pulmonary flow, cardiac output and pulmonary vascular resistance

30.2.6 Distribution of pulmonary blood flow and ventilation

- 30.2.6.1 Distribution of ventilation

- 30.2.6.2 Anatomical distribution of ventilation
- 30.2.6.3 Gravitational effects on compliance and ventilation distribution
- 30.2.6.4 Gravitational effects on pleural pressure
- 30.2.6.5 Distribution related to rate of alveolar filling – time constants
- 30.2.6.6 Distribution of perfusion
- 30.2.6.7 Gravitational effects on perfusion distribution
- 30.2.6.8 Gravity independent determinants of regional blood flow, (cardiac output, lung volume)
- 30.2.6.9 West's four zones of the lung
- 30.2.6.10 Ventilation: perfusion matching – V/Q ratio
- 30.2.6.11 Alveolar gas tensions
- 30.2.6.12 Dead space – anatomical and physiological
- 30.2.6.13 Quantification of dead space
- 30.2.6.14 Bohr, (dead space), equation
- 30.2.6.15 Venous admixture or shunt
- 30.2.6.16 Effect of V/Q ratio on arterial PO₂
- 30.2.6.17 Measurement of ventilation / perfusion matching
- 30.2.6.18 Alveolar air equation
- 30.2.6.19 Measurement of dead space

- 30.2.7 Gas diffusion
 - 30.2.7.1 Diffusion of oxygen from alveolus to the red blood cell (RBC)
 - 30.2.7.2 Diffusion of oxygen within the RBC and uptake by hemoglobin
 - 30.2.7.3 Diffusion of carbon monoxide by hemoglobin and measurement of diffusing capacity
 - 30.2.7.4 Factors affecting diffusing capacity

- 30.2.8 Oxygen
 - 30.2.8.1 The oxygen cascade
 - 30.2.8.2 Factors affecting alveolar oxygen tension
 - 30.2.8.3 The shunt equation
 - 30.2.8.4 Oxygen carriage in the blood
 - 30.2.8.5 Oxygen delivery and oxygen consumption and its measurement
 - 30.2.8.6 Physical solution
 - 30.2.8.7 Hemoglobin

- 30.2.8.8 The oxyhemoglobin dissociation curve and factors affecting affinity of hemoglobin for oxygen
 - 30.2.8.9 Abnormal forms of hemoglobin
 - 30.2.8.10 Oxygen stores
 - 30.2.8.11 The role of oxygen in the cell
 - 30.2.8.12 Energy production
 - 30.2.8.13 Aerobic and anaerobic metabolism
 - 30.2.8.14 Oxidative phosphorylation
 - 30.2.8.15 Critical oxygen tension
 - 30.2.8.16 Cyanosis
 - 30.2.8.17 Methods of oxygen delivery
 - 30.2.8.18 Oxygen toxicity
 - 30.2.8.19 Measurement of oxygen levels – blood gases, pulse oximetry, tissue PO₂
 - 30.2.8.20 Mechanisms and Effects of hypoxia
 - 30.2.8.21 V/Q mismatch, shunt, decreased FiO₂, hypoventilation
 - 30.2.8.22 Mechanisms of hypoxia under anesthesia
 - 30.2.8.23 Physiologic effects of hypoxia
- 30.2.9 Carbon dioxide
- 30.2.9.1 Carriage of carbon dioxide in the lung
 - 30.2.9.2 Physical solution
 - 30.2.9.3 Carbonic acid and effect of carbonic anhydrase
 - 30.2.9.4 Bicarbonate ion
 - 30.2.9.5 Carbamino carriage
 - 30.2.9.6 Haldane effect
 - 30.2.9.7 Distribution of CO₂ in the blood
 - 30.2.9.8 Factors affecting carbon dioxide tension
 - 30.2.9.9 Alveolar CO₂ – effect of ventilation
 - 30.2.9.10 End expiratory CO₂
 - 30.2.9.11 Carbon dioxide output
 - 30.2.9.12 Measurement of carbon dioxide
 - 30.2.9.13 Physiologic effects of hypercapnia and hypocapnia

30.3 Non-respiratory functions of the lung

- 30.3.1 Filtration
- 30.3.2 Biological hazards
- 30.3.3 Metabolism of endogenous compounds
- 30.3.4 Pulmonary interstitial fluid mechanics
- 30.3.5 Starling equation

B) Physics of gas delivery - See Monitoring and Equipment 15.2

C) Inhaled Anesthetics - See Volatiles 34

D) Thoracic Anesthesia

30.4 Demonstrate the knowledge and ability to provide care for patients presenting for thoracic surgery, including but not limited to:

- 30.4.1 Preoperative assessment and optimization of the patient for thoracic surgery
- 30.4.2 Chest radiology
- 30.4.3 Fiberoptic bronchoscopy
- 30.4.4 Physiology of the lateral decubitus position, the open chest and one lung ventilation
- 30.4.5 Indications for one lung ventilation
- 30.4.6 Regional anesthesia for thoracic surgery
- 30.4.7 Anesthetic management for thoracotomy and pulmonary resection
- 30.4.8 Anesthesia for esophageal and mediastinal surgery, including management of patients with a mediastinal mass
- 30.4.9 Management of thoracic trauma
- 30.4.10 Lung isolation for management of hemoptysis and bronchopleural fistula

E) Thoracic Surgical Procedures

30.5 Independently provide anesthetic management for:

- 30.5.1 Tracheostomy
- 30.5.2 Rigid and fiberoptic bronchoscopy
- 30.5.3 Bronchoscopy and Mediastinoscopy
- 30.5.4 One-lung ventilation
- 30.5.5 Lobectomy/Pneumonectomy
- 30.5.6 Esophageal resection

- 30.5.7 Video assisted thoracoscopy
- 30.5.8 Endobronchial surgery, including laser resection
- 30.5.9 Transthoracic vertebral surgery Management of
- 30.5.10 post-thoracotomy pain Management of post-
- 30.5.11 thoracotomy complications

31 Statistics

A) Definition of terms

- 31.1 Define the following statistical terms and state their differences where appropriate:
- 31.1.1 Mean; median; mode
 - 31.1.2 Standard deviation (SD); standard error of the mean (SEM); 95% confidence interval (95% CI)
 - 31.1.3 Type of data: continuous (ordinal/interval/ratio) vs. categorical (nominal)
 - 31.1.4 Distribution of data: normal (Gaussian) vs. non-normal
 - 31.1.5 α and P value (level of statistical significance) vs. β and statistical power (1- β)
 - 31.1.6 Type 1 error vs. type II error
 - 31.1.7 One vs. two sample tests; multiple sample tests
 - 31.1.8 One-tailed vs. two-tailed tests and when to use them
 - 31.1.9 Linear regression vs. correlation
 - 31.1.10 Bias
- 31.2 Define the following statistical terms and concepts, and independently compute corresponding values:
- 31.2.1 Sensitivity
 - 31.2.2 Specificity
 - 31.2.3 Positive predictive value
 - 31.2.4 Negative predictive value
 - 31.2.5 Incidence
 - 31.2.6 Prevalence
 - 31.2.7 Odds ratio
 - 31.2.8 Relative risk
 - 31.2.9 Absolute risk
 - 31.2.10 Number needed to treat (NNT)
 - 31.2.11 Number needed to harm (NNH)
 - 31.2.12 Intention-to-treat analysis

B) Statistical tests

- 31.3 Demonstrate knowledge of when the following statistical tests should be used for the following data types:
 - 31.3.1 Comparisons of two groups
 - 31.3.1.1 Continuous Gaussian data: Student's *t* test (parametric testing)
 - 31.3.1.2 Continuous non-Gaussian data: Mann-Whitney *U* test/Wilcoxon rank-sum test (non-parametric testing)
 - 31.3.1.3 Categorical data: Fisher's exact test or chi-square test (contingency tables)

C) Study Characteristics

- 31.4 Perform the following:
 - 31.4.1 State the variables required for an a *priori* power analysis/sample size projection:
 - 31.4.1.1 Desired level of statistical significance (*a*)
 - 31.4.1.2 Desired power ($1 - \beta$)
 - 31.4.1.3 Minimum clinically important difference to be detected
 - 31.4.2 Evaluate statistical and clinical significance of the findings
 - 31.4.2.1 Correctly interpret P values
 - 31.4.2.2 Correctly interpret measures of data scatter/dispersion/variance (e.g. standard deviation)
 - 31.4.2.3 State the difference between primary and secondary outcome variables
 - 31.4.2.4 Define and state the differences between the following types of experimental design
 - 31.4.3 Systematic reviews of the literature and meta-analyses
 - 31.4.3.1 Experimental studies
 - 31.4.3.2 Non-randomized and quasi-randomized controlled trials
 - 31.4.3.3 Randomized controlled clinical trials (RCTs)
 - 31.4.3.3.1 Double-blinded
 - 31.4.3.3.2 Single-blinded
 - 31.4.3.3.3 Non-blinded
 - 31.4.3.4 Observational analytic studies (retrospective or prospective)
 - 31.4.3.4.1 Cross-sectional studies

31.4.3.4.2 Case-control studies

31.4.3.4.3 Cohort studies

31.4.3.5 Descriptive studies

31.4.3.5.1 Surveys

31.4.4 Demonstrate awareness of the following methods/tools and be able to explain their purpose, but is not expected to manage by themselves

31.4.4.1 Univariate and multivariate statistics

31.4.4.2 Kaplan-Meyer analysis and comparison of survival curves (logrank test)

32 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

- 32.1 Define mild, moderate and deep hypothermia
- 32.2 Demonstrate knowledge of the mechanisms of heat loss during anesthesia
 - 32.2.1 Convection
 - 32.2.2 Conduction
 - 32.2.3 Radiation
 - 32.2.4 Evaporation
 - 32.2.5 Decreased heat production/metabolism
 - 32.2.6 Prepping, draping/exposure IV fluid & blood products
 - 32.2.7 Vasodilation/Central neural blockade

B) Principles of temperature measurement

- 32.3 Sites
- 32.4 Accuracy

C) Thermoregulation

- 32.5 Body Temperature Regulation
 - 32.5.1 Neonate
 - 32.5.2 Child
 - 32.5.3 Adult
 - 32.5.4 Elderly patient
- 32.6 Physiological changes with hypothermia
 - 32.6.1 Cardiovascular
 - 32.6.2 Respiratory
 - 32.6.3 CNS
 - 32.6.4 Metabolic/endocrine/trauma
 - 32.6.5 Musculoskeletal
 - 32.6.6 Renal

32.6.7 Haematological

32.6.8 GI

32.7 Effect of temperature on gases

32.7.1 Solubilities

32.7.2 Temperature compensation of arterial blood gases (ABGs)

D) Intraoperative heat loss

32.8 Demonstrate competence and knowledge of the description, mechanism, effectiveness, and complications of the following techniques:

32.8.1 Methods of prevention of heat loss and raise of body temperature under anesthesia

32.8.1.1 Ambient temperature

32.8.1.2 Humidification and circle systems

32.8.1.3 Fluid and blood warmers

32.8.1.4 Warming blankets

32.8.1.5 Reflection blankets

32.8.1.6 Core re-warming including CPB, bladder, peritoneal and other forms of dialysis

32.8.1.7 Body thermal gradients & complications of re-warming

32.8.2 Adverse consequences of hypothermia including the following:

32.8.2.1 Delayed awakening

32.8.2.2 Delayed drug metabolism

32.8.2.3 Shivering including increased oxygen consumption

32.8.2.4 Hypotension during re-warming

32.8.2.5 Impaired wound healing and infection

32.8.2.6 Cardiac complications (arrhythmias, ischemia, hypertension, poor peripheral perfusion)

32.8.2.7 Bleeding

32.8.2.8 Augmented hormonal and metabolic "Stress response"

32.8.2.9 Decreased patient comfort

E) Deliberate or therapeutic hypothermia

32.9 Cardiac surgery

32.10 Neurosurgery

- 32.11 Vascular surgery
- 32.12 Critically ill patient
- 32.13 Following cardiac arrest

F) Resuscitation Medicine

- 32.14 Implications of accidental hypothermia in non-anesthetized patients: Emergency Room or Intensive Care Unit
- 32.15 Alterations in ACLS protocols in severe hypothermia
- 32.16 Management of re-warming patients with severe hypothermia

33 Transplantation

A) Multiple organ donation

- 33.1 Preoperative evaluation and intraoperative management of organ donors
- 33.2 Define brain death, criteria for certifying brain death and various tests performed to confirm the diagnosis
- 33.3 Describe organ dysfunction after brain death especially cardiopulmonary complications, coagulopathy, temperature changes and diabetes insipidus
- 33.4 Describe the intraoperative management of multi-organ donors
 - 33.4.1 Multi-organ brain dead donors
 - 33.4.2 Living related donors for kidney & liver
 - 33.4.3 Donation after cardiac death (DCD)

B) Organ recipients

- 33.5 Manage recipients for organ transplantation
- 33.6 Describe the basic principles of immunosuppression and graft rejection
- 33.7 Reperfusion injury
- 33.8 Management of Hyperkalemia
- 33.9 Demonstrate an understanding of post transplant complications including rejection, infection, and immunosuppression, and be able to conduct anesthesia for surgical procedures in patients after organ transplantation
- 33.10 Transfusion medicine and coagulation management [See Hematology 11 F)]

C) Heart Transplantation

- 33.11 Patient Care
 - 33.11.1 Demonstrate an ability to:
 - 33.11.1.1 Conduct a preoperative evaluation of the patient presenting for cardiac transplantation
 - 33.11.1.2 Demonstrate awareness of the effects of end stage cardiac failure on other organ functions
 - 33.11.1.3 Determine the cardiovascular and pulmonary monitoring requirements for optimal anesthesia care
 - 33.11.1.4 Transport critically ill patients to and from the O.R. safely
 - 33.11.1.5 Demonstrate an understanding of:
 - 33.11.1.5.1 *The principles of myocardial preservation*
 - 33.11.1.5.2 *The principles of extracorporeal circulation including ECMO,*

circulatory assist devices and circulatory arrest

- 33.11.1.5.3 *Monitoring the patient during cardiopulmonary bypass, and be able to separate a patient from cardiopulmonary bypass*
- 33.11.1.5.4 *Management of coagulation issues and blood component therapy*
- 33.11.1.5.5 *Monitoring, diagnosis and treatment of perioperative myocardial ischemia, cardiac arrhythmias and, left & right ventricular dysfunction*
- 33.11.1.5.6 *Monitoring, diagnosis and treatment of acute pulmonary dysfunction and pulmonary hypertension in the peri-operative period*

33.12 Medical Knowledge

- 33.12.1 Perform a preoperative cardiac evaluation: History, medications, physical and airway examination, laboratory evaluation, CXR, EKG, stress testing, Echocardiography, cardiac catheterization data
- 33.12.2 Describe cardiac physiology: Cardiac cycle, pressure volume loops, systolic and diastolic function, preload, afterload, contractility
- 33.12.3 Describe coronary anatomy and physiology: Description of coronary anatomy, determinants of coronary blood flow, pathogenesis of myocardial ischemia, determinants of myocardial oxygen supply/demand ratio, coronary steal, coronary reserve
- 33.12.4 Demonstrate an understanding of the effects of cardiac deafferentation and deafferentation (Denervation physiology)
- 33.12.5 Describe relevant cardiovascular pharmacology
 - 33.12.5.1 Inotropes and vasopressors agents
 - 33.12.5.2 Beta-blockers
 - 33.12.5.3 Calcium channel antagonists
 - 33.12.5.4 Angiotensin converting enzyme inhibitors
 - 33.12.5.5 Peripheral vasodilators
 - 33.12.5.6 Antihypertensives
 - 33.12.5.7 Pulmonary vasodilators
 - 33.12.5.8 Antiarrhythmic drugs
 - 33.12.5.9 Diuretics
 - 33.12.5.10 Thrombolytics: TPA, uro- or streptokinase
 - 33.12.5.11 Anticoagulants: Heparin and substitutes, warfarin, anti-platelet drugs
 - 33.12.5.12 Heparin reversal agents – Protamine, heparinase
 - 33.12.5.13 Antifibrinolytics: Epsilon aminocaproic acid, tranexamic acid,

aprotinin

- 33.12.5.14 Miscellaneous: Magnesium, DDAVP, Potassium
- 33.12.6 Describe relevant anesthetic pharmacology in relation to cardiac function and preconditioning
- 33.12.7 Demonstrate an understanding of:
 - 33.12.7.1 *Extra corporeal membrane Oxygenation*
 - 33.12.7.2 *CardioPulmonary Bypass (CPB)*
 - 33.12.7.3 *Initiating and weaning from CPB*
 - 33.12.7.4 *Myocardial protection during CPB*
 - 33.12.7.5 *Problems during weaning from cardiopulmonary bypass*
 - 33.12.7.6 *Mechanical support as a bridge to transplantation: Types, indications/contraindications, complications and limitations*
 - 33.12.7.7 *Circulatory assist devices*
 - 33.12.7.8 *Intra-aortic balloon pump counter pulsation (IABP): indications, contraindications, insertion techniques and complications*
 - 33.12.7.9 *Management of right heart failure, specific pulmonary vasodilators*
 - 33.12.7.10 Independently manage anesthesia for surgical procedures after heart transplantation

D) Lung Transplantation

- 33.13 The consultant Anesthesiologist must demonstrate knowledge of:
 - 33.13.1 Preoperative assessment of a patient before lung transplantation
 - 33.13.2 Anesthetic management of lung transplant recipient
 - 33.13.3 Monitoring during lung transplantation
 - 33.13.4 Management of one lung ventilation, indications for cardiopulmonary bypass
 - 33.13.5 Anesthesia for surgical procedures after lung transplantation
 - 33.13.6 Outcomes
- 33.14 *The subspecialist Anesthesiologist must demonstrate an ability to independently provide anesthetic care for the patient undergoing lung transplantation*

E) Liver Transplantation

33.15 Manage a patient undergoing liver transplantation:

33.15.1 Medical Knowledge - Basic Science

33.15.1.1 Demonstrate knowledge of:

- 33.15.1.1.1 The pharmacology of various drugs in patients with end stage liver disease
- 33.15.1.1.2 Hepatic physiology
- 33.15.1.1.3 Antifibrinolytic agents
- 33.15.1.1.4 Interpret arterial blood gases and acid base balance
- 33.15.1.1.5 Interpret hemodynamic parameters
- 33.15.1.1.6 Physiology and monitoring of Coagulation system
- 33.15.1.1.7 *Stages of liver transplantation*
- 33.15.1.1.8 Transfusion medicine

33.15.2 Clinical Knowledge

- 33.15.2.1 Causes of liver dysfunction
- 33.15.2.2 Indications and contraindications for liver transplantation
- 33.15.2.3 Effect of liver failure on all organ systems
- 33.15.2.4 Scoring systems for severity of liver disease
- 33.15.2.5 Treatment of Hyperkalemia
- 33.15.2.6 Transfusion medicine

33.15.3 Patient Care

- 33.15.3.1 *The subspecialist transplant Anesthesiologist must be able to provide anesthetic care for patients undergoing liver transplant surgery and are expected to demonstrate an ability to:*
 - 33.15.3.1.1 *Perform preoperative evaluation of patients with end-stage liver disease*
 - 33.15.3.1.2 *Manage recipients of cadaveric or living related liver transplant*
 - 33.15.3.1.2.1 *Formulate anesthetic plan*
 - 33.15.3.1.2.2 *Appropriate preparation*
 - 33.15.3.1.2.3 *Manage patients during three phases of liver transplantation*
 - 33.15.3.1.2.4 *Interpret different coagulation parameters and treat coagulopathies*
 - 33.15.3.1.2.5 *Assess and manage blood volume status*

- 33.15.3.1.2.6 *Treat hyperkalemia and correct other electrolyte abnormalities*
- 33.15.3.1.2.7 *Treat reperfusion syndrome*
- 33.15.3.1.2.8 *Prevent and treat anemia*
- 33.15.3.1.2.9 *Prevent infection*
- 33.15.3.1.2.10 *Maintain normothermia*
- 33.15.3.1.2.11 *Transport and hand over the post transplant patient to the ICU staff*
- 33.15.3.1.2.12 *Management of patients for living donor hepatectomy and major liver resection*

34 Volatile Agents

Upon completion of this training, the Anesthesiologist must demonstrate knowledge of the volatile anesthetics with regard to safety, and efficacy, toxicity, and inertness of halogenated gases currently in use. The anesthesiologist must be able to discuss the theories of the mechanism of action of inhaled anesthetics, including but not limited to:

- Nitrous Oxide
- Ether, chloroform, trichloroethylene, methoxyflurane, cyclopropane
- Halothane, enflurane, isoflurane, desflurane, sevoflurane

A) Physical Characteristics

34.1 Explain and demonstrate knowledge of the following pharmacokinetic concepts:

34.1.1 Physical characteristics of gases

- 34.1.1.1 Chemical potential (escaping tendency)
- 34.1.1.2 Vapour pressure
- 34.1.1.3 Boiling point
- 34.1.1.4 Mixtures
- 34.1.1.5 Gases in solutions
- 34.1.1.6 Gas-liquid interface
- 34.1.1.7 Tension or partial pressure
- 34.1.1.8 Fractional volume
- 34.1.1.9 Solubility

34.1.2 Properties of Inhaled Anesthetics

- 34.1.2.1 Bidirectional transfer and equilibration
- 34.1.2.2 Relative lack of absorption by tissues
- 34.1.2.3 Metabolism

34.1.3 Uniqueness of Inhaled Anesthetics

- 34.1.3.1 Route of administration
- 34.1.3.2 Bidirectionality and equilibrium
- 34.1.3.3 Adjustability

B) Uptake and Distribution

- 34.2 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)
 - 34.2.1 Alveolar gas concentration/ Inspired gas concentration (F_A/F_I)
 - 34.2.1.1 Effect of fresh gas flow
 - 34.2.1.2 Capacity of circuit
 - 34.2.1.3 Effect of fractional concentration or pressure of gas
 - 34.2.1.4 Effect of time and time constant
 - 34.2.1.5 1st order kinetic
 - 34.2.1.6 Effect of circuit absorbents
 - 34.2.1.7 Theory with and without uptake
 - 34.2.1.8 Effect of FRC
 - 34.2.1.9 Effect of ventilation perfusion mismatching
 - 34.2.1.10 Concentration effect
 - 34.2.1.11 Overpressurization
 - 34.2.1.12 Second Gas effect
 - 34.2.2 Compartment model
 - 34.2.3 Vessel Rich group/Muscle/Fat/Vessel – poor group
 - 34.2.4 Gradient from machine to brain
 - 34.2.5 Partition coefficients
 - 34.2.5.1 Blood gas
 - 34.2.5.2 Blood brain
 - 34.2.6 Clinical differences between prolonged and short anesthesia
 - 34.2.7 Elimination
 - 34.2.8 Percutaneous and visceral
 - 34.2.9 Diffusion between tissues
 - 34.2.10 Metabolism
 - 34.2.11 Exhalation
 - 34.2.12 Diffusion hypoxia

C) Toxicity

- 34.3 Discuss and describe the metabolism and biotransformation of volatile agents
 - 34.3.1 Desflurane and Carbon Monoxide
 - 34.3.2 Effect of hepatic and renal disease on metabolism
 - 34.3.3 Sevoflurane and compound A
 - 34.3.4 Fluoride production
 - 34.3.5 Clinical overview of agents

D) Occupational Exposure

- 34.4 Demonstrate knowledge of the occupational and environmental concerns in the use of volatile anesthetic agents

E) Pharmacology

- 34.5 Demonstrate knowledge with respect to the following issues related to use of the various agents:
 - 34.5.1 Halothane
 - 34.5.1.1 Solubility and metabolism
 - 34.5.1.2 Controversy over its' continued use

 - 34.5.2 Enflurane and Isoflurane
 - 34.5.2.1 Fluoride production Seizure
 - 34.5.2.2 activity on EEG Coronary
 - 34.5.2.3 Steal controversy

 - 34.5.3 Desflurane
 - 34.5.3.1 Blood gas solubility
 - 34.5.3.2 Relative lack of Low potency, stability, pungency, high vapour pressure
 - 34.5.3.3 Peculiarity of vaporizer
 - 34.5.3.4 Tachycardia and hypertension
 - 34.5.3.5 Low metabolism
 - 34.5.3.6 Effect of dry carbon dioxide (CO₂) absorbent and carbon monoxide (CO) production
 - 34.5.3.7 A role in outpatient surgery

34.5.4 Sevoflurane

- 34.5.4.1 Acceptability as inhalational induction agent
- 34.5.4.2 Solubility
- 34.5.4.3 Coronary vasodilation and pre-conditioning
- 34.5.4.4 Non-production of antibody formation
- 34.5.4.5 CO production and heat
- 34.5.4.6 Compound A during low flow anesthesia
- 34.5.4.7 Nephrotoxicity controversy – Fluoride

34.5.5 Nitrous Oxide

- 34.5.5.1 Characteristics
- 34.5.5.2 Role as adjuvant
- 34.5.5.3 Controversies
- 34.5.5.4 Effect of PONV
- 34.5.5.5 Inactivation of B12 metabolism
- 34.5.5.6 Effect on closed, and potential air spaces
- 34.5.5.7 Environmental considerations

F) Clinical Effects

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

34.6.1 Minimum Alveolar Concentration (MAC)

- 34.6.1.1 Definitions, types (MAC awake, MAC movement, MAC aware, MAC BAR)
- 34.6.1.2 Describe the factors that increase and decrease MAC
- 34.6.1.3 MAC for commonly used agents

34.6.2 Induction

- 34.6.2.1 Volatile induction
- 34.6.2.2 Appropriate agents
- 34.6.2.3 Risks and benefits

34.6.3 Maintenance

- 34.6.3.1 Safety
- 34.6.3.2 Adjustability

- 34.6.3.3 Generalizability of use regardless of age, habitus
 - 34.6.3.4 Cardiac and cerebral blood flow
 - 34.6.3.5 Predictable recovery
 - 34.6.3.6 Absence of analgesia
 - 34.6.3.7 Post-operative nausea and vomiting (PONV)
 - 34.6.3.8 CO and Hepatitis
- 34.6.4 Central Nervous System
- 34.6.4.1 Cerebral Metabolic Rate of oxygen (CMRO₂) – effect on EEG
 - 34.6.4.2 Cerebral Blood Flow (CBF)
 - 34.6.4.3 ICP
 - 34.6.4.4 Autoregulation and Uncoupling
 - 34.6.4.5 Role of individual agents
 - 34.6.4.6 Role of nitrous oxide
 - 34.6.4.7 Effect on CSF production
 - 34.6.4.8 Effect on response to hyper and hypocarbia
 - 34.6.4.9 Cerebral protection
- 34.6.5 Circulatory System
- 34.6.5.1 Hemodynamics
 - 34.6.5.2 Cardiac Index
 - 34.6.5.3 Central Venous Pressure (CVP)
 - 34.6.5.4 Systemic vascular resistance, pulmonary vascular resistance
 - 34.6.5.5 Contractility
 - 34.6.5.6 Other effects
 - 34.6.5.7 Distribution of blood flow
 - 34.6.5.8 Halothane, sensitization of myocardium
 - 34.6.5.9 Relation to adrenaline
- 34.6.6 Pulmonary System
- 34.6.6.1 Effects in spontaneously breathing patients
 - 34.6.6.2 Resting Arterial pressure of carbon dioxide (PaCO₂)
 - 34.6.6.3 Mechanics of ventilation
 - 34.6.6.4 Response to Carbon Dioxide (CO₂)

- 34.6.6.5 Response to hypoxia
- 34.6.6.6 Smooth muscle tone and bronchodilations
- 34.6.6.7 Mucociliary function
- 34.6.6.8 Pulmonary vascular resistance and hypoxic pulmonary vasoconstriction (HPV) and relevance to one-lung ventilation (OLV)

- 34.6.7 Liver
 - 34.6.7.1 Relevance of hepatic blood supply and architecture of the liver
 - 34.6.7.2 Effects of volatile agents
 - 34.6.7.2.1 Mechanisms for Halothane Hepatitis

 - 34.6.7.3 Antibody formation
 - 34.6.7.4 Mechanism for
 - 34.6.7.5 Epidemiology
 - 34.6.7.6 Non-antibody mediated mild form

- 34.6.8 Neuromuscular System and Malignant Hyperthermia (MH)
 - 34.6.8.1 Effect on skeletal muscle
 - 34.6.8.2 Triggering of MH response; relative potency of different agents
 - 34.6.8.3 Investigation for MH
 - 34.6.8.4 Reproductive and genetic effects
 - 34.6.8.5 Limitation of animal studies
 - 34.6.8.6 Low grade long term exposure

- 34.6.9 Effects of Volatile Agents in Pregnant Patients
 - 34.6.9.1 Effect of methionine synthetase and thymidylsynthetase by nitrous oxide
 - 34.6.9.2 National Institute for Occupational Safety and Health (NIOSH) standards
 - 34.6.9.3 Effect on Uterine Smooth Muscle
 - 34.6.9.4 Effect on fetus
 - 34.6.9.5 Effect on fetal loss
 - 34.6.9.6 Toxicity

- 34.6.10 Nitrous Oxide
 - 34.6.10.1 Effect on sympathetic nervous system (SNS)

- 34.6.10.2 Preconditioning and cardioprotection
- 34.6.10.3 Autonomic *effects*
- 34.6.10.4 Effect on baroreflexes
- 34.6.10.5 Effect on Sympathetic Outflow (Desflurane)

Appendix A: List of Contributors

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