National Curriculum for Canadian Anesthesia Residency

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This is not an official document of the Royal College of Physicians and Surgeons of Canada. Please refer to the RCPSC Objectives of Training for current guidelines regarding anesthesia training in Canada.

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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-sub specialized Anesthesiology Resident.

Italicized items denote knowledge and skills that apply to specialty training of the Subspecialty Fellow.
1 Airway Evaluation and Management

See Ear, Nose and Throat 7

The competent Anesthesiologist shall demonstrate advanced knowledge and proficiency in all the objectives related to airway evaluation and management listed below.

1.1 Basic Science

a) Structure and function of upper and lower airways:
   i. Nose, mouth, teeth, tongue
   ii. Nasopharynx, oropharynx, pharynx
   iii. Epiglottis, larynx, glottis, vocal cords, valleculae
   iv. Cartilages
   v. Sensory and motor innervation
   vi. Conducting and respiratory airways: trachea, bronchi, bronchioles, alveoli

b) Physiology and pathophysiology of ventilation and respiration
   i. Control of breathing
   ii. Central nervous system
   iii. Diaphragm and accessory muscles

1.2 Airway Obstruction

a) Etiologies of airway obstruction

b) Complications
   i. Hypercarbia/acidosis
   ii. Hypoxia
   iii. Aspiration

1.3 Basic Airway Management

The competent Anesthesiologist must demonstrate knowledge and expertise in basic airway management for the patient with upper airway obstruction.

a) Acute Airway Obstruction

The competent Anesthesiologist must demonstrate proficiency in immediate recognition and management of the patient with an acutely obstructed airway

   i. Basic Life Support (BLS) protocols:
   ii. Assessing patient responsiveness
   iii. Obtaining assistance
   iv. Patient positioning
   v. Recovery position
   vi. Chin lift, head tilt, jaw thrust
   vii. Indications for and use of pharmacologic agents e.g. in management of laryngospasm
   viii. Rescue breathing
   ix. Cardiopulmonary resuscitation

b) Bag-Valve-Mark Ventilation
The competent Anesthesiologist must demonstrate knowledge and expertise in patient ventilation using bag-valve-mask devices, including:

i. Selection of appropriately-sized masks
ii. Assembly, use, and trouble-shooting of self-inflating ventilation devices
iii. Two-person mask ventilation techniques
iv. Role of PEEP valve
v. Role of reservoir bag

c) Basic Airway Adjuncts

The competent Anesthesiologist must demonstrate understanding of the use of basic adjuncts to overcome acute airway obstruction including appropriate sizing and insertion techniques:

i. Oropharyngeal airway
ii. Nasopharyngeal airway

1.4 Oxygen Delivery Systems

The competent Anesthesiologist must demonstrate an understanding of systems designed for delivery of oxygen to the patient, including:

i. Oxygen sources
ii. Wall oxygen systems and specifications
iii. High pressure oxygen supply
iv. Diameter Index Safety System (DISS)
v. Quick-connect systems
vi. Flowmeters
vii. Cylinder sizes, pressures, capacities
viii. Regulators and flowmeters
ix. Nasal Cannulae
x. Flow rates and delivered oxygen
xi. Capnography
xii. Face masks
xiii. Types: Simple, Venturi, Non-rebreathing
xiv. Flow rates and delivered oxygen

1.5 Universal Precautions

The competent Anesthesiologist must be able to demonstrate knowledge and understanding of the role of universal precautions in patient care, including airway management using face shields, barrier masks, gloves

See Infectious Disease 14

1.6 Airway Evaluation

The competent Anesthesiologist must demonstrate advanced knowledge and expertise in assessment of patient airways, particularly those features predisposing to difficulty in airway management.

a) Elicit a satisfactory patient history, including:

i. Review of old records
ii. History of prior encounters with anesthesia
iii. Dental/soft tissue damage

b) Physical Examination

i. Mallampati score
ii. Thyromental distance
iii. Upper lip bite test
iv. Range of motion of neck
v. Neck circumference
vi. Mandible, mouth opening
vii. Other predictors of airway difficulty
   - Dentition
   - Tongue
   - Gender
   - Age
   - Body habitus/obesity
   - Facial hair
   - Medical conditions, tumours, trauma, pregnancy

c) Investigations

The competent Anesthesiologist must 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:

i. Pulmonary function testing (vitalometry)
ii. Blood gas testing
iii. Flow-volume loops

1.7 Communication

The competent Anesthesiologist must demonstrate appropriate communication skills regarding the patient airway evaluation and planning

a) Clear communication of pre-operative findings/concerns/plans to the patient
b) Accurate written documentation of pre-operative assessment and patient discussion for colleagues
c) Accurate written documentation of intra-operative airway findings
d) After identification of the patient with a difficult airway the anesthesiologist must:
   i. Write a “Difficult Airway Letter”
   ii. Communicate this finding with the patient and family, other physicians including family physician
   iii. Recommend wearing of a Medicalert Bracelet.

1.8 Endotracheal Intubation

The competent Anesthesiologist must demonstrate knowledge and expertise in airway management using endotracheal intubation

a) Indications for Intubation
   i. Airway obstruction unrelied by basic manoeuvres
   ii. Oxygenation and Ventilation
   iii. Etiologies of hypoxia, hypercarbia
   iv. Definition of respiratory failure
   v. Objective criteria for intubation
   vi. Ventilatory Support
   vii. Mechanical ventilation strategies
   viii. Role of CPAP and PEEP
   ix. Airway protection
   x. Trauma/burns
   xi. Obtunded patient
   xii. Tracheobronchial toilet/suctioning
   xiii. Anesthesia and Surgery
   xiv. Muscle relaxant cases
   xv. Surgery around head and neck
   xvi. Airway procedures
   xvii. Bronchoscopy, biopsies, therapeutic procedures
b) Route of Intubation
   
   i. Orotracheal intubation
   
   ii. Nasotracheal intubation
      - Surgical and anatomic indications
      - Considerations
      - Contraindications
      - Blind nasal intubation

   iii. Transtracheal intubation
      - In situ via tracheotomy stoma
      - Considerations of fresh tracheotomy versus mature stoma

   iv. Urgent non-elective endobronchial intubation

   v. Indications for one-lung ventilation
      - Pulmonary hemorrhage
      - Foreign body

   vi. Technique/considerations using standard endotracheal tube

b) Intubation

The competent Anesthesiologist must demonstrate knowledge and expertise in managing normal and difficult airways using direct laryngoscopy and intubation, with appropriate use of adjuncts where necessary:

i. Preparation
   - Equipment choice
   - Appropriate laryngoscope blade size
   - Appropriate endotracheal tube size
   - Equipment check
   - Monitors
   - Suction
   - Alternative airway devices, airways

ii. Direct laryngoscopy
   - Curved blades
   - Straight blades
   - Levering blades
   - Other specialized blades

iii. Indirect Laryngoscopy Techniques
   The competent Anesthesiologist must demonstrate knowledge and expertise in managing normal and difficult airways using alternative to direct laryngoscopy:
      - Fibreoptic laryngoscopes
      - Rigid fiberoptic laryngoscopes
      - Shikani, Bullard, etc.
      - Flexible fiberoptic laryngoscopes
      - Video laryngoscopes
      - Glidescope, McGrath laryngoscope, etc.

iv. Adjuncts to facilitate endotracheal tube placement
   - Gum elastic bougie
   - Stylets
   - Malleable
   - Lighted (eg. Trachlight, Tubestat)
   - Manoeuvres to facilitate visualization
   - Optimal patient positioning
   - BURP (backward upward rightward position)
   - OELM (optimal external laryngeal manipulation)
v. Confirmation of intubation
   - Visualization
   - Auscultation
   - Capnography
   - Radiography

d) Management of Extubation

The Anesthesiologist must demonstrate an understanding of the methods of and considerations for airway management at the extubation phase, including:

   i. Airway toilet, suctioning
   ii. Awake extubation criteria
   iii. Deep extubation technique
   iv. Post-extubation stridor
   v. Extubation of the patient with a difficult airway

e) Supraglottic Devices

The competent Anesthesiologist must demonstrate knowledge and proficiency in airway management using supraglottic devices.

   i. Indications and contraindications of different supraglottic devices
   ii. Elective use as alternative to endotracheal intubation
   iii. Laryngeal mask airway (LMA)
   iv. LMA – ProSeal
   v. LMA – Classic
   vi. Emerging alternatives
   vii. Conduit for endotracheal intubation
   viii. Use of specific types of LMA as a conduit for endotracheal intubation
   ix. Emergent use in difficult airway algorithms
   x. CVCI (Cannot Ventilate, Cannot Intubate) situation

f) Complications of Airway Management

The competent Anesthesiologist must demonstrate an understanding of and an ability to recognize and treat the complications of airway management, including:

   i. Errors of endotracheal tube placement
   ii. Endobronchial intubation
   iii. Overinsertion
   iv. Patient repositioning, neck flexion
   v. Esophageal intubation
   vi. Airway trauma
   vii. Dental trauma
   viii. Soft tissue trauma
   ix. Post-extubation stridor
   x. Nasal trauma for nasal intubation
   xi. Aspiration
   xii. Prevention
   xiii. Fasting guidelines
   xiv. Anti-reflux pre-treatment strategies
   xv. Role of cricoid pressure
   xvi. Management
   xvii. Current guidelines, role of bronchoscopy, lavage, antibiotics, other
1.9 The Difficult Airway

The competent Anesthesiologist must demonstrate advanced knowledge and skills for the recognition and management of predicted and unexpected difficult airways. He/she must demonstrate knowledge of a range of safe options for securing difficult airways. He/she also must demonstrate appropriate communication, management and technical skills in doing so.

a) General Considerations

The competent Anesthesiologist must demonstrate a sound working knowledge of the difficult airway algorithms and current accepted airway guidelines. He/she must understand and be able to utilize the considerations and recommendations for difficult airway management, including:

i. Predicted versus unpredicted difficult airway
ii. Awake versus asleep strategy
iii. Failed intubation strategy
iv. Cannot ventilate, cannot intubate strategy
v. Calling for assistance
vi. Special considerations in the pediatric and obstetric populations

b) Further classification of difficult airways into descriptive categories:

i. Difficult mask ventilation
ii. Difficult laryngoscopy
iii. Difficult intubation
iv. Difficult ventilation

c) Predicted Difficult Airway

The competent Anesthesiologist must demonstrate knowledge and proficiency in formulating an approach to the recognized difficult airway. He/she must understand and be able to weigh alternative strategies.

Management Plan:

i. Intubation versus alternatives
ii. Supraglottic devices
iii. Regional anesthesia
iv. Awake versus asleep intubation
v. Fibreoptic versus videolaryngoscopic techniques
vi. Other devices
vii. Lighted stylet
viii. Other approaches
   - Retrograde wire or catheter-assisted intubation
   - Patient preparation for awake intubation
   - Psychological, communication of plan/concerns
   - Pharmacological
   - Anti-sialogogue
   - Anxiolytic
   - Strategies for uncooperative patients
   - Airway topicalization techniques
   - Local anesthetic pharmacology
   - Nerve block techniques
   - Aerosolized, spray, contact, injection

d) Unpredicted Difficult Airway

The competent Anesthesiologist must demonstrate an ability to deal with unexpected difficult airways. He/she 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. The Anesthesiologist should understand the principles of anesthesia crisis resource management and the various types of human error when faced with an unanticipated difficult airway.

e) The Surgical Airway

The competent Anesthesiologist must be able to demonstrate a working knowledge of surgical options for emergency airway management. He/she must demonstrate knowledge of the use of at least one cricothyrotomy kit or approach:

i. Mini-tracheostomy
ii. Cricothyrotomy
iii. Jet ventilation
iv. Contraindications to surgical airway techniques

f) Extubation of the Difficult Airway Patient

The competent Anesthesiologist must demonstrate an understanding of the implications for airway management at the extubation of the difficult airway patient. He/she should be able to demonstrate consideration of the following additional concerns:

i. The patient with a wired jaw
ii. The patient with airway edema
iii. Extubation over an introducer
iv. Assessment for readiness for extubation

1.10 Airway Education Resources

The competent Anesthesiologist must demonstrate familiarity with current and emerging airway management options through awareness of and scholarly participation in:

i. Internet airway resources and discussion groups
ii. Continuing medical education options
iii. Dedicated airway textbooks
iv. Patient airway simulators
2 Ambulatory Anesthesia

2.1 Ambulatory Anesthesia Settings
a) The Anesthesiologist must demonstrate an understanding of the various settings and administrative structures required for Ambulatory Anesthesia including:
   i. Hospital based centers
   ii. Hospital affiliated centers
   iii. Freestanding centers e.g. dental offices, cosmetic surgery clinics, endoscopy clinics
b) He/she must demonstrate knowledge with respect to guidelines or standards pertaining to the design and resources required for Ambulatory Anesthesia sites including:
   i. Anesthesia and life support equipment
   ii. Monitors
   iii. Drugs – in particular drugs required to manage emergencies including Malignant Hyperthermia
   iv. Special equipment
      ● Difficult airway
      ● Regional anesthesia
   v. Site physical design
      ● Basic knowledge of O.R. design requirements and standards per Canadian Anesthesiologists Society (CAS)
      ● Managing gas supplied in tanks, adequacy of reserve supply, downstream pressure regulation & monitoring
      ● O.R. ventilation and waste gas scavenging as per CAS recommendations
      ● Equipment maintenance and servicing
      ● Awareness that provincial guidelines specify requirements for number and qualifications of ancillary staff
      ● Provincial Colleges of Physicians and Surgeons role in accrediting non-hospital facilities

2.2 Pre-operative Assessment of Patients
The Anesthesiologist must demonstrate an understanding of the factors related to appropriate patient selection and appropriateness of surgical procedures for ambulatory surgery.

a) Obtain a thorough and pertinent medical history
b) Perform a thorough physical examination
c) Obtain appropriate and pertinent tests and consultations:
   i. Laboratory tests
   ii. Imaging studies
   iii. Electrocardiograms
   iv. Specialist consultations
d) Identify and evaluate any pre-existing comorbid conditions
   i. Provisions for pre-operative screening through record review, interview & examination and directed consultations
to reduce late cancellations as well as morbidity & mortality
   ii. ASA Status and appropriateness for ambulatory care
   iii. BMI stratification
   iv. Anesthesia for Pediatric cases in non-hospital facilities
   v. HRT/BCP discontinuation
e) Select eligible patients for ambulatory anesthesia based on:
   i. Type of surgery
   ii. Duration of surgery
   iii. Potential for blood transfusions
   iv. Potential severity of perioperative complications
   v. Post-operative care
f) Special considerations for pediatric patients
   i. Former premature patients
   ii. Comorbid conditions e.g. Obstructive sleep apnea
iii. Patients with upper respiratory tract infections
iv. Airway challenges

2.3 Pre-operative Patient Preparation
The Anesthesiologist must demonstrate knowledge with respect to preparing patients for ambulatory surgery with respect to:

a) NPO status
   i. Ensure appropriate NPO status based on timing of surgery
   ii. Provide a rationale for NPO policies
   iii. Establish an appropriate NPO policy for ambulatory site
b) Pre-existing medication management
   i. Order or withhold chronically administered medications as appropriate
c) Pre-operative medications – order anxiolytics, sedatives, analgesics in the per-operative period as appropriate for an ambulatory setting
d) Preparation for discharge planning – provision of clear instructions to patients and families

2.4 Anesthetic Techniques
The Anesthesiologist must demonstrate an approach to anesthetic techniques appropriate for ambulatory surgery:

a) General Anesthesia
Describe drugs and techniques appropriate for use in an ambulatory care setting

b) Regional Anesthesia.
The Anesthesiologist must demonstrate an understanding of regional anesthetic techniques appropriate for ambulatory surgery and the benefits and drawbacks of such techniques

c) Monitored Anesthesia Care
The Anesthesiologist must demonstrate an understanding of the use of monitored anesthesia care in the ambulatory setting

2.5 Anesthesia Care for Surgical Procedures
The Anesthesiologist must demonstrate knowledge with respect to procedures appropriate for ambulatory surgery.

a) Provide safe and competent anesthesia care for adult and pediatric patients for surgical procedures for:
   i. Otolaryngology
   ii. Vascular surgery
   iii. General surgery
   iv. Orthopaedic surgery
   v. Urologic surgery
   vi. Gynaecologic surgery
   vii. Plastic/cosmetic surgery
   viii. Dental surgery
   ix. Ophthalmology
   x. Diagnostic imaging

2.6 Post Operative Care
The Anesthesiologist must demonstrate an understanding of the requirements for postoperative care in an ambulatory setting including:

a) Post Anesthesia Care Unit
   i. Describe an arrange appropriate monitoring of the patient following completion of surgery
   ii. Identify and manage post-operative complications
   iii. Describe discharge criteria to Post Recovery Care
   iv. Provide appropriate post-operative pain management
   v. Provide appropriate post-operative nausea and vomiting management
b) Post Recovery Care
   i. Describe process for post-operative teaching and instructions
   ii. Assure post-operative follow up plans
   iii. Describe discharge criteria to go home

c) Unplanned Admission
Describe process for unplanned admission to hospital for patients failing to meet discharge criteria or for patients with post-operative complications requiring hospital admission

2.7 Emergency Situations
The Anesthesiologist must demonstrate an ability to recognize and treat potential emergency situations in the ambulatory setting, including disposition of the patient.

a) See Complications
b) Evacuation plans/procedures – particularly in free standing facilities: e.g. fire safety

2.8 Quality Control/Assurance
The Anesthesiologist must demonstrate an ability to identify parameters requiring monitoring for Quality Control/Assurance:

a) Peri-operative complications
b) Unplanned hospital admissions
c) Post-operative nausea and vomiting
d) Post-operative pain control
e) Peri-operative mortality
3 Autonomic Nervous System

3.1 Functional Anatomy and Physiology of the Autonomic Nervous System
The Anesthesiologist must demonstrate an understanding of the anatomy and physiology of the autonomic system including relevant pathophysiology and pharmacology. Describe:

a) functional anatomy and physiology of the sympathetic nervous system
b) functional anatomy and physiology of the parasympathetic nervous system
c) functional anatomy and physiology of the enteric nervous system
d) adrenergic and cholinergic receptors and the physiologic effects of their receptor agonists and antagonists
e) signal transduction, up-regulation and down-regulation of adrenergic receptors

3.2 Function of the Autonomic Nervous System
The Anesthesiologist must demonstrate an understanding of the function of the autonomic system

a) Describe the responses elicited if effector organs by stimulation of sympathetic and parasympathetic nerves
   i. Heart
   ii. Blood vessels
   iii. Bronchial tree
   iv. Gastrointestinal tract
   v. Eye
   vi. Pancreas
   vii. Sweat glands
b) Explain the Harlequin syndrome
c) Explain the function of the autonomic nervous system in visceral pain
   i. Throat
   ii. Lungs
   iii. Heart uterus
   iv. Small and large bowel
   v. Pancreas
   vi. Vagina
   vii. Testicles
   viii. Celiac ganglion block
d) Explain the effect of stellate ganglion block on upper limb blood circulation and sympathetic lumbar ganglion block on lower limb blood circulation
e) Explain the Marey’s law
f) Explain the Bainbridge reflex
g) Explain the Valsalva manoeuvre
h) Explain the Bezold-Jarsich reflex

3.3 Pharmacology of the Autonomic Nervous System
The Anesthesiologist must demonstrate an understanding of the pharmacology of the autonomic system

a) Describe the synthesis, storage, release, inactivation and metabolism of norepinephrine and epinephrine
b) Describe the synthesis, storage, release, and inactivation of acetylcholine
c) Name the more frequently used α and β-agonists, both direct and indirect and explain their clinical effect
d) Explain the effects of α and β-blockers
e) Explain the effects of calcium channel blockers on the blood vessels
f) Explain the effects of α2-blockers in regard to pain
g) Explain the effects of antihypertensive drugs on the autonomic nervous system, including drugs affecting the renin-angiotensin system
h) Explain the effects of antidepressant drugs on the autonomic nervous system, including MAOIs and tricyclic antidepressants
i) Explain the relation between the antinauseant drugs and the autonomic nervous system
j) Explain the relation between the tocolytics drugs and the autonomic nervous system
k) Describe the effect of anticholinergic and adrenergic drugs on a transplanted heart
l) Describe the effects of epinephrine injection in the presence of volatile anesthetics
3.4 Autonomic Dysfunction
The Anesthesiologist must demonstrate an understanding of the pathophysiology of the autonomic nervous system with respect to the following conditions:

a) Explain pheochromocytoma effects
b) Explain autonomic dysreflexia
c) Describe assessment of diabetic autonomic neuropathy
d) Describe autonomic changes with aging
e) Explain the oculocardiac reflex
f) Describe the effects of aging on the autonomic nervous system
g) Describe the surgical stress syndrome
4 Cardiovascular Anesthesia

General Objectives:

The competent Anesthesiologist shall demonstrate knowledge and proficiency in all the objectives listed below.

*The sub-specialist in Cardiovascular Anesthesia shall demonstrate proficiency in all of the above plus these additional specific objectives. A competent Anesthesiologist shall demonstrate knowledge of the principles of these objectives, but not be expected to perform these objectives.*

4.1 Cardiac Anesthesia

The consultant anesthesiologist must demonstrate knowledge with respect to the following:

4.1.1 Basic Science

a) Coronary anatomy and physiology
   i. 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
   ii. Describe the normal structure of coronary arteries and the determinants of arteriolar tone
   iii. Describe the determinants of coronary artery blood flow, myocardial oxygen supply and myocardial oxygen demand, including differences between the right and left ventricles
   iv. Describe the pathogenesis of myocardial ischemia, including the pathology of atherosclerotic heart disease, dynamic stenosis, collateral circulation and coronary steal
   v. Describe the pathogenesis of perioperative ischemia and infarction, including similarities and differences from MI in the ambulatory (non-surgical) setting

b) Cardiac Physiology
   i. Describe the phases of the cardiac cycle and relate these to the electrocardiogram
   ii. Discuss the determinants of cardiac output (heart rate and stroke volume), including those variables which influence stroke volume (preload, afterload, contractility)
   iii. Describe commonly used indices of systolic function, such as dP/dt, EF, and ESPVR; pressure volume loops
   iv. 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
   v. Describe the differences between the function of the left and right ventricle, and the interaction between the two
   vi. Describe the normal anatomy, structure and function of the four heart valves
   vii. Pericardium anatomy and physiologic consequences of diseases of the pericardium

c) Electrophysiology
   i. Describe the normal anatomy of the cardiac conduction system
   ii. Describe the phases of cellular action potentials, including the major associated ion currents
   iii. Describe the automaticity of the cardiac conduction system, understanding the differences between the SA node, AV node, Bundle of His and Purkinje fibres
   iv. Describe excitation-contraction coupling, and how electrical activation of the myocyte leads to contraction and relaxation

d) Neurohumoral Regulation of the Heart
   i. Describe the sympathetic and parasympathetic innervation of the heart
   ii. Describe the interaction of the SNS and PSNS with cardiac variables, including heart rate, contractility, relaxation as well and venous and arteriolar tone
   iii. 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
   iv. Describe the major hormonal systems which regulate cardiac function, including the rennin-angiotensin system, natriuretic peptides, vasopressin and catecholamines
   v. Be able to describe major cardiac reflex systems, such as the:
      - Baroreceptor reflex
      - Chemoreceptor reflex
Bezold-Jarisch reflex
Vagal manoeuvres
Cushing’s reflex
e) Vascular Anatomy and Physiology
i. Describe the anatomy of the pulmonary vasculature
ii. Describe the regulation of pulmonary artery tone, including autonomic and humoral mechanisms
iii. Understand the impact of pulmonary vascular resistance on the function of the right ventricle
iv. Describe the anatomy of the aorta, including major branches
v. Describe the vascular supply of the major organs and the four limbs
vi. Be able to describe the autonomic and humoral control of vascular smooth muscle, and how these systems regulate arterial and venous tone
f) Embryology (see also pediatric anesthesia section)
i. Demonstrate a basic understanding of cardiac embryology
ii. Be aware of how this relates to major congenital cardiac diseases, such as:
   - Patent ductus arteriosis
   - Coarctation of the aorta
   - Major abnormalities of the great vessels, such as transposition
   - Major valvular abnormalities, such as Ebstein’s anomaly, pulmonary atresia, and Tetralogy of Fallot
   - Hypoplastic heart syndromes
   - ASD
   - VSD
iii. Describe normal fetal circulation. Understand the differences between adult and fetal circulation
iv. Describe the normal transition from fetal to adult circulation, especially as it relates to the immediate post-natal period

The consultant Anesthesiologist must demonstrate an ability to apply the aforementioned principles in management with respect to the immediate assessment and management, and pharmacology and perioperative monitoring.

4.1.2 Clinical Assessment
The Anesthesiologist must demonstrate the ability to:
a) Be able to take a focused cardiac history
b) Complete a focused physical examination of the cardiovascular system
c) Be able to interpret relevant laboratory data
d) Interpret the summary reports of advanced cardiac investigations such as:
   i. Vascular studies such as the ankle-brachial index and carotid Doppler studies
   ii. Holter monitors
   iii. Myocardial stress tests
   iv. Myocardial perfusion studies
   v. Left – and – right-sided cardiac catheterization studies
   vi. Static echocardiography reports
e) As they relate to relevant perioperative assessment
f) Compile the above to arrive at relevant anesthetic considerations and risks

4.1.3 Pathophysiology
The Anesthesiologists must demonstrate an understanding of the pre-existing cardiac disease in planning for non-cardiac as well as cardiac surgery for patients with cardiac disease. He/she must demonstrate an ability to manage patients with:
a) Medically optimized pre-existing cardiac disease
   i. Anti-anginals
   ii. Anti-hypertensives
   iii. Anti-dysrhythmics
   iv. Diuretics
b) Thoracic Aortic Disease (atheroma, aneurysms, dissections)
c) Coronary Artery Disease

See Critical Care 6.10, 6.11

- Acute myocardial ischemia
- Myocardial infarction
- Complications of myocardial infarction e.g. dysrhythmia, VSD, CHF, MR, LV, aneurysm, pseudoaneurysm
- Management in the face of recent thrombolytic and anti-platelet therapy
- The implications of recent PCI and coronary stent placement

d) Valvular heart disease

- AS
- AR
- MS
- MR
- PS
- TR

e) Cardiac tamponade

f) Constrictive pericarditis

g) Cardiomyopathies

- Dilated
- Restrictive
- Obstructive (HOCM with or without SAM, Dynamic left ventricular obstruction in the elderly)

h) Cardiogenic shock

- Right sided CHF, pulmonary hypertension
- Left sided CHF from diastolic and/or systolic dysfunction

i) Aberrant conduction (e.g: WPW), dysrhythmia, ablation procedures (procedures in the EP lab)

j) Pacemaker and Implantable Cardioverter Defibrillator (AICD) insertion

k) Valve replacement or repair surgery

l) Mitral valve assessment for repair

m) Cardiac tumors

n) Urgent and non-urgent cardiac re-operation

o) Cardiac transplant

p) Heparin induced thrombocytopenia

q) Heparin resistance

r) Sudden acute and sub-acute ventricular and supra-ventricular arrhythmia

s) Adult Congenital Heart Disease

t) Acute Pulmonary emboli and chronic thrombo-embolic pulmonary HTN

u) Endocarditis

4.1.4 Perioperative Management of Cardiac Surgery

a) The Anesthesiologist must demonstrate knowledge of special issues related to cardiac surgery and Anesthesiology

b) The indications for elective and emergent CABG surgery

c) The indications for IABP

d) Know pathophysiology and management of complications after cardiac surgery: e.g. bleeding, graft occlusion, early and late arrhythmia, stroke, tamponade, Neuro-cognitive dysfunction

e) Antifibrinolytics and their role in blood conservation

f) Knowledge of CPB and its physiologic effects and complications

g) Methods of blood conservation in cardiac and non-cardiac surgery including cell savers

h) HIT and new/novel anticoagulants (e.g: recombinant Hirudin, Argatroban, bivalirudin)

i) Anesthesia for procedures in the cath lab (e.g: A fib ablation, PFO closure, percutaneous valve replacement)

j) Patient-prosthesis mismatch (PPM) after valve replacement

k) Protamine reactions

l) Circulatory arrest

m) Cardiovascular ICU care
n) Fast-track Cardiac Anesthesia and Surgery
o) Cardioplegia
p) Left and right ventricular assist devices, Bi-VAD and artificial heart
q) Heart and heart-lung transplantation
r) Temporary pacemaker utilization post cardiac surgery
s) Ischemic preconditioning and volatile anesthetic preconditioning
t) Resource utilization and cost effectiveness techniques in cardiac anesthesiology, surgery and CV intensive care

4.1.5 Pharmacology

a) The Anesthesiologist must demonstrate knowledge with respect to mechanism of action, pharmacokinetics and pharmacodynamics, indications, contraindications, side effects, complications, dose, antidote, interactions, and anesthetic implications of:

i. Sympathomimetics, α- and β- adrenergic antagonists
ii. Phosphodiesterase inhibitors
iii. Calcium sensitizing agents (levosimendan)
iv. Peripheral vasodilators, including the nitrates;
v. Calcium-channel blockers
vi. Diuretics
vii. Other anti-hypertensive agents
viii. Other anti-dysrhythmic drugs, including digitalis
ix. Prostaglandins
x. Nitric Oxide
xi. Anti-fibrinolytic agents
xii. Anti-platelet agents
xiii. Thrombolytics
xiv. Heparin and non-heparin anticoagulants
xv. Protamine
xvi. Drugs for pulmonary hypertension
xvii. Use of epidurals and spinal cord stimulation in myocardial ischemia

b) The anesthesiologist must demonstrate knowledge with respect to effects on the cardiovascular system for the following agents:

i. IV induction agents
ii. Sedatives
iii. Opioids
iv. Volatile anesthetics
v. Nitrous oxide
vi. Local anesthetics
vii. Neuromuscular blocking agents
viii. Anti-cholinesterases and cholinergic agonists
ix. Anti-cholinergic agents
x. NSAIDs and Cox-2 inhibitors

c) The anesthesiologist must 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.)

4.1.6 Monitoring

The anesthesiologist must demonstrate and ability to:

a) 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.
b) 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.
c) Demonstrate principals of non-invasive and invasive BP monitoring and its pitfalls
d) Discuss resonant frequency, damping, etc
e) Secure large-bore peripheral intravenous, arterial (radial, brachial and femoral) and central venous (internal jugular, subclavian and femoral) access.
f) Be able to set up and insert a PA catheter. Be able to assess right-sided catheterization variables, including CVP, PAP, PCWP and cardiac output. Be able to interpret mixed-venous blood gases, and determine whole-body oxygen delivery and consumption. Understand the indications, limitations and complications of PA catheters in critical care settings.

g) Discuss non-invasive methods of estimating CO and limitations

h) Be facile in the laboratory monitoring of the acid-base, oxygen carrying, coagulation and inflammatory components of the hematologic system.

i) Demonstrate an understanding of Thromboelastogram monitoring

j) TEE
   i. Be able to describe the indications and contraindications of perioperative TEE in the cardiac and non-cardiac surgical settings.
   ii. Understand the sensitivity and specificity of TEE in the early detection of myocardial dysfunction, volume assessment, venous air embolism, valvular dysfunction and anatomical abnormalities.

4.2 Vascular Anesthesia

The consultant anesthesiologist must demonstrate an understanding of the anatomy and physiology relevant to the management of patients presenting for vascular surgery including:

4.2.1 Anatomy, Physiology and Pathophysiology

a) A knowledge of the basic sciences as applicable to anesthesia, including vascular anatomy, and pertinent physiology
b) The anatomy and physiology of spinal blood supply
c) Knowledge of the physiologic consequences of aortic cross clamping
   i. Thoracic
   ii. Abdominal supraceliac
   iii. Abdominal infrarenal
d) The pathology of atherosclerotic disease;
e) The major diseases of the of the aorta:
   i. Aortic aneurysm;
   ii. Aortic dissection;
   iii. Aortic occlusive disease;
   iv. Embolic disease and ischemic limb;
   v. Connective tissue disease;
   vi. Aortitis;
   vii. Aortic injury after blunt trauma

The consultant anesthesiologist must demonstrate an ability to apply the aforementioned knowledge in management with respect to patient assessment and management, and pharmacology and perioperative monitoring.

4.2.2 Clinical Assessment

The anesthesiologist must demonstrate an understanding of:

a) A comprehensive preoperative assessment
b) 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.
c) 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.
d) Recognize that prior to provision of anesthetic care specific medical intervention and modification of risk factors may be required.

4.2.3 Clinical Management of Vascular Surgery

The anesthesiologist must demonstrate an understanding of the following considerations:

a) The differences of clamping at various levels of the aorta
b) Management of patients and the hemodynamic effects of aortic cross clamping
c) Intra-operative support
d) Be able to manage the following cases on the descending aorta
   i. thoracic aneurysm repair
   ii. abdominal aneurysm repair
iii. aortic dissection
iv. renal protection and supra-celiac clamps
v. spinal cord protection during thoracic aortic surgery
vi. repair of the ruptured aneurysm

e) peripheral vascular surgery
f) carotid endarterectomy
g) amputation
h) Post-operative management of adult patients for aortic, peripheral vascular and carotid procedures
i) Demonstrate competence in all technical procedures commonly employed in vascular anesthetic procedures, including airway management, cardiovascular resuscitation, patient monitoring and life support, general, and regional anesthetic and analgesic techniques and postoperative care.
j) Manage massive transfusions and its inherent complications
k) The anesthesiologist must demonstrate knowledge in the use of spinal drainage for thoracic aneurysm repair
   i. Indications
   ii. Contraindications
   iii. Methodology
   iv. Monitoring
   v. Complications
l) Be able to manage diseases of the ascending aorta and aortic arch

4.2.4 Pharmacology
See Cardiac Anesthesia section 4.1.5

4.2.5 Monitoring
The anesthesiologist must demonstrate an understanding of monitoring standards for vascular surgery including:

a) Monitoring brain function during Carotid Endarterectomy
b) Monitoring spinal cord during thoracic aortic surgery
c) ACT
d) Invasive monitoring
e) Special issues related to vascular anesthesia

4.2.6 Pain Management
The anesthesiologist must demonstrate knowledge of the principles of management of patients with postoperative pain following abdominal and peripheral vascular procedures

a) Epidural analgesia
b) Risks of neuraxial anesthesia with antiplatelet agents, intraoperative heparinization and other alterations in coagulation status
c) Patients with chronic pain due to chronic vascular insufficiency
d) Phantom limb pain - advantages and disadvantages of regional versus general anesthesia for CEA
5 Complications of Anesthesia

With respect to complications, the competent Anesthesiologist shall demonstrate the ability to:

- Assess a patient’s potential for complications based on comorbidities and planned procedures
- Obtain informed consent
- Prevent potential complications
- Manage potential complications
- Arrange appropriate patient disposition
- Document complications appropriately
- Disclose relevant information to the patient
- Arrange appropriate debriefing and quality assurance measures

5.1 Complications of Anesthesia in General

a) Awareness under anesthesia
b) Allergy and anaphylaxis
c) Extravasation of drugs and fluids
d) Drug interactions
e) Bacteremia
f) Hyper-/hypotension
g) Tachy-/bradycardia
h) Hyper-/hypocarbia
i) Hypoxemia
j) Hyper-/hypothermia
k) Raised airway pressure
l) Cardiac arrest and ACLS protocols
m) Intraoperative fires/burns

5.2 Complications of Regional Anesthesia

See Regional Anesthesia

5.3 Complications of Medication Administration

The Anesthesiologist must demonstrate an understanding of the complications related to administration of anesthetic and other drugs:

a) Inhalation Anesthetics
   See Volatile Agents 34.6
b) Intravenous Induction Agents and Sedatives
   See Pharmacology 23.6
c) Narcotics/Opioids
   See Pharmacology 23.7
d) Antiemetics and Anticholinergics
   See Pharmacology 23.8
e) Neuromuscular Blocking Agents
   See Neuromuscular Junction 17.2
f) Reversal Agents (CNS and Neuromuscular)
   See Neuromuscular junction 17.4
g) Local Anesthetic Agents
   See Regional 27.5
h) Non-anesthetic drugs commonly used in the OR
   i. Vasoactive drugs
   ii. Electrolyte solutions
   iii. Bronchodilators
   iv. Anticonvulsants
   v. Corticosteroids
   vi. Antibiotics
   vii. Antifibrinolytics
   viii. Anticoagulants and their reversal agents
5.4 Allergy
See Immunology 13.4

5.5 Fluid Management
The Anesthesiologist must demonstrate an understanding of the complications related to fluid and blood product administration including:

a) See Critical Care 6.4
b) Blood products See Hematology section 11.6

5.6 Airway – please see Airway sections 2, 3, 8f

5.7 Monitoring
See Monitoring and Equipment 15.13

a) Failure to secure access
b) Arterial/venous trauma including tears, fistula formation
c) Arterial occlusion
d) Pneumo-/hemothorax

5.8 Patient Positioning

a) Complications relating to changing positions
b) Pressure: nerves and eyes, vascular structures, skin
c) Stretching: nerves particularly brachial plexus
d) Management of emergencies in prone position
e) Venous air embolism
f) Inadequate organ perfusion

5.9 Type of surgery

a) Laparoscopic
b) Thoracic
c) Neuro
d) Vascular (e.g. spinal cord ischemia with AAA)
e) Orthopedics (e.g. fat embolism, hypotension from reaction to cement with arthroplasty)

5.10 Ventilation
See Critical Care 6.3

a) Conventional
b) Non-conventional
c) Non-invasive

5.11 Occupational Hazards for Anesthesiologists and other OR personnel
The Anesthesiologist must demonstrate an understanding of the potential risks to themselves and others when dealing with high risk patients and situations in the operating room:

a) Needle stick
b) Infections – needle, airborne, contact
c) Inhalation of agents
d) Violent patient – Assault – physical, verbal
e) Lifting patients – back and other injuries
f) PTSD after adverse events  
g) Fatigue  
h) Substance abuse
6 Critical Care

The consultant 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.

6.1 Monitoring

See Monitoring 15.13

6.2 Airway Management

The Anesthesiologist must demonstrate an in depth understanding of airway management in the critically ill patient

See Airway

6.3 Mechanical Ventilation

The Anesthesiologist must demonstrate an understanding of the various models of mechanical ventilation used in critical care, their indications, contraindications and side effects:

a) Indications for and contraindications of non-invasive and invasive positive pressure ventilation
b) Hemodynamic effects of positive pressure ventilation: Heart-lung interaction
c) Modes of ventilation
   i. CMV
   ii. SIMV
   iii. Pressure support ventilation
   iv. Pressure control ventilation
   v. Non-invasive positive pressure ventilation
   vi. High frequency oscillation
d) Ventilator induced lung injury and it's prevention and ARDS net protocol
e) Managing patient-ventilator dysynchrony
f) Weaning from mechanical ventilation
g) Monitoring ventilatory therapy
   i. Arterial and venous blood gases
   ii. Pulse oximetry
   iii. Ventilator graphics
h) Sedation and paralysis for mechanical ventilation
   i. Pharmacology of common sedative and analgesic agents
   ii. Indications for neuromuscular blockade and pharmacology of neuromuscular blocking agents
   iii. Complications of prolonged mechanical ventilation and neuromuscular blockade + Myopathy of critical illness

6.4 Management of Fluid and Electrolyte and Acid-Base Disorders

The Anesthesiologist must demonstrate an understanding of fluid and electrolyte disturbances encountered in critical care management and their management

a) Normal distribution of total body water and electrolytes
b) Options for fluid replacement
   i. Crystalloids
   ii. Synthetic colloids
   iii. Albumin
c) Management of electrolyte abnormalities
   i. Hyponatremia
   ii. Hypernatremia
   iii. Hypokalemia
   iv. Hyperkalemia
   v. Hypocalcemia
   vi. Hypomagnesemia
   vii. Hypo and hyperphosphatemia
d) Classification of metabolic acidosis
6.5 Nutrition
The Anesthesiologist must demonstrate an understanding, but not in depth knowledge, of the nutritional needs of the critically ill patient and an approach to management thereof:

a) Options for nutritional replacement
   i. Enteral feeding
   ii. TPN
b) Estimation of resting energy expenditure – the Harris–Benedict equation

6.6 Transfusion Therapy
The Anesthesiologist must demonstrate an understanding of transfusion therapy as it applies to the critically ill patient

See Hematology

6.7 Hemodynamic Management of Shock
The Anesthesiologist must demonstrate an understanding of the various forms of shock and the management thereof

a) Pathophysiology of shock
b) Hypovolemic shock
c) Septic shock
d) Cardiogenic shock
e) Obstructive shock
   i. Pulmonary embolism
   ii. Pericardial tamponade
   iii. Tension pneumothorax
   iv. Air embolism
   v. Amniotic fluid embolism
f) Distributive shock
   i. Spinal shock
   ii. Anaphylactic shock
   iii. Systemic inflammatory response system (SIRS)
g) Fluid therapy
h) Pharmacology of and critical indications for vasopressors and inotropic therapy

6.8 Management of Hypertension
The Anesthesiologist must demonstrate an understanding of the causes and management of hypertension in the critically ill patient

a) Pharmacology of antihypertensive agents
b) Diagnosis and management of hypertensive crisis

6.9 Respiratory Failure
The Anesthesiologist must demonstrate an approach to the management of critically ill patients in respiratory failure

a) Differential diagnosis of respiratory failure
b) Acute Respiratory Distress Syndrome (ARDS)
c) Hospital acquired pneumonia
d) Chronic obstructive pulmonary disease
e) Ventilator associated pneumonia
f) Severe community acquired pneumonia
g) Management of acute asthma
h) Pulmonary hypertension
i) Thoracentesis
j) Chest tube insertion and management

6.10 Acute Coronary Syndromes
The Anesthesiologist must demonstrate an understanding of the diagnosis and management of acute coronary syndromes
This is not an official document of the Royal College of Physicians and Surgeons of Canada. Please refer to the RCPSC Objectives of Training for current guidelines regarding anesthesia training in Canada.

a) Pharmacologic management of ACS
b) Percutaneous coronary angioplasty and stenting
c) Coronary artery bypass grafting
d) Management of cardiac failure
   i. Pharmacology
   ii. Supportive care
   iii. Intra-aortic balloon pump
e) Complications of myocardial infarction
   i. Acute mitral regurgitation
   ii. Ventricular septal defect
   iii. Ventricular free wall rupture
   iv. Ventricular aneurysm

6.11 Management of Arrhythmias and Cardiac Arrest
The Anesthesiologist must demonstrate an in depth knowledge of the ACLS protocols and an approach to the management of arrhythmias and cardiac arrest

a) ACLS guidelines for the management of:
   i. Ventricular tachycardia, (including polymorphic VT), and ventricular fibrillation
   ii. Asystole
   iii. Atrial flutter and fibrillation
   iv. Other supraventricular tachycardias
   v. Symptomatic bradycardia
   vi. AV block
   vii. Wolff – Parkinson – White syndrome
b) Principles of safe cardioversion and defibrillation
c) Transthoracic and transvenous pacing
d) Management of the pacemaker dependent patient, patient with ICD
e) Management of a patient with an ICD
f) Pharmacology of antiarrhythmic therapy

6.12 Infectious Disease
The Anesthesiologist must demonstrate an approach to the diagnosis and management of infectious diseases in the critically ill patient

See Infectious Disease 14.2, 14.6

6.13 Neurocritical Care
The Anesthesiologist must demonstrate an understanding of issues encountered in patients in a neurocritical care unit:

a) Management of severe head trauma and raised intracranial pressure
b) Management of cerebrovascular accident due to ischemic stroke
c) Intracranial hemorrhage
d) Subarachnoid hemorrhage
e) Status epilepticus
f) Differential diagnosis and management of decreased level of consciousness and coma
g) Management of agitation and delirium
h) Guillain – Barre syndrome
i) Spinal shock

6.14 Pulmonary Embolism and Thromboembolic Disease

a) Diagnosis of deep vein thrombosis and pulmonary embolism
b) Principles of prophylactic and therapeutic anticoagulant therapy
c) Diagnosis and management of massive pulmonary embolism

6.15 Acute and Chronic Renal Failure
See Renal/ Urologic 29.3

The Anesthesiologist must demonstrate an understanding of the management of the critically ill patient with renal failure:

a) Management of the critically ill patient with chronic renal failure
b) Differential diagnosis and management of acute renal failure
c) Management of rhabdomyolysis
d) Management of hyperkalemia
e) Hepatorenal syndrome
f) Principles of hemodialysis and continuous renal replacement therapy: acute vs. chronic
g) Hemodialysis, use in poisoning

6.16 Management of Acute and Chronic Hepatic Failure

See Hepatobiliay 12.3

The Anesthesiologist must demonstrate an understanding of the management of the critically ill patient with hepatic failure

a) Differential diagnosis and management of acute and fulminant hepatic failure
b) Indications for urgent liver transplantation
c) Management of complications of hepatic failure
   i. Cerebral edema
   ii. Hepatic encephalopathy
   iii. Coagulopathy
   iv. Ascites
   v. Spontaneous bacterial peritonitis

6.17 Gastrointestinal Emergencies

The Anesthesiologist must demonstrate an understanding of the management of the critically ill patient presenting with gastrointestinal emergencies

a) Differential diagnosis and management of upper and lower gastrointestinal bleeding
b) Differential diagnosis and management of peritonitis
c) Prevention and management of aspiration
d) Disorders of bowel mobility
e) Prevention of stress ulceration
f) Management of acute pancreatitis
g) Intestinal ischemia
h) Acute magacolon
i) Abdominal compartment syndrome

6.18 Endocrine Emergencies

The Anesthesiologist must demonstrate an understanding of the management of the critically ill patient presenting with endocrine emergencies

a) Diabetic knowledge
b) Hyperosmolar nonketotic coma
c) Thyroid storm
d) Hypothyriism and myxedema coma
e) Hypercalcemia
f) Adrenal insufficiency
g) Diabetes insipidus
h) Syndrome of inappropriate ADH

6.19 Management of Poisoning and Drug-Related Complications
The Anesthesiologist must demonstrate an understanding of the management of the patients after poisonings, drug overdoses and exposure to agents used in bioterrorism

a) Evaluation and supportive care of the patient with suspected poisoning
b) Salicylates
c) Methanol/ethylene glycol/isopropyl alcohol
d) Sedative agents
   i. Barbiturates
   ii. Benzodiazepines
e) Antipsychotic agents
   i. Phenothiazines
   ii. Lithium
f) Antidepressants
   i. Monoamine oxidase inhibitors
   ii. Tricyclic antidepressants
g) Acetaminophen
h) Narcotics
   i. Beta blockers
   j. Calcium channel blockers
   k. Digitalis
   l. Carbon monoxide
   m. Organophosphate poisoning
   n. Cyanide

6.20 Drug Related Syndromes
The Anesthesiologist must demonstrate an understanding of the diagnosis of management of idiosyncratic drug reactions including

a) Diagnosis and management of serotonin syndrome
b) Diagnosis and management of malignant hyperthermia
c) Diagnosis and management of neuroleptic malignant syndrome

6.21 Critical care of the Trauma Patient
The Anesthesiologist must demonstrate an in depth understanding of the management of the trauma patient including:

a) Principles of ATLS
   i. Primary survey
   ii. Secondary survey
   iii. Tertiary survey
b) Supportive care
   i. Management of hypovolemia
   ii. Management of hypothermia
   iii. Management of coagulopathy
   iv. Management of abdominal compartment syndrome
c) Evaluation and management of
   i. Blunt trauma
   ii. Penetrating trauma
   iii. Crush injury
   iv. Thoracic trauma
   v. Abdominal trauma
d) Evaluation and management of neurologic trauma
   i. Head injury and raised intracranial pressure
   ii. Spinal cord injury and spinal shock
   iii. Determination of brain death
   iv. Management of the brain dead organ donor
e) Burns
f) Airway management of the trauma patient
6.22 Obstetrical Critical Care

See Obstetrics 18.10

The Anesthesiologist must demonstrate an understanding of obstetrical conditions requiring critical care management

a) Pre-eclampsia/eclampsia
b) HELLP syndrome
c) Respiratory critical care of the pregnant patient
   i. Pneumonia
   ii. ARDS
   iii. Asthma
   iv. Respiratory failure
d) Postpartum hemorrhage
   i. Amniotic fluid embolism
   ii. Abruption placenta
   iii. Disseminated intravascular coagulation
   iv. Uterine rupture
e) Management of cardiac arrest in pregnancy
f) Thromboembolic disease in pregnancy
g) Postpartum care of the parturient with cardiovascular disease
   i. Acute coronary syndrome
   ii. Valvular heart disease
   iii. Postpartum cardiomyopathy

6.23 Postoperative Care

The Anesthesiologist must demonstrate an understanding of the management of patients requiring critical care admission after major surgical procedures including:

a) Cardiac surgery
b) Thoracic surgery
c) Vascular surgery
   i. Abdominal aortic aneurysm
   ii. Revascularization of the lower limb
   iii. Carotid endarterectomy
d) Solid organ transplant
e) Major abdominal surgery
   i. Hepatic resection
   ii. Pancreatectomy
   iii. Esophagectomy
   iv. Bowel resection
f) Fluid and electrolyte management after major surgery

6.24 Ethical Principles of Critical Care Management

The Anesthesiologist must demonstrate an understanding of ethical concerns related to management of critically ill patients

a) Patient confidentiality and privacy legislation
b) Patient autonomy
c) Principles of informed consent and decision making
d) Next of kin designation
e) End of life decision making
f) Organ procurement for transplantation
g) Management and review of adverse events
h) Communication with families in crisis
i) Cultural aspects of Critical Care

6.25 Principles of Crisis Management and Team Leadership
The Anesthesiologist must demonstrate an understanding of crisis resource management and team leadership in critical situations

a) Leadership
b) Resource assessment and allocation
c) Situational awareness
d) Communication and collaboration during a crisis
7 Ear, Nose and Throat Surgery

See Airway 1

The competent Anesthesiologist shall demonstrate advanced knowledge and clinical proficiency in all the objectives listed below

7.1 General ENT Considerations:
He/she must demonstrate knowledge of the general considerations for providing anesthetics for ENT procedures. He/she must be able to communicate closely with the surgeon and operating room personnel regarding perioperative airway management concerns including:

a) Preoperative Patient Concerns
   i. Co-morbid conditions (e.g. smoking, COPD, alcohol, cancer)
   ii. Spectrum of patients, Pediatric to elderly
b) Airway Anatomy – See Airway 1.1
c) Shared and Remote Airway Considerations
   i. Implications of limited physical and visual access during anesthetic
   ii. Specialized endotracheal tubes to facilitate surgical access
   iii. Vigilance against airway disconnections and kinking during surgical manoeuvres
   iv. Occult bleeding into the airway during surgery
   v. Throat packs
   vi. Use of nitrous oxide and muscle relaxants
d) Difficult Airway
   i. Implications of presenting disease process
      - Tumours and mass effects
      - Post surgical or irradiation scarring
      - Congenital deformities
      - Foreign bodies
      - Trauma
      - Infections, abscesses
   ii. Considerations for appropriate endotracheal tube type, size and placement
      - Microlaryngoscopy tubes
      - Laser tubes
      - Nasal versus oral intubation
      - Oral and nasal RAE tubes
   iii. Control of ventilation and oxygenation
      - Awake airway control
      - Intravenous versus inhalation induction
      - Other options – surgery under local anesthetic
   iv. Emergence and extubation strategies
      - Re-examination of airway for bleeding/clots
      - Deep extubation versus awake extubation
      - Consideration of throat packs, nasal packing

7.2 Endoscopy and Airway Infections
He/she must demonstrate understanding of the anesthetic concerns and goals for endoscopy, with proficient evaluation and management of the patient. He/she must also be able to manage patients presenting with acute infections that threaten airway patency, including epiglottitis and abscesses

a) Considerations of presenting complaints
   i. Hoarseness, stridor, hemoptysis
   ii. Foreign body aspiration
   iii. Airway trauma
   iv. Papillomatosis
   v. Tumours
   vi. Stenosis
7.3 **Nasal Cavity Search**

He/she must demonstrate an understanding of the considerations for nasal cavity surgery, and demonstrate expertise in managing these cases.

a) Considerations of presenting complaints
   i. Nasal obstruction, polyps, infections
   ii. Associated problems, e.g. Asthma, allergies, cystic fibrosis
   iii. Epistaxis – trauma, coagulopathy, hemodynamic stability

b) Procedural considerations
   i. Use of vasoconstrictors
      - Cocaine, alternatives to cocaine e.g. phenylephrine, oxymetazoline
   ii. Throat packs
   iii. Occult blood loss
   iv. Patient immobility vs. Short case lengths
   v. Post-op nasal packing, bleeding, positioning

7.4 **Laser Surgery of the Upper Airway**

He/she must be able to demonstrate advanced knowledge and practical skills in dealing with laser surgery cases.

a) Basic laser science
   i. Types of surgical lasers and indications
      - Short wavelength lasers
      - Infrared lasers

b) Safety considerations
   i. Protection of patient and personnel
      - Eye protection
      - Skin protection
   ii. Airway fires
      - Prevention strategies
         - Surgeon techniques
         - Gas mix
         - ETT modifications
   iii. Fire management protocol

7.5 **Tonsillectomy and Adenoidectomy**

He/she must possess a sound understanding of the concerns for and management of tonsil and adenoid surgery, particularly in the pediatric patient.

a) Indications and pre-operative evaluation
   i. Chronic/recurrent upper respiratory tract infection
   ii. Pediatric obstructive sleep apnea
      - Adenotonsillar hypertrophy
   iii. Bleeding dyscrasias
   iv. Loose teeth

b) Procedural considerations
   i. Induction and maintenance technique
   ii. ETT, NTT, LMA
   iii. Deep extubation vs. awake extubation
iv. Airway toilet
v. Re-operation for bleeding after adenotonsillectomy
   - Chronology of bleeding
   - Coagulopathy
   - Full stomach
   - Airway difficulty
   - Hemodynamic stability, blood loss
vi. Role of NSAIDs
vii. Postoperative nausea and vomiting and the use of antiemetic agents

7.6 Major Head and Neck Cancer Surgery
He/she must demonstrate an understanding of the anesthetic considerations of major head and neck surgery, with appropriate expertise to manage these cases

a) Patient condition/comorbidities/optimization
   i. Smoking, COPD, alcohol
   ii. Elderly, malnutrition
   iii. Cardiovascular disease
   iv. Prior irradiation, chemotherapy

b) Airway patency or compromise
   i. Tumour mass effects
   ii. Indirect nasopharyngoscopy
   iii. Stridor, hoarseness, airway bleeding
   iv. Edema, inflammation, fibrosis

c) Intra-operative management
   i. Consideration for awake tracheotomy
   ii. Monitoring
      - Invasive monitoring
      - Post-operative monitoring
      - Nerve identification by surgeon
      - Avoidance of muscle relaxation
   iii. Case length
      - Temperature control
      - Blood loss considerations
   iv. Hemodynamic instability
      - Surgical stimulation of carotid sinus, stellate ganglion
   v. Free flap considerations
      - Avoidance of vasoconstrictors
      - Temperature control

7.7 Tracheostomy
He/she must demonstrate an understanding of the pathological processes necessitating tracheotomy, and provide expert anesthetic management of the patient with or undergoing tracheotomy

a) Indications for:
   i. Emergent tracheotomy for airway obstruction
      - Epiglottitis
      - Upper airway tumours
   ii. Elective tracheostomy
      - For pulmonary toilet
         - Prolonged orotracheal intubation
      - During major head and neck cancer surgery
      - Chronic ventilatory failure

b) Anesthetic options for emergency tracheostomy
   i. Awake tracheostomy under local anesthetic
   ii. General anesthetic
      - Awake fibreoptic intubation
iii. Management of loss of tracheostomy with fresh stoma

c) Trans-tracheal intubation
   i. Patient with pre-existing tracheal stoma

7.8 Surgery for Obstructive Sleep Apnea

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

a) Diagnosis of obstructive sleep apnea
   i. Presumptive indicators in patient history and physical exam
   ii. Definitive indicators and severity classification from formal sleep studies

b) Physiological derangements
   i. Cardiopulmonary
      ● Ischemic changes, arrhythmias, pulmonary and systemic hypertension
   ii. Behavioural
      ● Somnolence, cognition
   iii. Sensitivity to respiratory depressants

c) Management of the obstructive sleep apnea patient
   i. Intraoperative
      ● Intubation, extubation, and airway management considerations
   ii. Post-operative considerations
      ● Ongoing need for CPAP or BiPAP mask

7.9 Ear Surgery

He/she must demonstrate an understanding of the considerations for various surgeries on the external and internal ear structures. He/she must demonstrate expertise in the care of patients presenting for ear surgery.

a) Anesthetic considerations
   i. Variety of procedures
      ● Myringotomy
      ● Myringoplasty, tympanoplasty
      ● Mastoidectomy
   ii. Identification/preservation of facial nerve
      ● Monitoring
   iii. Nitrous oxide, muscle relaxants
   iv. Positioning
   v. Post-operative nausea and vomiting
8 Endocrinology

8.1 Pancreatic disorders: diabetes mellitus
The Anesthesiologist must demonstrate knowledge with respect to the types of Diabetes Mellitus, the treatment regimens and anticipated complications. He/she must demonstrate an approach to:

a) 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
b) He/she must demonstrate an ability to establish a perioperative preparation protocol in relation to the type and severity of diabetes mellitus and the anticipated surgical procedures
c) He/she must be able to describe the implications of tight perioperative glucose level control on patient outcome

Acute problems:
The Anesthesiologist must demonstrate knowledge regarding the pathophysiology and management of acute emergencies related to DM including ketoacidosis and hyperosmolar coma.

8.2 Thyroid Dysfunction: Hypo and Hyperthyroidism
The Anesthesiologist must demonstrate knowledge regarding the pathophysiology and clinical manifestations of hyper and hypothyroidism and the effects on anesthetic management

He/she must demonstrate an approach to evaluation and management of the patient with thyroid dysfunction including effects of therapy.

Acute problems:
He/she must be able to describe the pathophysiology of thyroid storm and myxedema coma, their clinical manifestations and the treatment modalities

8.3 Parathyroid Dysfunction: Hypo and Hyperparathyroidism
The Anesthesiologist must demonstrate knowledge with respect to:

a) The evaluation of parathyroid gland function with respect to calcium metabolism and the treatment modalities used to ensure normocalcemia
b) The anesthetic considerations of patients with parathyroid dysfunction

He/she must be able to describe the pathophysiology of hypo and hyper-calcemic states, their clinical manifestations and the treatment of these conditions.

8.4 Adrenal Dysfunction
The Anesthesiologist must demonstrate an understanding 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:

a) Pheochromocytoma: pathophysiology, clinical manifestations, preoperative preparation and perioperative management
b) Cushing syndrome: Etiology, pathophysiology, clinical manifestations and perioperative management
c) 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
d) Acute adrenal crisis: Diagnosis and Management

He/she must demonstrate an understanding of the management of the patient receiving corticosteroid therapy presenting for anesthesia and surgery.

8.5 Posterior Pituitary Dysfunction: SIADH and Diabetes Insipidus
The anesthesiologist must 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.

8.6 **Anterior Pituitary Dysfunction: Panhypopituitarism and Acromegaly**
The Anesthesiologist must demonstrate knowledge of the pathophysiology, clinical manifestations and treatment of acute and chronic panhypopituitarism. He/she must demonstrate an understanding of the pathophysiology, clinical presentation and treatment of the acromegalic patient. He/she must describe the anesthetic considerations for patients with acromegaly.

8.7 **Carcinoid Syndrome**
The Anesthesiologist must be able to list the clinical manifestations of carcinoid syndrome and the anesthetic considerations arising from them.
9 Ethics

In Anesthesiology, as in most areas of medical education, ethics falls into two separate areas. First there is the intellectual knowledge of the theories, principles, and concepts of ethics and the understanding of how they can be used to recognize and deal with the ethical issues that arise daily in practice. Second, there is a set of behaviours that are expected in physicians. In exhibiting these behaviours and linked qualities physicians are described as behaving professionally and they are said to be professional. Competencies arising from these two areas – ethical analysis and ethical behaviour – need to be considered, taught and, most importantly, evaluated separately. Ethical competencies can be usefully considered in all of the CanMEDS roles, not just in Professionalism although many are best considered there. The consultant anesthesiologist must demonstrate an understanding of ethical principles as they apply to the clinical practice:

a) Know the major ethical theories, perspectives and principals
   i. Theories; Deontological, Teleological
   ii. Perspectives: duty, virtue, principles, utilitarian/consequentialist, feminist, communitarian
   iii. Principles
   iv. Georgetown four: beneficence, Non-maleficence, Respect for Persons, (Autonomy,) Justice
   v. Know that there are others: truth-telling, promise-keeping, not killing
b) Recognize that there are ethical components in decisions doctors need to make every day; ethics is not just found in the “hard choices”
c) Demands for inappropriate care/ineffective therapy
   i. Understand the concept of “futility”; when it may apply, its hazards
   ii. Who decides goals of care?
d) End of Life Care
e) With-holding v withdrawing care (no ethical difference)
f) The concept of brain death and its diagnosis
   i. Organ donation
   ii. DCD: donation after Cardiac Death
g) Understand the ethical basis and use of the principle of informed choice
   i. Consent/Refusal
   ii. Jehovah’s Witnesses
h) Know how to assess Capacity, know the regulations and principles governing Substitute Decision Makers (for relevant Province)
i) Understand the effect of difference in value systems
   i. Religious, cultural, ethnic
   ii. Have ways to deal with difference
j) Recognize and respect Diversity
   i. Gender, religious, cultural, ethnic, sexual, age, disability (mental & physical)
k) Respect privacy & confidentiality and know the difference
   i. Occasions when confidentiality is commonly at risk
   ii. Occasions when confidentiality is legitimately breached
   iii. Statutory reporting, harm to self & others
l) Truth Telling
   i. Disclosure of diagnosis/Breaking bad news
   ii. Disclosure of error
m) The patient with a DNR order coming to the OR
10 Geriatrics

The competent Anesthesiologist must demonstrate knowledge of the physiologic, pharmacologic and pathologic changes accompanying the aging process. He/she must demonstrate knowledge of the impact that these changes have on the safe anesthetic management of the elderly patient

Goals & Objective

10.1 Physiology and Pathophysiology in the Geriatric Patient

The Anesthesiologist must demonstrate an understanding of the following issues related to the geriatric population compared to non-geriatric adults, regarding

- Anatomic changes
- Physiologic changes
- Anesthetic considerations

a) Central Nervous System
b) Autonomic Nervous System
c) Cardiovascular System
d) Respiratory System
e) Gastrointestinal System
f) Renal System
g) Hepatic System
h) Musculoskeletal
i) Thermoregulation
j) Hematologic System

Preoperative Evaluation/Assessment of the Geriatric Patient

10.2 Perioperative management

The Anesthesiologist must demonstrate an ability to evaluate and prepare the geriatric patient for anesthesia

a) Comorbidities and the Geriatric Patient
   i. Elicit appropriate history and perform physical examination of the elderly patient to identify existing comorbid conditions
   ii. Obtain appropriate investigations and consultation for optimizing elderly patient prior to surgery
   iii. Demonstrate knowledge of pre-existing comorbidities of body systems and the impact they have in the safe anesthetic management of the elderly patient
b) Preoperative Testing
   i. Demonstrate appropriate rationale, selection and use of ancillary testing based on planned surgical procedure and patient health status
   ii. Demonstrate appropriate knowledge in interpretation of diagnostic tests

10.3 Pharmacology and the Geriatric Patient

10.3.1 Pharmacodynamics

The competent Anesthesiologist will be able to demonstrate a knowledge of differences in pharmacokinetics in the elderly patient based upon differences in:

a) Absorption
b) Distribution
c) Metabolism
d) Excretion
10.3.2 Pharmacokinetics

The competent Anesthesiologist will be able to, specifically, describe changes in the pharmacodynamics, pharmacokinetics, rationale for selection and appropriate use of of agents routinely used in anesthesia practice including, but not limited to:

a) Intravenous induction agents
b) Muscle relaxants
c) Opioids
d) Benzodiazepines
e) Volatile agents including nitrous oxide
f) Local anesthetics

10.4 Anesthesia and the Geriatric Patient

The Anesthesiologist must demonstrate an ability to provide perioperative care for geriatric patients by being able to discuss evidence related to choice of anesthesia technique and post operative outcome in this patient population

a) General Anesthesia in the Geriatric Patient
   i. Discuss the physiologic effects of general anesthesia in the elderly patient
   ii. Discuss indications, contraindications and risks associated with the use of general anesthesia specific to the elderly
   iii. Provide safe, competent general anesthesia for all major and minor surgical procedures

b) Regional Anesthesia in the Geriatric Patient
   
   See Regional
   
   Describe the alterations in anatomy, physiology, pharmacology and complications specific to the geriatric patient of the following techniques:
   
   i. Epidural Anesthesia
   ii. Spinal Anesthesia
   iii. Head and neck blocks
   iv. Upper extremity blocks
   v. Lower extremity blocks

10.5 Perioperative Complications in the Geriatric Patient

The Anesthesiologist must demonstrate an understanding of the potential complications related to anesthetizing geriatric patients. Discuss the:

- risk factors contributing
- strategies to minimize
- investigation and management

Of the following conditions:

a) Post operative cognitive dysfunction/Post operative delirium
b) Cardiovascular complications
c) Respiratory complications
d) Hepatic complications
e) Renal complications

10.6 Post Operative Pain Management in the Geriatric Patient

The Anesthesiologist must demonstrate an ability to provide effective pain management in geriatric patients
a) Discuss the importance of post operative pain management in this patient population
b) Discuss risk, benefits and complications of various routes, agents and modalities for delivery of agents for post operative pain management

10.7 **Post Operative Recovery and the Geriatric Patient**

The Anesthesiologist must demonstrate an ability to anticipate and deal with postoperative recovery of management to geriatric patients.

a) Discuss age-related impediments to recovery of preoperative function and independence
b) Advocate on behalf of patients with respect to postoperative recovery of function and independence
11 Hematology
The anesthesiologist must demonstrate knowledge of the following:

11.1 Physiology of oxygen transport:

i. physiology of oxygen delivery and oxygen consumption
ii. physiologic adaptive responses to (euvoletic) anemia
iii. impaired oxygen delivery
iv. clinical and laboratory indicators of shock
v. understand the concepts of VO2 for tissue metabolic processes, DO2, oxygen, extraction ratio, DO2 crit
   (critical threshold of oxygen delivery
vi. be able to calculate arterial oxygen content

The competent 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.

11.2 Hemoglobinopathies

a) Methemoglobin, including precipitation by some pharmacologic agents (nitric oxide, nitroglycerine, nitroprusside), and
   pharmacology of methylene blue.
b) Sulhemoglobin
c) Carboxyhemoglobin
d) Anemias
   i. Acute blood loss: predict increased risk of acute blood loss, clinical signs of acute blood loss, perioperative
      management, strategies to minimize blood loss
   ii. Management of the patient who refuses transfusions of blood products
   iii. Chronic blood loss/anemia secondary to deficiency of iron, B12, folic acid
   iv. Anemia of chronic disease, anemia of chronic renal failure, aplastic anemia, anemia associated with liver failure
   v. Hemolytic anemias including
      • Congenital spherocytosis *
      • G6PD deficiency *
      • Immune haemolytic anemias (eg. Drug-induced, hypersplenism)*
      • Sickle cell disease *, including prevention, end organ complications and pain management
      • Mechanical etiologies (eg. Mechanical heart valve) *
      • Thalassemias *
e) Polycythemia
   i. primary polycythemias
   ii. secondary to hypoxemia

11.3 Physiology of Normal Hemostasis

a) role of vasculature
b) platelets (adhesion, activation, aggregation, and various factors involved with platelet function)
c) protein coagulation factors
d) physiologic mechanisms to limit the coagulation: Antithrombin, Tissue Factor Pathway Inhibitor, Protein C and Protein S,
   and the fibrinolytic system
e) alterations seen in the normal postoperative period (and the effect on postoperative DVT), normal pregnancy, the newborn,
   trauma, sepsis, shock and cancer
f) laboratory to assess the coagulation system
g) laboratory monitoring of the various pharmacological agents
h) 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).

11.4 Pharmacology: Anticoagulants/Antifibrinolytics
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a) pharmacodynamics (mechanism of action)
b) pharmacokinetics (dose, clinical duration of action, etc.)
c) clinical pharmacology (indications, side effects, complications and contraindications).
d) understanding of the impact on INR, PTT, TT, fibrinogen level, fibrin degradation products.
e) Perioperative use of
   i. Protamine
   ii. vitamin K
   iii. desmopressin (DDAVP)
   iv. recombinant activated Factor VII (rFVIIa).
f) Perioperative management of anticoagulant or antiplatelet agents;
   i. Coumadin
   ii. heparin (both unfractioned and low molecular weight)
   iii. agents used as alternatives to patients who have a history of heparin induced thrombocytopenia
   iv. platelet inhibitors such as cyclooxygenase inhibitors (e.g. ASA, NSAIDS)
   v. ADP inhibitors (e.g. Clopidogrel, ticlid)
   vi. glycoprotein IIB IIIA inhibitors (e.g. Abciximab)
   vii. phosphodiesterase inhibitors (e.g. Persantine)
   viii. anti-fibrinolytic agents (e.g. aminocaproic acid, tranexamic acid, aprotinin).

The competent 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.

11.5 Disorders of Coagulation

a) Congenital “bleeders”
   i. Hemophilia A*
   ii. Hemophilia B*
   iii. Von Willebrand’s disease *

b) Congenital “clotters”
   i. Protein C deficiency *
   ii. Protein S deficiency *
   iii. Antithrombin deficiency *
   iv. Other thrombophilias *

c) Acquired “bleeders”
   i. Effects of anticoagulant drugs or antiplatelet drugs
   ii. Dilutional thrombocytopenia or dilution of procoagulants
   iii. DIC
   iv. Liver disease
   v. Massive blood transfusion (see transfusion medicine)
   vi. Hypothermia
   vii. Thrombocytopenia due to PIH, drug-induced, ITP, etc
   viii. Effects of extracorporeal circulation
   ix. Sepsis

d) Acquired “clotters”
   i. Heparin-induced thrombocytopenia *
   ii. TTP *
   iii. Antiphospholipid Antibody Syndrome *
c) Hematologic Emergencies

   i. New diagnosis of acute leukemia (blast crisis) especially acute promyelocytic leukemia
   ii. TTP
   iii. hyperviscosity syndrome
   iv. acute thrombosis
   v. acquired hemophilia

11.6 Blood Products

Regarding the following blood products:

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

The competent anesthesiologist will understand the following:

a) Indications
b) Physiology
c) Risks
d) Benefits
e) Management of complications,
   i. febrile reactions
   ii. allergic reactions
   iii. volume overload
   iv. transfusion-related acute lung injury (TRALI)
   v. acute and delayed haemolytic reactions
   vi. sepsis
   vii. coagulopathy
   viii. electrolyte disturbances
   ix. hypothermia
   x. transfusion-associated graft vs. host disease (TA-GVHD)
   xi. immune-related effects
   xii. transfusion-transmitted diseases (hepatitis B and C, HIV etc)
   xiii. effect of age of stored RBC’s
   xiv. Effect on 2-3 DPG
f) administration of the following blood products, including:
   i. informed consent
   ii. identification and verification of both the patient and the blood product
   iii. 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)
   iv. documentation

11.7 Blood banking

The consultant anesthesiologist is expected to have a working knowledge of blood bank procedures

a) Clerical procedures
b) Serologic procedures

   i. uncrossmatched (emergency release) RBC’s
   ii. type-specific uncrossmatched RBC’s
   iii. computer assisted and serological crossmatches
   iv. type and screen
   v. frozen plasma
   vi. platelets
   vii. cryoprecipitate
viii. antibody investigation.

11.8 Reduction of use of Homologous Blood Products:
The consultant anesthesiologist is expected to have working knowledge of:

a) methods used to reduce blood loss
   i. patient position
   ii. controlled hypotension (including the physiology, indications, contraindications, and technique, including the pharmacologic agent(s) used)
   iii. regional anesthesia
   iv. pharmacologic agents (eg antifibrinolytic agents, role of recombinant activated Factor VII (rFVIIa)).

b) alternatives to blood products and their risks and benefits

c) Use of crystalloids

d) Use of colloids
   i. physiologic effects of colloids in comparison to crystalloids
   ii. understand the crystalloid/colloid controversy
   iii. compare starch vs. albumen

e) Management the patient (preoperative discussion, intraoperative and postoperative management) who refuses blood products for religious or other reasons

f) Calculate “allowable blood loss”

g) Demonstrate working knowledge of
   i. preoperative autologous donation (PAD)
   ii. directed donation
   iii. haemoglobin-based oxygen carriers, and perfluorocarbon emulsions
   iv. erythropoetin therapy
   v. Acute normovolemic hemodilution
   vi. perioperative RBC salvage and autotransfusion (including indications, contraindications, complications and technique).
12 Hepatobiliary

The Anesthesiologist must demonstrate knowledge of the anatomy and physiology of the hepatic system.

12.1 Anatomy and Physiology of the Liver and Biliary Tract

a) Functional anatomy
b) Blood supply/control of hepatic blood flow
c) Physiologic functions of the liver
   i. Glucose homeostasis
   ii. Fat metabolism
   iii. Protein synthesis: drug binding/coagulation/ester linkages hydrolysis
   iv. Drug and hormone metabolism
   v. Bilirubin formation and excretion
d) Effect of anesthesia on hepatic function

12.2 Liver function tests: listing and interpretation

The Anesthesiologist must demonstrate knowledge of the pharmacology relevant to the hepatic system

a) Pharmacokinetics and pharmacodynamics
b) Knowledge of mechanisms of hepatic drug elimination:
   i. Changes in hepatic blood flow
   ii. Ability to biotransform (intrinsic clearance)
   iii. Changes in binding of drugs; biotransformation
   iv. Bile excretion
c) Knowledge of altered response to drugs in cirrhotic patient
d) Knowledge of possible hepatotoxic drugs

12.3 Pathophysiology

The Anesthesiologist must demonstrate knowledge of:

a) Postoperative hepatic dysfunction:
   i. Differential diagnosis
   ii. Approach to determine etiology
b) Pre-, intra-, and post-hepatic dysfunction.
c) Halothane hepatitis
d) Viral Hepatitis
   i. Types
   ii. Transmission
   iii. Course
   iv. Prevention
   v. Hazards to healthcare providers
e) Other forms of hepatitis and the implications thereof:
   i. Alcoholic
   ii. Other drugs/toxins
   iii. Infection – non – viral hepatitis
   iv. Autoimmune
f) Liver failure/ End stage liver disease
   i. Etiologies
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ii. Child’s classification for preoperative prediction of surgical risk
iii. Complications (systemic review)
iv. Anesthetic management

g) Anesthetic management for acute or chronic alcoholism
h) Anesthetic management for a patient with a previous liver transplant

12.4 **Anesthesia for Hepatobiliary Procedures**
The competent Anesthesiologist must demonstrate knowledge and understanding of anesthesia and the hepatic system. He/she 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.

The competent Anesthesiologist must be able to demonstrate understanding of the considerations of, and to independently provide anesthetic care for patients presenting for the following procedures:

a) Cholecystectomy: open and laparoscopic
b) Endoscopic biliary tract procedures
c) Pancreatic resection
d) Biliary duct reconstruction
e) Whipples’ procedure
f) Liver resections
g) Liver donation
h) T.I.P.S. procedure
i) Liver transplant
13 Immunology and Rheumatology

13.1 Physiology
The consultant anesthesiologist is expected to understand basic physiology of the immune system, including the following:

a) Cellular immunity, roles of T-lymphocytes (helper T-lymphocytes, suppressor T-lymphocytes, cytotoxic T-lymphocytes
b) Cell-mediated immunity, its role in rejection of transplanted organs

13.2 Immunological Diseases
The specialist anesthesiologist shall be able, in collaboration with the appropriate consultant (time permitting), demonstrating an ability to manage the patient with the following disorders presenting for surgical or obstetric management:

a) Hereditary angioedema in C1 esterase inhibitor protein deficiency
b) Congenital and acquired immunodeficiency states
   i. HIV/AIDS

c) Selective IgA deficiency and anaphylaxis associated with blood transfusions
d) Cold autoimmune diseases: (eg. cryoglobulinemia, cold Hemaglutinin disease, paroxysmal cold hemoglobinuria)
e) Amyloidosis

13.3 Autoimmune disease
The specialist anesthesiologist shall be able, in collaboration with the appropriate consultant (time permitting), to manage the patient with the following autoimmune disorders presenting for surgical or obstetric management. The consultant anesthesiologist shall be well-versed on the anesthetic considerations of the individual autoimmune diseases

a) Organ-specific autoimmune diseases
   i. Type 1 diabetes mellitus
   ii. Myasthenia gravis
   iii. Grave’s disease
   iv. Addison’s disease
   v. Autoimmune haemolytic anemia
b) Systemic autoimmune diseases
   i. Rheumatoid arthritis
   ii. Rheumatic fever
   iii. Ankylosing spondylitis
   iv. Systemic lupus erythematosus
   v. Scleroderma
   vi. IgA deficiency
   vii. Sarcoidosis

13.4 Pre-existing Allergies
For the following conditions, the specialist anesthesiologist shall demonstrate an understanding of:

- Pathophysiology
- Clinical manifestations
- Investigation
- Management
a) Protamine allergy
b) Latex allergy
c) Metabisulfite allergy
d) Volatile agent allergic hepatitis
e) Transfusion reaction
f) Intravenous contrast media allergy
g) Food allergies associated with drug or medical substance allergies
   i. Eggs/ propofol
   ii. Banana/ kiwi /latex
   iii. Fish/ protamine
   iv. Shellfish/ iodine prep
h) 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 (eg. genetic deficiency of an enzyme)
   i. Anaphylaxis
   ii. Drug-induced release of histamine (anaphylactoid)
   iii. Activation of the complement system

13.5 Transplantation: (covered in Transplantation section)
See Transplantation 33

13.6 Systemic Inflammatory Response Syndrome (SIRS)
The consultant anesthesiologist shall have an understanding of the SIRS and its role in multi-organ failure in the critically-ill patient. The consultant anesthesiologist shall be able to assess such patients presenting for surgical core.

13.7 Rheumatology/Connective Tissue Disorders
The Anesthesiologist must demonstrate knowledge of the pathophysiology, clinical presentation, natural history, treatment modalities and multisystemic implications of the connective tissue disorders. He/she must demonstrate an understanding of the anesthetic considerations of the following diseases:

a) Epidermolysis bullosa
b) Scleroderma
c) Systemic lupus erythematosus
d) Rheumatoid arthritis
e) Ankylosing spondylitis
f) Marfan syndrome
14 Infectious Diseases

14.1 Prevention of Infection
The anesthesiologist must be able to describe the measures necessary for the prevention of infections including

a) Mechanism of transmission of selected infectious diseases; tuberculosis, MRSA, C difficile, viral hepatitis
b) Isolation measures
   i. Universal precautions
   ii. Droplet precautions
   iii. Airborne precautions
c) Effect of tracheal intubation on the development of infectious complications
d) Aseptic technique
e) Management of needle stick injuries

14.2 Infectious Syndromes
The anesthesiologist must demonstrate knowledge regarding:

a) Infections syndromes leading to uni or multi-systemic decompensation, including the differential diagnosis and treatment modalities
   a) Participate in the treatment of a patient in septic shock
   b) Infection in the immunocompromised host
   c) Pathophysiology of sepsis and multiorgan failure
   d) Infection in solid organ and marrow transplant patients
e) Community acquired infection
   i. Community acquired pneumonia
   ii. Meningitis and encephalitis
   iii. Genitor-urinary sepsis
   iv. Intra-abdominal sepsis
      ● Perforated viscus
      ● Cholecystitis and ascending cholangitis
      ● Pancreatitis
      ● Spontaneous bacterial peritonitis
   v. Soft tissue infection – severe cellulitis and necrotizing fasciitis
   vi. Head and neck infection
      ● Epiglottitis
      ● Ludwig’s angina
   vii. Bacterial endocarditis
f) Prevention and management of nosocomial infection
   i. Line-related bloodstream infection
   ii. Clostridia difficile colitis
   iii. Hospital acquired pneumonia
   a) Clostridial myonecrosis
   b) Tetanus
c) Toxic shock syndrome
d) Infections with group A streptococci
e) Herpes zoster (see pain management objectives)

14.3 Patients with Immunodeficiency Syndromes
The anesthesiologist must demonstrate knowledge of the problems related to, and anesthetic considerations of immunodeficiency related to:

i. AIDS
ii. Chemotherapy
iii. Transplantation

14.4 Antibiotic Prophylaxis
The anesthesiologist must demonstrate an understanding of the rationale behind surgical antibiotic prophylaxis for wound infection. He/she must demonstrate knowledge of the indications and considerations for the prevention of endocarditis and be able to administer the appropriate doses of the antibiotics indicated.

14.5 Upper Respiratory Tract Infections
The anesthesiologist must demonstrate knowledge of the issues related to the management of patients with current or recent upper respiratory tract infections.

14.6 Pharmacology

  a) Pharmacology, spectrum, and complications of antibacterial, antiviral and antifungal therapy
  b) Major anti-infectious agents
     i. Indications
     ii. Complications related to their use (toxicity, superinfection)
     iii. Microbiological techniques used to make adjustment to therapy (dosage, culture)
  c) 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

The competent 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:

15.1 Monitoring

The competent 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

15.1.1 Pressure Measurement

The Anesthesiologist must demonstrate an understanding of principles of measurement

a) Principles of Measurement
   i. Know the definitions of the various units (joules, kilopascals) commonly used in Anesthesia
   ii. Describe how most anesthesia monitors measure force (Newton’s 2nd Law)

b) Static Pressure Measurement
   i. Know the principle of measuring static columns of fluid (CVP)
   ii. Know the definition of 1 atmosphere of pressure

c) Dynamic Pressure Management
   i. Be knowledgeable about how modern pressure transducers work
   ii. Be able to describe the effects of compliance in these systems
   iii. Be able to describe the characteristics of the pressure versus time waveform in clinical practice

d) Signal-Processed Pressure Monitor
   i. Non-invasive blood pressure monitor
   ii. Be able to describe how a NIBP cuff works (how systolic, MAP and diastolic pressure are determined)
   iii. Describe the different false readings associated with NIBP

15.1.2 Flow Measurement

The Anesthesiologist must demonstrate an understanding of the principles behind flow measurement

a) Principles of Flow
   i. Be able to describe the differences between flow and velocity
   ii. Be able to describe the relationship between pressure and flow
   iii. Describe the different forces that can act on fluids (gravity, pressure gradient, and viscous force/friction)
   iv. Be knowledgeable about the Bernoulli equation and its relevance in anesthesia
   v. Be knowledgeable about the relevance of the Reynold’s number in anesthesia

b) Mass/Volume Flow Meters
   i. Know how cardiac output is measure using thermodilution and the potential errors associated with it

c) Velocity/Flow Measurements
   i. Know how pilot tubes are used in anesthetic monitors
   ii. Know how a venture tube works and its relationship to the Bernoulli equation

d) Balance-of-Pressure Flow Meters
   i. Describe how the Thorpe and Bourdon flowmeters work and their applications in everyday anesthetic practice

15.1.3 Sound Measurement

The Anesthesiologist must demonstrate an understanding of principles of sound measurement and its’ application to monitoring:

a) Principles of Sound
   i. Describe how Doppler ultrasound works
   ii. Describe what sound waves are and how they travel

b) Passive – Stethoscope
   i. Describe how different clinical conditions create different sounds heard using the stethoscope
   ii. Describe the basic components of a stethoscope

c) Active – Echo, Doppler
   i. Be knowledgeable about the principles and physics of TEE
   ii. Be knowledgeable about the principles and physics of Doppler
   iii. Be able to describe the principles and features of ultrasound and its use in vascular access and nerve localization
15.1.4 Electricity
The Anesthesiologist must demonstrate an understanding of principles of the use of electricity in monitoring and the principles of electrical safety. He/she must:

a) Know the differences between AC and DC current
b) Understand micro and macroshock
c) Understand the principles behind electrical isolation in the operating room
d) Passive electrical examination
   i. EKG – describe how the EKG senses electrical impulses and the problems processing these signals
   ii. EEG – know that the signal strength is 1/10th of that in an EKG
   iii. BIS (and other monitors of depth of anesthesia)
        ● Know how a BIS monitor works
        ● Know how to interpret the BIS index
        ● Know how the various BIS levels correlate clinically
e) Active Electrical Examination
   i. Somatosensory Evoked Potentials (SSEPs)
      ● Know how SSEPs are measured
      ● Know the clinical uses of SSEPs in the OR
      ● Know how different anesthetic agents affect measurement of SSEPs
   ii. Motor Evoked Potentials (MEPs)
      ● Know the uses and limitations of MEPs
      ● Know how different anesthetic agents affect measurement of MEPs

15.1.5 Measurement Utilizing Light
The Anesthesiologist must demonstrate and understanding of principles of light transmission and its’ utility in various forms of monitoring:

a) Principles of light
   i. Know the difference between sound and electromagnetic waves (ie. Different speeds, different propagation waves)
   ii. Know the definition of the Beer-Lambert Law and how it relates to various anesthetic monitors
   iii. Know how the different Light Monitors work – Capnometer (mainstream and sidestream), Agent Analyzer
        Capnometer
            ● Describe how the capnometer works
            ● Know the different wavelengths of light measured
            ● Describe the different phases in a CO2 waveform and identify clinical correlations in various waveforms
b) Pulse Oximeters function
   i. Describe the four different species of haemoglobin measured
   ii. Know how fractional haemoglobin saturation is determined
   iii. Know how the Beer-Lambert equation relates to the pulseoximeter
c) Raman Scattering
   i. Know how Raman scattering works
   ii. Describe the difference between Raman scattering and absorption based gas analysis

15.1.6 Temperature Measurement
The Anesthesiologist must demonstrate an understanding of principles of temperature measurement:

a) Principles of Temperature
   i. Know the definition of specific heat and a calorie
b) Temperature Monitors
   i. Know the three techniques for measuring temperature
   ii. Know the three electrical techniques for measuring temperature
      ● Resistance Thermometer
      ● Thermistor
      ● Thermocouple

15.1.7 Neuromuscular Monitors
The Anesthesiologist must demonstrate an understanding of principles of monitoring of the cardiovascular system
a) Describe how a peripheral nerve stimulator works
b) Describe the different patterns of nerve stimulation
   i. Single twitch
   ii. TOF
   iii. Titanic
   iv. PTC
   v. DBS

15.1.8 Cardiovascular Monitors
The Anesthesiologist must demonstrate an in depth understanding of monitoring of the cardiovascular system

a) Electrocardiography
b) Monitoring arterial blood pressure
   i. Non-invasive blood pressure monitoring
   ii. Invasive arterial blood pressure monitoring
      • Sites of cannulation
      • Indications, contraindications
      • Complications
      • Insertion technique
      • Function of the catheter – transducer system and sources of error

c) Monitoring central venous pressure
   i. Principles of sterile technique and prevention of line – related blood stream infections
   ii. Complications and principles of safe insertion technique
   iii. Sites of cannulation
   iv. Ultrasound guided insertion technique
   v. Physiology of central venous pressure monitoring and sources of error
   vi. Waveform analysis

d) Pulmonary artery catheter insertion and monitoring
   i. Indications and contraindications
   ii. Insertion technique
   iii. Sources of error and principles of trouble shooting
   iv. Principles of monitoring cardiac output, pulmonary artery pressure, pulmonary artery occlusion pressure and calculation of work indices and vascular resistance
   v. Waveform analysis
   vi. Estimation of fluid responsiveness: Systolic pressure variation and transthoracic thermodilution
   vii. continuous mixed venous oximetry

e) Echocardiography
   Indications for, strengths and limitations of transthoracic and transesophageal echocardiography

15.2 Equipment

15.2.1 Inhaled Anesthetic Delivery Systems
The Anesthesiologist must demonstrate an understanding of principles behind the functionality of vaporizers and gas delivery systems

a) Gas delivery systems
   i. storage and delivery of anesthetic gases via pipelines and cylinders
   ii. anesthesia breathing circuits
b) Gas laws
   i. Boyle’s law, Charles’ Law, Henry’s Law, Graham’s law of diffusion, Dalton’s law of partial pressures
   ii. Partial pressure
   iii. Blood / gas solubility
   i.

c) Anesthetic Machine
The Anesthesiologist must demonstrate an in depth understanding of the anesthetic machines:
i. Be knowledgeable about the safety features of the anesthetic machine
ii. Be able to describe the CSA/ASA standards for anesthetic machines
iii. Pipeline and Cylinder gas supply
iv. Pressure failure mechanisms
v. Flow meter and proportioning systems
vi. Breathing circuits
   ● Bain
   ● Circle
vii. Vaporizers
viii. CO2 absorption
ix. Anesthesia ventilators
x. Scavenger systems
xi. Low-flow anesthesia
xii. Perform a complete pre-use check of the machine

15.2.2 Equipment Cleaning and Sterilization
The Anesthesiologist must demonstrate an understanding of the methods of cleaning and sterilizing equipment and the advantages and limitations of these methods

15.2.3 Lasers
The Anesthesiologist must demonstrate an understanding of principles of the physics of laser use

a) Describe the three ways that laser light is different than ordinary light
   i. Monochromatic
   ii. Coherent
   iii. Collimated
b) Describe the essential components in a laser
c) Be knowledgeable about the different lasers available in the OR
   i. CO2
   ii. Argon
   iii. Krypton
   iv. Holmium
   v. Nd:YAG
d) Know the potential hazards of lasers in the OR and how to protect against them
e) Know the Airway Fire Protocol

15.2.4 Ultrasound Machines
The Anesthesiologist must demonstrate an understanding of principles of ultrasound technology

a) Ultrasound Principles
   i. Describe the principles of US
   ii. Describe how M-mode and Two-dimensional Echocardiography work
b) TEE
   i. Know the design and the basic waveforms seen with a TEE
   ii. List the indications, limitations and complications of use
c) Regional Ultrasound
   i. Know the basic structures seen with ultrasound and identify nerves
16 Neurology/ Neurosurgical Anesthesiology
The competent Anesthesiologist shall demonstrate proficiency in all of the objectives listed below

16.1 Basic Science
The Anesthesiologist must demonstrate knowledge and an understanding of the anatomic, physiologic, and pharmacologic principles that are unique to the neurosurgical patient. He/she must demonstrate knowledge of:

a) Anatomy
   i. Basic anatomy of the central nervous system, including the spinal cord and meninges
   ii. Anatomy of the Circle of Willis
   iii. Vascular supply to the spinal cord
   iv. Cellular anatomy of the blood brain barrier

b) Physiology
   i. Cerebral blood flow
   ii. Determinants of Cerebral Perfusion Pressure
   iii. Cerebral metabolic rate for oxygen
   iv. Cerebral pressure autoregulation
   v. Carbon dioxide reactivity
   vi. Response to hypoxia
   vii. Flow metabolism coupling
   viii. Production, flow and re-absorption of cerebral spinal fluid
   ix. Effects of hypo and hyperthermia

c) Pharmacology
   i. Direct and indirect effects of intravenous and inhaled anesthetic agents on cerebral physiology
   ii. Basic principles of neuroprotection and neuroresuscitation
   iii. Mechanism of action of osmotic diuretics
   iv. Prevention and treatment of vasospasm
   v. Controlled hypo- and hypertension
   vi. Anesthetic consideration of anticonvulsants

16.2 Neurological diseases
The consultant Anesthesiologist must demonstrate the ability to independently provide anesthesia care for:

a) Patients with increased intracranial pressure at risk of hemiation
   i. Supratentorial tumors
   ii. Posterior fossa tumors
b) Patients with traumatic neurological diseases
   i. Spinal cord injury
      • Cervical; unstable cervical spine
      • Thoracic: autonomic hyperreflexia
      • Lumbar
   ii. Traumatic Brain Injury

c) Patients with cerebrovascular diseases
   i. Carotid stenosis
   ii. Stroke
      • Embolic
      • Hemorrhagic
   iii. Intracranial aneurysms
   iv. Arteriovenous malformations
   v. Cerebral hyperperfusion

d) Patients with common neurological disorders
   i. Parkinson’s disease
   ii. Multiple Sclerosis

e) Patients with common non-traumatic disorders of the spine
   i. Cervical or lumbar disc herniation
   ii. Spinal stenosis
   iii. Spondylopathies, including Ankylosing spondylitis

f) Patients with neuroendocrine disorders
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i. Hypopituitarism
ii. Hyperpituitarism
iii. Diabetes Insipidus
iv. Syndrome of inappropriate ADH secretion
v. Cerebral salt wasting syndrome

g) Patients with congenital neurological diseases
   i. Cerebral Palsy
   ii. Meningomyelocoele
   iii. Chiari Malformations
   iv. Dandy-Walker complex
   v. Craniosynostosis
   vi. Tethered spinal cord

16.3 Anesthesia for Neurosurgical Procedures

16.3.1 Surgical procedures

The Anesthesiologist must be able to demonstrate understanding of the implications of, and provide anesthetic care for neurosurgical patients presenting with the following conditions:

a) Intracranial Masses
   i. Supratentorial tumour resection
   ii. Posterior fossa tumour resection
   iii. Pituitary tumour resection

b) Traumatic Brain Injury
   i. Evacuation of subdural hematoma, acute vs. chronic
   ii. Evacuation of epidural hematoma
   iii. Evacuation of intracranial hemorrhage
   iv. Decompressive craniectomy

c) Intra and Extracranial Vascular disease
   i. Intracranial aneurysm clipping
   ii. Intracranial Arteriovenous malformation resection
   iii. Carotid endarterectomy

d) Hydrocephalus
   i. Ventriculoperitoneal or atrial shunt placement
   ii. External ventricular drain placement

e) Epilepsy
   i. Epilepsy surgery
   ii. awake craniotomy

f) Interventional Neuroradiology
   i. Intracranial aneurysm coiling
   ii. Arteriovenous malformation embolization
   iii. Carotid artery stenting

g) Surgery of the Spine
   i. Laminectomy/Disectomy/Decompression
   ii. Spinal instrumentation/fusion
   iii. Spinal cord tumour resection

h) Pediatric Neurosurgery
   i. Surgery for meningomyelocoele
   ii. Cranietomy for craniosynostosis
   iii. Untethering of spinal cord

16.3.2 Perioperative Management

a. Management of neurosurgical anesthesia emergencies
   i. Acute increase in intracranial pressure
   ii. Venous air embolism
   iii. Intraoperative aneurysm rupture
b) Management of fluid therapy in the neurosurgical patient

c) Patients requiring intraoperative neurological monitoring
   i. Electroencephalography, including bispectral analysis
   ii. Somatosensory Evoked Potentials
   iii. Motor evoked potentials
   iv. Wake up test
17 Neuromuscular Junction

The Anesthesiologist shall demonstrate an in depth understanding of the neuromuscular junction and its’ relevance in anesthesia:

17.1 Neuromuscular Junction physiology
The competent anesthesiologist must demonstrate an ability to:

a) Describe a synapse: the motor neuron and the muscle fiber
b) Describe the nerve action potential
c) Describe the formation of neurotransmitter at the motor nerve ending
   i. Acetylcholine synthesis
   ii. Storage
   iii. Release
   iv. Recycling
d) Explain acetylcholinesterase action
e) Describe a postjunctional receptor
f) Explain how a postjunctional receptor works
g) Explain the effects of the prejunctional receptor on nerve transmission
h) Explain the quantal theory at the neuromuscular junction
i) Describe the action potential across nerve membrane, including sodium and calcium channels

17.2 Pharmacology of Muscle Relaxants
The competent Anesthesiologist must demonstrate an ability to:

a) Explain the action of neuromuscular relaxants, nondepolarizing and depolarizing, on prejunctional and postjunctional receptors
b) Explain a desensitization block
c) Explain how certain drugs can affect neuromuscular relaxants effects
   i. Volatile agents
   ii. Antibiotics
   iii. Calcium
   iv. Local anesthetics
   v. Antiepileptics
   vi. Diuretics
   vii. Channel blocks and other effects
d) Pharmacology of succinylcholine
   i. Pharmacokinetics and pharmacodynamics
   ii. Indications
   iii. Contraindications
   iv. Butryrylcholinesterase activity and reversal of succinylcholine
   v. Drug interactions and adverse effects
e) Pharmacology of non-depolarizing neuromuscular blocking agents
   i. Pharmacokinetics and pharmacodynamics
   ii. Potency
   iii. Metabolism and elimination
   iv. Clinical management and dosage
   v. Drug interactions and adverse effects
   vi. Indications
   vii. Contraindications

17.3 Prejunctional, Immature and Extrajunctional Receptors

a) Describe the “fade” phenomenon with neuromuscular relaxants through a prejunctional effect and the effect of different neuromuscular relaxants on that phenomenon
b) Explain how immature and extrajunctional receptors form, and the effects of depolarizing neuromuscular relaxants on such receptors
c) Describe the Myopathy following long term administration of neuromuscular relaxants during critical illness
17.4 Neuromuscular Reversal
The competent Anesthesiologist must demonstrate an in depth understanding of the reversal of neuromuscular blockade

a) Explain how antagonists of neuromuscular block works
   i. Neostigmine
   ii. Pyridostigmine
   iii. Edrophonium
   iv. Suggamadex ®

b) Explain the role of anticholinergic drugs in neuromuscular reversal
   i. Atropine
   ii. Glycopyrrolate

c) Describe the effects of neuromuscular relaxants on the autonomic nervous system

d) Explain the influence of neuromuscular diseases on neuromuscular relaxants effects

e) Explain the influence of age, obesity on neuromuscular relaxants effects

f) Describe the determinants of speed and adequacy of reversal of neuromuscular blockers

g) Describe the side effects of anticholinesterase agents

17.5 Monitoring Neuromuscular Blockade
The Anesthesiologist must demonstrate an understanding of monitoring of blockade of the neuromuscular junction

a) Peripheral nerve stimulation – patterns used

b) Assessment of complete/adequate reversal

c) Clinical indications of reversal

17.6 Pathology
Pathophysiology, clinical presentation, classification, and perioperative management of patients with the following conditions:

a) Myesthenia Gravis

b) Eaton-Lambert syndrome
18 Obstetrical Anesthesia

General Issues

The 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.

18.1 Maternal Physiology
The Anesthesiologist must demonstrate an understanding of:

a) Maternal physiology: time course and changes during gestation
   i. Cardiovascular adaptations to pregnancy
   ii. Pulmonary, respiratory, and airway changes
   iii. Gastrointestinal, hematologic, and renal changes
   iv. Central nervous system changes
b) MAC and local anesthetic adjustments during pregnancy
c) Approach to CPR in parturient, awareness of need for delivery of baby

18.2 Fetal and Placental Physiology
The Anesthesiologist must demonstrate an understanding of:

a) Placental development, structure and inability to auto regulate placental flow
b) Placental gas exchange, nutrient transport, drug transfer
c) Antenatal fetal evaluation (growth, fluid, position, biophysical profile)
d) Fetal circulation
e) Fetal and neonatal effects of maternally administered anesthetic drugs
f) Fetal adaptations to hypoxia
g) Fetal heart rate patterns during labour and their response to hypoxia or asphyxia
h) Impact on fetus of drop in maternal cardiac output
i) Interpret fetal heart rate patterns during labour

18.3 Neonatal Physiology
The Anesthesiologist must demonstrate an understanding of:

a) Intrapartum fetal resuscitation
b) Neonatal physiologic adaptations to extrauterine life
c) Resuscitation of the newborn – NRP protocol
d) Predict the likelihood of need for resuscitation
e) Recognize the neonate needing resuscitation
f) Initiate resuscitation of a neonate

18.4 Obstetric Management of Labour
The Anesthesiologist must demonstrate an understanding of:

a) Physiology of labour and the smooth muscle of the uterus
b) The stages of labour and typical duration
c) Effect of uterine contractions on placental exchange and fetal oxygenation
d) Indications for analgesia during labour
e) Effect of analgesia on labour and delivery
f) Effect on labour of maternal hydration, position, hyperventilation, hypotension
g) Recognition and management of uterine hypertonus or hyperstimulation
h) Commonly used drugs in obstetrics including indications contraindications, classification, and therapeutic uses and side effects of:
i. Oxytocin, carbitocin
ii. Ergotamine
iii. Prostaglandins, hemabate
iv. Magnesium sulphate
v. Uterine relaxants
vi. Magnesium sulphate
vii. Nitroglycerine

18.5 Labour Analgesia and Anesthesia

18.5.1 Anatomy and physiology of labour pain

The Anesthesiologist must be able to

a) Describe the pain pathways for stages of labour
b) Describe the anatomy of spinal and epidural space

18.5.2 Labour analgesia

See Regional anesthesia 24.1, 24.5

For the following analgesic options, discuss:

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

a) Non-pharmacologic options
b) Opioids – IV, IM, SC, IV PCA
c) Inhaled N2O
d) Neuraxial opioids (Intrathecal and epidural)
e) Spinal-single shot
f) Combined spinal/epidural
g) Continuous spinal catheter technique
h) Epidural Local anesthetics
i) Pudendal and paracervical blocks

18.6 Anesthesia for Obstetrical surgery

For the following anesthetic options, discuss:

- Indications
- Contraindications
- Mechanism of action
- Pharmacokinetics/pharmacodynamics
- Maternal Side effects
- Fetal effects
- Effects on Uterine blood flow
- Complications
- Management of complications
18.6.1 Regional Anesthesia for Cesarean Section
a) Spinal
b) Epidural
c) Conversion of labour analgesia epidural for anesthesia
d) Combined spinal- epidural

18.6.2 General Anesthesia for Cesarean Section
a) Indications for general endotracheal (GETA) anesthesia
b) Risks for morbidity and mortality associated with GA in parturient
c) Ventilatory requirements of parturients
d) Drug choices and doses for induction and maintenance for caesarean or operative delivery
e) Impact on the fetus of the induction to delivery and uterine incision to delivery time intervals
f) Appropriate pre-op assessment of the parturient for GA
g) Physiologic changes of pregnancy impacting on GA management
h) Demonstrate:
   i. Develop and execute a plan for general endotracheal anesthesia based on the physiologic and physical changes of pregnancy
   ii. Perform a rapid sequence induction
   iii. Recognize and outline management of a difficult airway based on physical examination
   iv. Outline a failed intubation plan
   v. Outline a plan for postoperative management of patient following GA
   vi. Recognize pulmonary aspiration of gastric contents and outline a plan for the PACU and postoperative care of a patient who has aspirated

a) Inherent maternal anesthetic risk of urgent or emergent delivery
b) Surgical and anesthetic management of bleeding during delivery, including drug therapy, surgical manoeuvres, transfusion therapy

18.6.3 Anesthesia for other obstetric surgery
a) Retained placenta
b) Double set-up
c) Postpartum tubal ligation
d) Insertion/ removal of suture for cervical incompetence

18.6.4 Post Operative Pain Control
The Anesthesiologist must demonstrate an understanding of:

a) The various components of multimodal analgesic techniques used after caesarean or vaginal delivery. These include the use of:
   i. Neuraxial opioids
   ii. Parenteral opioids
   iii. Non-steroidal anti-inflammatory drugs
   iv. Adjunctive drugs
   v. Local anesthetics
b) Transfer of drugs into breast milk and the effects on the neonate

He/she must demonstrate an ability to:
c) Recognize and manage inadequate postpartum analgesia  
d) Provide appropriate post operative pain management  
e) Recognize and treat side effects of postoperative pain modalities used  

18.7 Obstetrical Complications and Their Management  
The Anesthesiologist must demonstrate an understanding of:  

a) The management of maternal ante – or postpartum hemorrhage  
   i. Uterine rupture  
   ii. Abruptio placentae or atony  
   iii. Placenta previa or accrete  
   iv. Retained placenta  
b) The treatment for maternal embolic events  
   i. Amniotic fluid  
   ii. Air  
   iii. Thrombus  
c) Management of fetal emergencies – prolapsed vasa previa  
d) Management of intra-uterine fetal death  

18.8 Medical Diseases During Pregnancy and Their Peri-Operative Management  
For the following diseases, the Anesthesiologist must demonstrate an understanding of:  

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

a) Hypertensive Disorders of Pregnancy  
   i. Classification of hypertensive disorders during pregnancy  
   ii. Epidemiology of preeclampsia – risk factors  
   iii. Pathophysiology of preeclampsia as a multisystem disease  
   iv. Medical/obstetric management of preeclampsia  
      - Term vs. preterm fetus  
      - Mild vs. severe diseases  
      - Assessment of fetal well being  
      - Seizure prophylaxis and management; magnesium sulphate effects  
      - Antihypertensive therapy  
      - Management of oliguria  
      - Indications for invasive monitoring  
   v. Anesthetic selection for and management of the preeclamptic parturient  
      - Labour and vaginal delivery  
      - Abdominal delivery – non-urgent  
      - Abdominal delivery – urgent  

b) Morbid Obesity  
   i. The anesthetic considerations for morbidly obese parturient  
   ii. The use of regional anesthesia in morbidly obese patients  
   iii. The management of general anesthesia in obese patients  

c) Respiratory Disease Knowledge  
   i. Asthma  
   ii. ARDS  

d) Cardiac Disease Knowledge  
   i. Understand when invasive monitors are needed for delivery and postpartum care  
   ii. Understand the pathophysiology and management of parturients with:  
      - Congenital heart disease  
         - Left to right shunt  
         - Right to left shunts (Tetralogy of Fallot)  
         - Pulmonary hypertension (Eisenmenger’s Syndrome)  
         - Coarctation of aorta
iii.   IHSS
iv.    Ischemic Heart Disease
v.     Valvular Heart Disease
   ●   Aortic stenosis
   ●   Aortic insufficiency
   ●   Mitral stenosis
   ●   Mitral regurgitation
vi.    Peripartum Cardiomyopathy
e)  Endocrine Disease
   i.   Knowledge of diabetes mellitus
   ii.  Knowledge of thyroid disease
   ●   Hyperthyroidism
   ●   Hypothyroidism
   iii. Understand the impact of these conditions on the pregnancy and *vice versa.*
iv.    Pheochromocytoma
v.     Ability to manage glucose control in the parturient during caesarean or vaginal delivery
f)  Hematologic and Coagulation Disorders
   i.   Knowledge of anemias
   ii.  Knowledge of coagulation disorders
   iii. Knowledge of the guidelines concerning regional anesthesia and anticoagulation
g)  Miscellaneous Disorders
   i.   Renal disease
   ii.  Liver disease
   iii. Musculoskeletal disorders
   iv.   Scoliosis
   v.    Rheumatoid arthritis
   vi.   Spina bifida cystica
   vii.  Autoimmune disorders
   viii. Prior back surgery including Harrington rod placement

18.9  Anesthetic Management of Non-Obstetric Surgery During Pregnancy

a)  Considerations for elective surgery during pregnancy
b)  Discuss potential teratogenicity of medications
c)  Considerations for trauma or emergency surgery during pregnancy
d)  Understand when fetal monitoring is needed during maternal surgery
e)  Physiology of pregnancy as it might impact cardiovascular, respiratory and transfusion decisions during surgery
f)  Ability to discuss risks of elective surgery with patients and colleagues

18.10 Ethical Issues

a)  Awareness of potential for maternal-fetal conflicts of interest
   i.   General anesthesia for stat caesarean delivery in face of perceived fetal jeopardy
b)  Respect for all moral and religious points of view
   i.   Jehovah Witness patient
c)  Awareness of fetal development and current limits of viability
d)  Recognize own ethical attitudes versus patient’s moral concerns
e)  Willingness to arrange for non-prejudicial transfer of care, if necessary
f)  Recognize need for timely consultation on difficult moral and legal issues

18.11 Morbidity and Mortality

a)  Discuss major causes of morbidity and mortality in pregnant patients
b)  Discuss anesthesia related morbidity and mortality in pregnant patients

18.12 Ultrasound
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a) Understand the physics of ultrasound used in medical practice  
b) Understand the relevant ultrasound anatomy of the neuraxis  
c) Perform ultrasound examination of the neuraxis for regional techniques  
d) Perform regional techniques under ultrasound guidance
19 Ophthalmology
The competent Anesthesiologist shall demonstrate the knowledge with respect to relevant anatomy and physiology of the eye

19.1 Anatomy and Physiology
He/she will demonstrate an ability to:

a) Describe the anatomy of the eye including chambers, relevant blood supply and innervation
   i. Describe the oculo-cardiac reflex including determinants that predispose patients, and intraoperative management of the OCR
b) Describe the determinants of IOP and factors that influence it
c) Describe the pathophysiology of glaucoma

19.2 Anesthetic Considerations
The Anesthesiologist must demonstrate an ability to independently provide anesthesia for patients undergoing ophthalmic surgery with respect to:

a) Preoperative Evaluation
   i. Identify the common medical conditions associated with patients having ocular surgery
b) Pharmacologic Interventions
   i. Describe the drugs commonly used in ophthalmologic patients including mydriatics, miotics, and topical and systemic drugs used to decrease IOP
   ii. Describe the systemic effects of the aforementioned medications
   iii. Describe the ocular effects of systemic medications
c) Effects of Anesthesia on IOP or Retinal Perfusion
   i. Describe the perioperative factors that will increase or decrease IOP and influence retinal perfusion
d) Anesthetic Technique
   i. IV sedation
      • Identify the drugs used to provide sedation and the side effects and complications associated with those drugs
   ii. Topical anesthesia
      • Describe the local anesthetics commonly used to provide topical anesthesia to the eye
   iii. Regional anesthesia
      • Describe retrobulbar and peri-bulbar blocks. Know the indications and contra-indications for these blocks
      • Describe the complications including globe perforation, optic nerve damage, hemorrhage and total spinal associated with these blocks and the management thereof
   iv. General anesthesia
      • Know the issues surrounding limited access to the airway, the importance of smooth induction and emergence
      • Know the significance of Ketamine, nitrous oxide, and succinylcholine on the eye
e) Post Operative Nausea and Vomiting Prophylaxis
   i. Appreciate the importance of PONV prophylaxis in eye surgery

19.3 Specific Eye Surgery
The Anesthesiologist must demonstrate an understanding of the concerns for specific surgical procedures and an ability to provide anesthetic management for:

a) Open eye injury / ruptured globe
b) Strabismus repair
c) Retinal detachment surgery
d) Retinal surgery for vitreous hemorrhage
   i. Know the significance of the intravitreous gas bubble
e) Cataract surgery
f) Oculoplastics
   i. Blephoraplasty
   ii. DCR
iii. Ptosis repair
iv. Orbital reconstruction
g) Corneal transplant
h) Removal of foreign body
i) Conjunctival – pterygium
j) Laser surgery
k) Enucleation of the eye
20 Orthopedic Surgery

The Anesthesiologist must demonstrate an understanding of the issues related to providing anesthetic care for patients undergoing orthopedic surgery with respect to:

20.1 General considerations:

a) Preoperative Assessment
b) Co-morbid medical conditions
c) Associated chronic pain
d) Use of anti-coagulants
e) Local, Regional or General
f) Positioning
g) Tourniquet
h) Cement – Methyl methacrylate
i) Fat embolism, PE
j) DVT prophylaxis
k) Infection
l) Compartment syndrome
m) Blood loss – transfusion sparing techniques, cell save, etc
n) Multi-modal analgesia

20.2 Limb Fractures

The Anesthesiologist must demonstrate an ability to independently provide anesthetic care for patients with fractures taking into account the following concerns:

a) Urgent vs. emergent
b) Open vs. closed fractures
c) Compound vs. simple
d) Neurovascular compromise
e) Compartment syndrome
f) Hemorrhage

20.3 Joint Replacements

The Anesthesiologist must demonstrate an ability to independently provide anesthetic care for patients presenting for joint replacement taking into account the following concerns:

a) Age, Co-morbidities
   i. RA
   ii. OA
   iii. AS
b) Chronic pain
c) Positioning
   i. Beach chair
   ii. Lateral
d) Tourniquet
e) Cement
f) Blood loss
g) Post op pain, regional techniques
h) Rehabilitation, mobilization, physiotherapy
i) Anti-coagulation

20.4 Tendon/Ligament Reconstruction

The Anesthesiologist must demonstrate an ability to independently provide anesthetic care for patients presenting for tendon/ligament reconstruction

20.5 Spine
20.5.1 Principles of anesthesia for spinal decompression/stabilization surgery
The Anesthesiologist must demonstrate an understanding of the concerns related to spinal surgery with respect to:

a) Spinal cord anatomy and physiology
b) Stable vs. Unstable
c) Emergency vs. Elective
d) Instrumentation
e) Spinal shock
f) Spinal cord compromise
   i. Protection
   ii. Precautions
   iii. Awake positioning
g) Spinal cord monitoring
   i. SSEP
   ii. Wake up tests
h) Post operative neurological assessment
i) Considerations of dural tear
j) Prolonged OR
k) Post-operative respiratory function
l) Implications of surgery on different levels of the spine:
   i. C-spine
     ● Unstable vs. stable c-spine
     ● Anterior and posterior approach
     ● Airway management, Shared airway
     ● Lack of access
     ● Awake positioning
   ii. T-spine
     ● One lung ventilation
     ● Blood loss
     ● Embolism
     ● Autonomic hyper-reflexia
   iii. L-spine
     ● Implications of prone position
     ● Disc/laminectomy
     ● Spine decompression +/- fusion
     ● Implications of bone graft/coral graft

20.5.2 Scoliosis Surgery
The Anesthesiologist must demonstrate an ability to independently provide anesthetic care for patients presenting for scoliosis surgery with respect to:

a) Pre-op assessment
   i. Pediatric vs. adult
   ii. Co-morbidities (MS, CP etc)
b) Respiratory function
c) Cardiovascular function
d) Anesthetic management
e) Prone positioning
f) Blood loss
g) VAE

20.5.3 Spinal Cord Tumours
The Anesthesiologist must demonstrate an understanding of the concerns related to spinal cord tumours with respect to:

a) Blood loss
b) Neurological compromise
c) Primary vs. metastases – radiation, chemotherapy etc.
20.6 **Pelvic Surgery**
The Anesthesiologist must demonstrate an understanding of the concerns related to pelvic surgery with respect to:

a) Urgent vs. Emergent  
b) Major trauma and associated injuries  
c) Blood loss  
d) Prolonged procedure  

20.7 **Ambulatory Orthopedics**
The Anesthesiologist must demonstrate an understanding of the concerns related to ambulatory surgery with respect to:

a) Arthroscopic surgery  
b) Pain management   
   i. Regional anesthetic techniques  
   ii. Ambulatory plexus techniques  

20.8 **Pediatric Orthopedics**
The Anesthesiologist must demonstrate an understanding of the concerns related to pediatric patients with respect to:

a) Considerations of pediatric patients  
b) Emergent vs. elective  
c) Co-morbid conditions  
d) Congenital conditions  
e) Prolonged surgery  
f) Temperature regulation
21 Pain Management

21.1 Acute Pain
The competent Anesthesiologist shall demonstrate an understanding of the anatomy and physiology and an approach to management of acute pain.

The sub specialist in Acute Pain Management shall demonstrate proficiency in all of the above plus these additional specific objectives. A competent Anesthesiologist shall demonstrate knowledge of the principles of these objectives, but not be expected to perform these objectives.

21.1.1 Anatomy and Physiology of Pain
The Anesthesiologist must demonstrate an understanding of the anatomy and physiology of acute pain:

a) Pain Pathways
   i. Describe the structure of nerve fibers that contribute to pain
   ii. Describe the gross anatomic pathways at the peripheral, spinal, brainstem, thalamic and cortical levels that are involved in the perception of pain
b) Pain Transduction
   i. List and describe the function of the major neuromodulators involved in the perception of pain at each anatomic level
   ii. Explain the mechanisms involved in central and peripheral sensitization
   iii. Describe the role and mechanism of mediators of inflammation in the pain process
   iv. Describe the role and mechanism of gene expression in the pain process
c) Neuroendocrine Stress Response
   i. Describe the systems affected by the stress response, and the overall impact on each of those systems
   ii. 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
d) Neuropsychological
   i. Describe the affective and functional aspects of the pain experience and incorporate them into an analgesic plan

21.1.2 Assessment of Pain
The Anesthesiologist must demonstrate a knowledge of the methods used for assessment of acute pain:

a) Objective vs. Subjective
   i. Explain the relevance of objective assessment relative to patient self-reports, and create useful assessment plans based on these principles
b) Characterization of Pain
   i. Assess the relative contributions of somatic, inflammatory, functional and neuropathic processes in a given patient’s pain problem
c) Pain Rating Scales
   i. Describe the VAS, numeric, verbal and FACES rating scales, including their relative advantages and disadvantages, and apply them in clinical practice

21.1.3 Analgesic Interventions
The Anesthesiologist must demonstrate knowledge of the various approaches to acute pain management and ability to provide effective management of acute pain:

a) Multimodal and Regional Analgesia
   i. Describe the multimodal approach to analgesia, including its benefits and limitations
   ii. Advocate with other disciplines to create effective policies for multimodal therapies
   iii. Describe the relative merits of different co-analgesics and select an appropriate co-analgesic regimen to improve analgesia and minimize risk or side effects
   iv. Identify common impediments to analgesia and modify therapy appropriately
   v. Discuss the advantages, disadvantages, indications, contraindications and complications of the regional techniques listed in the above section as they apply to acute pain management
b) Systemic Pharmacological Interventions
c) General Analgesic Pharmacology
   i. Effectively describe and utilize the pharmacokinetics and analgesic therapies taking into account the characteristics of specific agents and routes of administration
   ii. Discuss the use of intrathecal/epidural administration of opioids and adjuncts
   iii. Identify patients with special pharmacokinetic and pharmacodynamic characteristics and modify therapy appropriately

d) PCA
   i. Describe the pharmacokinetic rationale behind PCA
   ii. List and manage the potential risks for PCA
   iii. Devise appropriate management protocols for PCA
   iv. Prescribe PCA appropriately
   v. Utilize different routes for PCA-IV, SC, Epidural, oral
   vi. Describe the agents which may be used for PCA

21.1.4 Analgesic Agents
The Anesthesiologist must demonstrate an understanding and ability to use the various groups of analgesics available for management of acute pain. He/she must be able to describe the various analgesics according to the properties of each agent including:

- 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

a) Opioids
   i. Describe the mechanism of action of opioids
   ii. Describe the types of opioid receptors with reference to their functions and distribution in the body
   iii. Develop protocols and policies to govern the administration of opioids in the perioperative setting

b) NSAIDs
   i. Describe the mechanism of action of NSAIDs
   ii. Develop protocols and policies to govern the administration of NSAIDs in the perioperative setting
   iii. NSAIDs vs Cox-2

c) Acetaminophen
   i. Describe the mechanism of action of acetaminophen
   ii. Develop protocols and policies to govern the administration of acetaminophen in the perioperative setting

d) Topical Analgesics
   i. Identify appropriate situations and agents for topical analgesia
   ii. Discuss the relative advantages and disadvantages of this route with specific reference to the agent and the situation
   iii. Prescribe topical opioids appropriately
   iv. Describe the indications, contraindications and rationale for the use of other topical analgesics
   v. Describe the use of topical agents to a patient

e) NMDA Antagonists
   i. Contrast the pharmacokinetic and pharmacodynamics characteristics of NMDA antagonists
   ii. Describe the mechanism of action of NMDA antagonists
   iii. Develop protocols and policies to govern the administration of NMDA antagonists in the perioperative setting

f) Anticonvulsants
   i. Describe the indications, contraindications, advantages and disadvantages of anticonvulsants in acute pain management
   ii. Describe the analgesic mechanism of action and anticonvulsants
   iii. Develop protocols and policies to govern the administration of anticonvulsants in the perioperative setting

g) Alpha-Agonists
   i. Describe the mechanism of action of alpha-agonists
   ii. Develop protocols and policies to govern the administration of Alpha-agonists in the perioperative setting
   iii. Select the appropriate agent, dose, and route of administration for acute pain management in the spectrum of patients and procedures

h) Antidepressants
   i. Describe the mechanisms of action of Antidepressants with respect to acute pain management
ii. Develop protocols and policies to govern the administration of antidepressants in the perioperative setting
iii. Select the appropriate agent, doses, and route of administration for acute pain management in the spectrum of patients and procedures relevant to his/her level of training

i) Tramadol
   i. Identify and minimize related complications and side effects
   ii. Describe the mechanism of action of Tramadol

j) Cannabinoids
   i. Describe the indications, contraindications, advantages and disadvantages of Cannabinoids including issues specific to all relevant routes of administration
   ii. Describe the types of cannabinoids available (THC/synthetic THC analogue/THC/CBD & marijuana
   iii. List the systemic effects of cannabinoids including variations specific to particular routes of administration
   iv. Identify and minimize related complications and side effects
   v. Describe the mechanism of action of cannabinoids with respect to analgesia
   vi. Develop protocols and policies to govern the administration of cannabinoids in the perioperative setting

21.1.5 Non-Pharmacologic Interventions
The Anesthesiologist must demonstrate an understanding and ability to use/prescribe non-pharmacologic interventions for the management of acute pain

a) Recognize the importance of non-pharmacologic factors in analgesia
b) Support allied health professional in provision of non-pharmacologic interventions
c) TENS
   i. Explains the theoretical mechanism of TENS in analgesia
   ii. Discuss the efficacy of TENS in acute pain management
   iii. Coordinate access to TENS as a non-pharmacologic adjunct in appropriate situations

21.1.6 Outcomes of Acute Pain Management
The Anesthesiologist must demonstrate an understanding of the outcomes relevant to the various modalities of analgesia used for management of acute pain

a) Outcomes
   i. Discuss the extent to which analgesia may contribute to patient outcomes, and the mechanisms for such contribution
   ii. Design analgesia plans that optimize recovery for patients
   iii. Advocate with other disciplines to implement appropriate multimodal recovery plans
b) Addiction, Tolerance and Substance Abuse
   i. Identify and distinguish between tolerance, dependence and addiction
   ii. Identify the special physiological, psychological, pharmacokinetic and pharmacodynamics issues in the tolerant or abusing patient
   iii. Recognize addictive behaviour and warning signs of substance abuse
   iv. Educate allied health and other medical professional to the risks and appropriate management of tolerance and addiction in relation to acute analgesic therapy
   v. Describe the biopsychosocial aspects of substance abuse and its interaction with analgesic therapy
   vi. Generate an appropriate acute pain plan in cooperation with the patient setting realistic analgesic and functional goals
   vii. Recognize and treat opioid withdrawal

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

The sub-specialist in Chronic Pain Management shall demonstrate proficiency in all of the above plus these additional specific objectives. A competent Anesthesiologist shall demonstrate knowledge of the principles of these objectives, but not be expected to perform these objectives.

21.2.1 Anatomy and Physiology of Pain
The Anesthesiologist must demonstrate an understanding of the anatomy and physiology of the development and management of chronic pain.

a) Pain Pathways
   i. Describe the structure of nerve fibers that contribute to pain
   ii. Describe the gross anatomic pathways at the peripheral, spinal, brainstem, thalamic and cortical levels that are involved in the perception of pain

b) Pain Transduction
   i. List and describe the function of the major neuromodulators involved in the perception of pain at each anatomic level
   ii. Explain the mechanisms involved in central and peripheral, spinal, brainstem, thalamic and cortical levels that are involved in the perception of pain

c) Neuroendocrine Stress Response
   i. Describe the systems affected by the stress response, and the overall impact on each of those systems
   ii. Describe the specific changes within each of the affected systems that lead to the overall functional impact on those systems
   iii. 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

21.2.2 Assessment of Pain
The Anesthesiologist must demonstrate knowledge of the methods used for assessment of chronic pain:

a) Objective vs. Subjective
   i. Delineate between nociceptive (somatic and visceral) and neuropathic
   ii. Explain the relevance of objective assessment relative to patient self-reports, and create useful assessment plans based on these principles
   iii. Assess the relative contributions of somatic, inflammatory, functional and neuropathic processes in a given patient’s pain problem
   iv. Perform a comprehensive assessment of the patient in pain, including functional and psychosocial impacts
   v. Interpret the results of multidimensional pain indices, and compare the clinical utility of different instruments

b) Pain Rating Scales
   i. Describe the VAS, numeric, verbal and FACES rating scales, including their relative advantages and disadvantages, and apply them in clinical practice

21.2.3 Analgesia, Outcomes, and Goals of Therapy

a) Rehabilitative and Functional Outcomes
   i. Describe the affective and functional aspects of the pain experience and incorporate them into an analgesic plan
   ii. Generate an appropriate plan in cooperation with the patient setting realistic analgesic and functional goals
   iii. Coordinate a multidisciplinary pain management plan, making appropriate use of allied health professionals and resources
   iv. Contribute to policies and protocols designed to facilitate a multi-disciplinary approach to pain management

b) Tolerance, Addiction and Substance Abuse
   i. Identify and distinguish between tolerance, dependence and addiction
   ii. Identify the special physiological, psychological, pharmacokinetic and pharmacodynamics issues in the tolerant or abusing patient
   iii. Recognize addictive behaviour and warning signs of substance abuse
   iv. Educate allied health and other medical professional to the risks and appropriate management of tolerance and addiction in relation to chronic analgesic therapy
   v. Describe the biopsychosocial aspects of substance abuse and its interaction with chronic analgesic therapy
   vi. Generate an appropriate comprehensive long-term plan in cooperation with the patient setting realistic analgesic and functional goals

21.2.4 Analgesic Interventions
The Anesthesiologist must demonstrate knowledge of the various approaches to chronic pain management and ability to provide effective management of chronic pain
a) Multimodal and Regional Analgesia
   i. Describe the multimodal approach to analgesia, including its benefits and limitations
   ii. Advocate with other disciplines to create effective policies for multimodal therapies
   iii. Describe the relative merits of different co-analgesics
   iv. Select an appropriate co-analgesic regimen to improve analgesia and minimize risk or side effects in a spectrum of patients
   v. Identify common impediments to analgesia and modify therapy appropriately
   vi. Discuss the advantages, disadvantages, indications, contraindications and complications of the regional techniques as they apply to chronic pain management
   vii. Identify and manage complications and adverse effects of regional analgesic techniques in an ambulatory chronic pain population

b) Pharmacologic Interventions
   i. General Analgesic Pharmacology
      • Effectively 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
      • 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
      • Identify patients with special pharmacokinetic and dynamic characteristics and modify therapy appropriately
      • 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
   ii. PCA
      • Describe the pharmacokinetic rationale behind PCA
      • List and manage the potential risks of PCA
      • Devise appropriate management protocols for PCA
      • Prescribe PCA appropriately
      • Diagnose and address common complications
      • Utilize different routes for PCA-IV, SC, Epidural, oral
      • Utilize different agents or combinations for PCA, and provide a rationale based on advantages and disadvantages

21.2.5 Analgesic agents

The Anesthesiologist must demonstrate an understanding and ability to use the various groups of analgesics available for management of acute pain. He/she must be able to describe the various analgesics according to the properties of each agent including:

• 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

a) Topical Analgesics
   i. Identify appropriate situations and agents for topical analgesia
   ii. Discuss the relative advantages and disadvantages of this route with specific reference to the agent and the situation
   iii. Prescribe topical opioids appropriately
   iv. Describe the indications, contraindications and rationale for the use of other topical analgesics
   v. Describe the use of topical agents to a patient

b) Opioids
   i. Describe the mechanism of action of opioids
   ii. Describe the types of opioid receptors with reference to their functions and distribution in the body
   iii. Develop protocols and policies to govern the administration of opioids in the perioperative setting
   iv. Intrathecal/epidural route
v. Mechanisms to avoid/reverse opioid tolerance (opioid rotation; use of antagonists etc)
vi. Detoxification protocols (slow vs. rapid detox)
vii. Discuss opioid conversions – equipotency; iv:po conversions
viii. Methadone
c) NSAIDs
   i. Describe the mechanism of action of NSAIDs
   ii. Develop protocols and policies to govern the administration of NSAIDs in the chronic pain setting
   iii. NSAIDs vs. Cox-2
d) Acetaminophen
   i. Describe the mechanism of action of Acetaminophen
   ii. Develop protocols and policies to govern the administration of acetaminophen in the chronic pain setting
e) NMDA Antagonists
   i. Describe the mechanism of action of NMDA antagonists
   ii. Describe the role of excitatory amino acids in pain and sensitization
   iii. Develop protocols and policies to govern the administration of NMDA antagonists in the chronic pain setting
   iv. Methadone in chronic pain – titration protocol; mechanism of action; conversion; ways of administering: methadone license
f) Anticonvulsants
   i. Describe the analgesic mechanism of action of anticonvulsants
   ii. Develop protocols and policies to govern the administration of anticonvulsants in the perioperative setting
   iii. Iv lidocaine therapy
g) Alpha-agonists
   i. Describe the mechanism of action of Alpha-agonists
   ii. Develop protocols and policies to govern the administration of Alpha-agonists in the chronic pain setting
h) Antidepressants
   i. Describe the mechanisms of action antidepressants with respect to analgesia
   ii. Develop protocols and policies to govern the administration of antidepressants in the chronic pain setting
i) Tramadol
   i. Identify and minimize related complications and side effects
   ii. Describe the mechanism of action of Tramadol
j) Cannabinoids
   i. Describe the indications, contraindications, advantages and disadvantages of cannabinoids including issues specific to all relevant routes of administration
   ii. List the systemic effects of cannabinoids including variations specific to particular routes of administration
   iii. Identify and minimize related complications and side effects
   iv. Describe the mechanism of action of cannabinoids with respect to analgesia
   v. Develop protocols and policies to govern the administration of cannabinoids in the perioperative setting
21.2.6 Non-Pharmacologic Interventions
The Anesthesiologist must demonstrate an understanding and ability to use/prescribe non-pharmacologic interventions for the management of acute pain.

- Recognize the importance of non-pharmacologic factors in analgesia
- Support allied health professional in provision of non-pharmacologic interventions TENS and acupuncture
- Explain the theoretical mechanism of TENS in analgesia
- Discuss the efficacy of TENS in chronic pain management
- Coordinate access to TENS as a non-pharmacologic adjunct in appropriate situations

a) Other Non-Pharmacologic Interventions
   i. Use of Biofeedback
   ii. Chiropractic interventions
   iii. Massage
   iv. Physiotherapy – ultrasound/interferential/TENS etc
b) Spinal Cord and Peripheral Nerve Stimulation
   i. Identify clinical situations in which stimulation may be of benefit
   ii. Describe the purported mechanism of action of stimulation
   iii. Coordinate access to stimulation for appropriate patients
   iv. Discuss the relative advantages, disadvantages, indications and contraindications of stimulation for chronic pain
   v. Identify complications of implanted stimulators
   vi. Insert peripheral and spinal stimulators
   vii. Order initial and titrate follow up settings for optimum patient comfort
viii. Manage complications of implanted stimulators, utilizing consultants as appropriate
ix. Intrathecal pumps/spinal & epidural catheters
x. Beneficial situations
xi. Mechanism of action
xii. Advantages/disadvantages/indications/contraindications
xiii. Complications & their management
xiv. Insert pumps
xv. Common drugs – opioids/baclofen/LA/clonidine/ketamine
xvi. How to titrate/wean po/iv drugs in this situation
22 Pediatric Anesthesia

22.1 Basic Science

The 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.

22.1.1 Anatomy / Physiology

He/she must demonstrate knowledge of:

a) The Respiratory System
   i. Anatomic features of the neonatal, infant, pediatric and adolescent airway
   ii. The physiology of the respiratory system and its’ maturation over time with respect to
      • Control of respiration
      • Compliance
      • Lung volumes
      • Oxygen consumption/metabolic rate
      • Normal values for different stages of development
      • Pediatric basic and advanced life support

b) The Cardiovascular System
   i. The anatomy and physiology relevant to the transitional circulation
   ii. Maturation of the myocardium and the autonomic nervous system
   iii. Normal values for different stages of development
   iv. Pediatric basic and advanced life support

c) The Central Nervous System
   i. Anatom – size, fontanelles
   ii. Physiology – Intracranial pressure and volume, cerebral blood flow, autoregulation

d) The Genitourinary System
   i. Renal maturation
   ii. Fluid and electrolyte management
   iii. Fluid distribution
   iv. Maintenance requirements
   v. Hydration

e) The Gastrointestinal/Hepatic System
   i. Feeding, fasting guidelines
   ii. Glucose control
   iii. Maturation of hepatic function

f) Thermoregulation
   i. Body surface area
   ii. Ability to thermoregulate
   iii. Heat loss

g) Psychological Issues
   i. Anxiety and understanding and coping mechanism in different age groups and premedication
   ii. Separation, effects of hospitalization
   iii. Parental anxiety
   iv. Consent in the pediatric population

22.1.2 Pharmacology

The anesthesiologist must demonstrate an understanding of the variations in drug handling in infants and children as a result of differences in

a) Pharmacokinetics/pharmacodynamics
   i. Absorption
   ii. Volume of distribution
   iii. Protein binding
   iv. Pharmacokinetics/Pharmacodynamics
   v. Metabolism
   vi. Clearance
vii. Excretion
viii. Toxicity

22.2 Pain Management
He/she must demonstrate knowledge of options for perioperative analgesia including systemic analgesia, local infiltration, regional nerve blocks and neuraxial analgesia and the indications, contraindications, advantages and disadvantages of each modality in the pediatric population.

He/she must demonstrate competence in ordering continuous opioid infusions, PCA and epidural orders.

He/she must demonstrate competence in performing single shot caudal blocks.

Equipment – specific to age group

22.3 Coexisting Diseases in Pediatric Patients
The consultant Anesthesiologist must demonstrate the ability to independently provide anesthetic care for:

In addition to the requirements for a consultant anesthesiologist the subspecialty pediatric anesthesiologist must demonstrate the ability to independently provide anesthetic care for:

a) Full term infants, former preterm infants, children and adolescents presenting for common surgical procedures.
   i. The anesthetic management of very premature infants

b) Children with cardiovascular diseases
   i. ASD, VSD, PDA
   ii. Postoperative repaired simple lesions
   iii. Cardiomyopathies
   iv. Heart transplant recipients
   v. Complex congenital heart disease
   vi. Transposition of great vessels
   vii. Truncus Arteriosus
   viii. Hypoplastic left heart syndrome
   ix. Pulmonary hypertension
   x. Postoperative: Norwood, Bicaval pulmonary anastomosis, Fontan operation
   xi. Obstructive lesions

c) Pediatric patients with respiratory diseases
   i. Upper respiratory tract infections
   ii. Asthma, including management of status asthmaticus
   iii. Cystic Fibrosis
   iv. Chronic Lung Disease
   v. Stridor

d) Patients with diseases of the gastrointestinal tract
   i. Hepatobiliary disease
   ii. Gastroesophageal reflux
   iii. Feeding disorders

e) Patients with Neuromuscular diseases
   i. Hydrocephalus
   ii. Spina bifida
   iii. Cerebral palsy
   iv. Seizure disorders, including management of status epilepticus
   v. Duchenne’s Muscular Dystrophy
   vi. Myotonic Dystrophy
   vii. Developmental delay

g) Patients with Infectious diseases
   i. Septic shock
   ii. Communicable diseases
      • HIV
      • Hepatitis
      • TB

h) Patients with Endocrine/metabolic diseases
   i. Diabetes
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ii. Thyroid diseases
iii. Mucopolysaccharidoses
iv. Obesity
v. Mitochondrial diseases

h) Patients with Hematologic diseases/malignancies
   i. Anemias including Sickle cell disease, Thalassemia
   ii. Bleeding disorders: hemophilia, Von Willebrand’s disease
   iii. Others: ITP, leukemia
   iv. Malignancies
   v. Mediastinal masses

i) Psychological
   i. Perioperative anxiety in pediatric patients presenting for multiple types of surgery

j) Children with more common syndromes
   i. Down’s syndrome
   ii. Mental retardation
   iii. Malignant hyperthermia syndrome
   iv. Pierre Robin Syndrome, Crouzon’s, Goldenhaar, Treacher Collins etc
   v. Epidermolysis Bullosa

22.4 Anesthesia for Surgical Procedures
The Anesthesiologist must be able to demonstrate understanding of the implications of, and to independently provide anesthetic care for children presenting for:

In addition to the requirements for the consultant anesthesiologist the subspecialty pediatric anesthesiologist must be able to demonstrate understanding of the implications of, and to independently provide anesthetic care for children presenting for:

a) Neonatal/Infant Surgery
   i. Pyloromyotomy
   ii. Inguinal hernia repair
   iii. Laparotomy
   iv. Tracheo-esophageal fistula repair
   v. Omphalocele
   vi. Gastrochisis
   vii. Necrotizing enterocolitis
   viii. Congenital diaphragmatic hernia

b) General Surgery
   i. Emergency surgery and the implications thereof:
       • Full stomach
       • Evaluation and Resuscitation
       • Fluid and electrolytes
       • Trauma surgery
       • Laparoscopic surgery
       • Antireflux surgery
       • Cholecystectomy/splenectomy
       • Liver transplantation
       • Lung transplantation
       • Thoracic surgery including the need for lung isolation

c) Otolaryngology
   i. Tonsillectomy and adenoidectomy (bleeding tonsil)
   ii. Myringotomy
   iii. Mastoidectomy
   iv. Thyroidectomy
   v. Typanoplasty
   vi. Removal of foreign body from the airway/esophagus
   vii. Epiglottitis
   viii. Neonatal airway surgery
   ix. Laryngeal/tracheal reconstruction
   x. Airway papillomas
   xi. Laryngoscopy (diagnostic/therapeutic)
   xii. Bronchoscopy (rigid/flexible)
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xiii. Tracheostomy
d) Orthopedic Surgery
   i. Fracture reduction
   ii. Hip reconstruction
   iii. Soft tissue surgery
   iv. Spinal surgery
e) Plastic Surgery
   i. Cleft lip/palate repair
   ii. Burn debridement/skin graft
   iii. Correction of congenital limb deformities
   iv. Craniofacial reconstructive surgery
f) Neurosurgery
   i. V-P shunt insertion, revision
   ii. Tumour resection
   iii. Drainage of extra/subdural hematoma
   iv. Raised ICP
   v. Myelomingocele repair
g) Urology
   i. Circumcision, Hypospadias repair
   ii. Ureteric reimplantation
   iii. Cystoscopy
   iv. Nephrectomy
   v. Insertion Peritoneal Dialysis catheter
   vi. Renal transplant
   vii. Bladder extrophy repair
h) Ophthalmology
   i. Strabismus repair
   ii. Cataract surgery
   iii. Glaucoma
   iv. Eyelid surgery
   v. Laser for retinopathy of prematurity
i) Cardiac Surgery
   i. Pacemaker insertion
   ii. Cardiac catheterization
   iii. Coarctation repair
   iv. PDA ligation
   v. Cardiopulmonary bypass for complete repair/palliative treatment of Congenital Heart lesions
j) Dental Surgery
   i. Dental extractions/restorations
   ii. Orthognathic surgery
k) Remote Locations
   i. MRI/CT
   ii. Interventional radiology procedures
   iii. Medical procedures: e.g Bone marrow aspiration/biopsy, LP, gastroscopy, colonoscopy, joint injections
   iv. Cardiac catheterization
l) Perioperative/PACU issues

The Anesthesiologist must be able to demonstrate the ability to evaluate and manage common problems which may arise perioperatively:

i. Criteria for day surgery, especially for prematures
ii. Un-cooperative patient
iii. Delirium
iv. Post extubation stridor
v. Pain
vi. Nausea and vomiting
vii. Laryngospasm
viii. Anaphylaxis
23 Pharmacology
The competed Anesthesiologist shall demonstrate an understanding of the terminology and principles relevant to the pharmacology of all agents

23.1 Terminology: Definitions and Distinctions
a) Hyperactivity
b) Hypersensitivity
c) Tolerance
d) Tachyphylaxis
e) Synergism
f) Antagonism
g) Potency of drugs
h) Efficacy of drugs

23.2 Transfer of Drugs Between Compartments
The Anesthesiologist must demonstrate an ability to:

a) Describe the following processes:
   i. Passive diffusion
   ii. Active transport
   iii. Facilitated diffusion
b) Explain the impact of the pKa of drugs and of the acidic or basic state on their transfer between compartments
c) 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

23.3 Transit of Drugs
a) Intake
The Anesthesiologist must demonstrate an ability to explain the specific properties of the following routes of administration:
   i. Oral
   ii. Sublingual
   iii. Transcutaneous
   iv. Intramuscular
   v. Subcutaneous
   vi. Neuraxial
   vii. Inhalational
   viii. Intravenous
b) Distribution
The Anesthesiologist must demonstrate an ability to describe the various properties, processes and structures involved in the distribution of drugs and their impact on drug action:
   i. Water and lipid solubility
   ii. Ionisation
   iii. Binding to proteins and tissues
   iv. Placental transfer
   v. Blood brain barrier
   vi. Perfusion gradients

c) Elimination
The Anesthesiologist must demonstrate an ability to:

i. Define clearance, extraction ratio, intrinsic clearance
ii. 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
iii. Explain the impact of alterations of liver function and blood flow on the extraction process
iv. Describe the main pathways of drug metabolism: biotransformation (phase 1 reactions) and conjugation (phase II)
v. Describe the impact of various factors affecting biotransformation
   - Individual variability
   - Age
   - Sex
   - Exposure to other substances (induction and inhibition)
   - Liver and kidney disease

23.4 Pharmacokinetic Principles
The Anesthesiologist must demonstrate an ability to:

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

23.5 Pharmacodynamic Principles

a) Define pharmacodynamics
b) Describe the information provided by the following elements of dose-response curves
   i. Potency
   ii. slope of curves
   iii. Efficacy
   iv. variability
c) Explain the time lag between end of injection s or infusions and drug effect
d) Describe the impact of factors affecting this time lag:
   i. organ perfusion
   ii. partition coefficients
   iii. rate of transit
   iv. drug receptor affinity
   v. delay between receptor exposure and drug effect
e) Describe the elements governing drug-receptor interaction
   i. Law of mass action
   ii. Affinity for receptors
   iii. Spare receptors
   iv. Ion channels
   v. G proteins
   vi. Second messenger
f) Define biophase and explain the interrelationship between kinetics, dynamics and effect
g) Explain the differences between agonists, partial agonists and antagonists
h) Drug interactions
   i. Explain the overall benefits and pitfalls of the drug interaction processes in anesthesia
   ii. Describe mechanisms which create interactions
      - physico-chemical properties of drugs
      - interference with transit of drugs
      - competition of binding sites
      - enzyme induction and inhibition
23.6 **Anesthetic Drugs**

For each of the following drugs, the anesthetist must have an in-depth knowledge of the following:

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

23.6.1 Intravenous Induction Agents, Sedatives

a) Propofol  
b) Pentothal  
c) Ketamine  
d) Etomidate  
e) Midazolam

23.6.2 Narcotics/Opioids and adjuncts

See Pain 23.1.3, 21.1.4

a) Fentanyl  
b) Remifentanil  
c) Sufentanil  
d) Alfentanil  
e) Morphine  
f) Hydromorphone  
g) Meperidine

23.6.3 Muscle relaxants

See Neuromuscular Junction 17.2

23.6.4 Reversal agents

See Neuromuscular Junction 17.4

23.6.5 Antiemetics

See Post Anesthesia Care Unit 25.3

23.6.6 Volatiles

See Volatiles 34

23.6.7 Vasopressors and inotropes

See Autonomic Nervous System 3.4, Cardiovascular 4.1.5

23.6.8 Miscellaneous

a) Intravenous lidocaine
b) Naloxone

c) Flumazenil
24 Plastic Surgery

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

a) Burns
   i. Describe the types of burns including thermal, chemical and electrical burns
   ii. Describe the initial assessment and resuscitation of the burn patient
   iii. Describe the anesthetic considerations of the burn patient presenting for plastic procedures
      • Skin flaps
      • Split thickness skin grafts
      • Dressing changes
   iv. Describe the use of hyperbaric oxygen in the treatment of burns and carbon monoxide poisoning

b) Cold Injuries
   i. Describe the anesthetic considerations of the patient presenting with frostbite
   ii. Describe the use of hyperbaric oxygen in the treatment of frostbite

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

a) The general and regional anesthetic options for limb reimplantation
b) Manoeuvres used to increase digital blood flow
c) General principles of prolonged procedures
   i. Temperature maintenance
   ii. Fluid and blood loss
   iii. Pressure point padding

24.3 Anesthesia for Free Flap and Pedicle Flap Surgery
The Anesthesiologist must demonstrate an understanding of:

a) General and regional anesthetic options for free flap and pedical flap surgery
b) The factors that influence flap perfusion including fluids/temperature/vasoactive substances
c) Common co-morbidities of patients presenting for flap surgery
   i. Cancer
   ii. Infection
   iii. Paraplegia
   iv. Quadriplegia
d) The indications for hyperbaric oxygen therapy for flap preservation
e) The post operative complications of surgery
   i. Flap necrosis
   ii. Infection/sepsis

24.4 Cosmetic Surgery
The Anesthesiologist must demonstrate an understanding of the anesthetic implications of the following surgeries

a) Liposuction
b) Breast augmentation, reduction mammoplasty, and amstopexy
c) Abdominoplasty
d) Facelift, neck lift, brow lift, and blepharoplasty
e) Rhinoplasty
f) Facial laser resurfacing

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

a) The anesthetic options for minor hand procedures
b) The advantages/disadvantages and complications of the various anesthetic techniques
   i. Local infiltration
   ii. IV block
   iii. Peripheral nerve block
   iv. General anesthesia

24.6 Craniofacial

24.6.1 Adult Craniofacial
The Anesthesiologist must demonstrate an understanding of the anesthetic concerns for adult patients undergoing craniofacial surgery including:

a) Facial reconstructive surgery
b) Maxillo-facial trauma

24.6.2 Pediatric Craniofacial
The Anesthesiologist must demonstrate the ability to describe the anesthetic implications of the following pediatric craniofacial surgeries:

a) Cleft lip/palate surgery
b) Ear reconstruction
25 Post-Anesthetic Care Unit (PACU)

The consultant Anesthesiologist must demonstrate an understanding of the structure and function of the Post Anesthetic Care Unit and an ability to identify, prevent and treat common problems arising in the PACU.

25.1 Physical and Staffing Requirements

The Anesthesiologist must demonstrate an understanding of the physical and staffing requirements of the PACU including:

a) Space
b) Personnel
c) Equipment
d) Monitoring
e) Medications, IV fluids

25.2 Patient Management

The Anesthesiologist must demonstrate an understanding of the considerations for patients entering the PACU.

The Anesthesiologist must demonstrate an approach to management of patients in the PACU including:

a) Fluid and electrolyte management
   i. Goals of resuscitation
   ii. Accurate measures of preload
   iii. Fluid responsiveness
b) 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
c) Antiemetics
d) Monitoring guidelines
e) Discharge criteria

25.3 Complications

The Anesthesiologist must demonstrate an ability to identify and manage common problems in the PACU including:

a) Respiratory complications
   i. COPD
   ii. Aspiration
   iii. Negative pressure pulmonary edema
b) Hypoxemia and hypoventilation
   i. Assessment of Ventilation
   ii. Recognition and Diagnosis
   iii. Oxygen Delivery Systems including BIPAP and CPAP
c) Recognition and treatment of upper airway obstruction, stridor, Aspiration, obstructive sleep apnea
d) Hypotension and Hypertension
   i. Diagnosis and Management
   ii. Shock
e) Cardiac complications
   i. Myocardial ischemia/chest pain
   ii. Brady-/tachycardia
   iii. Dysrhythmias
   iv. Cardiogenic shock
   v. Pulmonary edema
f) Anaphylaxis

  g) Inadequate analgesia
      i. Blocks and Neuraxial Anesthesia
      ii. Opiates
      iii. Non-opiates
      iv. Challenges in Pain Management

  h) Oliguria/Polyuria
      i. Assessment of Volume Status
      ii. Differential diagnosis

  i) Post-Operative Mental Status Changes
      i. Delirium
      ii. Differential diagnosis
      iii. Delayed Emergence
      iv. Decreased level of consciousness, Acute CVA

  j) Fluid and Electrolyte Abnormalities
      i. Acid base
      ii. TURP Syndrome, Hysteroscopy syndrome
      iii. Hypo- and Hyper-calcemia, kalemia, natremia, magnesemia, glycemia

  k) Nausea and Vomiting
      i. Risk factors
      ii. Pharmacology

  l) Hyperthermia, Hypothermia & Shivering
      i. Postoperative fever
      ii. Malignant Hyperthermia
      iii. Hypothermia

  m) Neurological
      i. Residual Neuromuscular Blockade
      ii. Prolonged regional blocks and peripheral nerve blocks
      iii. Peripheral Neuropathies
26 Preoperative Consultation

The competent Anesthesiologist must demonstrate an ability to assess, evaluate, optimize and manage patients in the preoperative period with the following considerations regarding systemic illness

26.1 Cardiovascular

a) Hypertension
   i. Identify significant hypertension and predict the impact on intraoperative risk on long-term health
   ii. Recommend appropriate timing of surgery relative to severity of hypertension and urgency of surgical indication.
       Coordinate further investigation and consultations
   iii. Prescribe appropriate therapy to correct preoperative hypertension
   iv. Liaise with primary care provider to facilitate long-term management

b) Pulmonary Hypertension
   i. Identify patients with pulmonary hypertension by history, physical exam and laboratory/imaging findings
   ii. Identify the impact of the proposed anesthesia and surgery on the underlying disease
   iii. Coordinate further investigations and consultations necessary to safely and expeditiously perform the necessary surgery

c) Cardiomyopathy
   i. Identify right and left ventricular dysfunction by use of history, physical and laboratory findings/imaging
   ii. Identify appropriate preoperative management of ventricular dysfunction
   iii. Utilize consultants appropriate to optimize ventricular dysfunction

d) Valvular Disease
   i. Utilize history and physical examination to identify cardiac murmurs
   ii. Identify patients that require a preoperative echocardiogram to evaluate the severity of stenotic and regurgitant lesions of aortic, mitral, pulmonic and tricuspid valves
   iii. Identify risk factors for bacterial endocarditis
   iv. Prescribe appropriate prophylaxis for endocarditis

e) Congenital Heart Disease
   i. 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
   ii. Describe the physiology and design appropriate management plans for R-L, L-R and bidirectional shunts
   iii. Prescribe appropriate prophylaxis for endocarditis

f) Pacemakers/Implantable Cardioverter/Defibrillator
   i. Identify indications for preoperative pacemaker/ICD insertion or intraoperative pacing
   ii. Coordinate consultation for perioperative pacing
   iii. Identify the type of pacemaker/ICD and verify function
   iv. Coordinate appropriate perioperative assessment and programming of a pacemaker/ICD

g) Arrhythmia
   i. Identify the presence, type and severity of abnormal rhythms, using history, physical and EKG
   ii. Identify rhythm abnormalities requiring preoperative therapeutic or prophylactic therapy
   iii. Prescribe appropriate therapeutic or suppressive therapy
   iv. Utilize consultants effectively to coordinate appropriate pharmacologic or electrophysiologic therapy

h) Conduction Abnormalities
   i. Identify the presence, severity and type of abnormalities of conduction
   ii. Identify and manage reversible contributors to abnormal conduction

i) Peripheral Vascular Disease
   i. Identify the presence, severity and physiologic impact of peripheral vascular disease
   ii. Predict the impact of carotid disease on intraoperative risk
   iii. Identify the important preoperative variables that affect outcome in major vascular surgery, and provide a plan to optimize them

j) Patient with heart transplantation

k) Cardiac tamponade and constrictive pericarditis

l) Superior vena cava syndrome

m) Cardiac Risk Assessment
   i. 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
   ii. Identify patients with clinical risk factors who would benefit from further preoperative testing, balancing the potential risks and the urgency of the surgical indication

n) Cardiac Risk Reduction
   i. Utilize pharmacologic therapy to reduce perioperative cardiac risk
ii. Describe the risks and benefits of beta-blockers, alpha-2 agonists, statins, and anti-platelet therapy for the reduction of perioperative cardiac risk

iii. Identify indications for preoperative surgical or interventional management for cardiac risk reduction

iv. Utilize appropriate consultation to coordinate preoperative cardiac risk reduction

v. 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

26.2 Respiratory

a) Airway Assessment
   i. Predict difficulty with laryngoscopy and intubation by use of history and physical findings
   ii. Predict difficulty with manual ventilation by use of history and physical findings
   iii. Use investigations including xray, computed tomography and pulmonary function studies to identify and/or quantify airway management concerns
   iv. Identify, grade the severity and list the implications of special airway situations including:
      - Airway obstruction – intra and extrathoracic
      - Madiastinal mass
      - Bronchopleural fistula
      - Tracheo-esophageal fistula
      - Tracheal stenosis
      - Anatomic/structural abnormalities congenital and acquired
      - Difficult airway and congnivity impairment
      - Patient scheduled for tracheotomy
   v. Prescribe appropriate preoperative therapy to facilitate difficult airway management
   vi. Coordinate the availability of special equipment, support and logistical preparation for special airway situations
   vii. Provide pertinent information to prepare the patient with awake intubation or possibility of dental damage

b) Respiratory Risk Assessment
   i. Identify, grade the severity and estimate the impact on risk of perioperative complications of COPD, Asthma
   ii. Restrictive defect
   iii. Bullous lung disease/Bronchopleural fistula CO2 retention
   iv. Obstructive +/- or central sleep apnea
   v. Recurrent aspiration
   vi. ARDS
   vii. CF/bronchiectasis
   viii. Infection (pneumonia, upper respiratory tract infection, empyema)
   ix. Pneumothorax/Chest tube

c) Reduction of Respiratory Risk

Identify patients with contagious pulmonary infection, coordinate special precautions for perioperative period

   i. Identify and coordinate the availability of special intraoperative interventions to manage patients with any of the above problems
   ii. Provide appropriate preoperative therapy to reduce the severity of the above problems
   iii. Smoking cessation
   iv. Utilize consultants effectively to assist in assessing perioperative respiratory problems and reducing risk
   v. 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
   vi. Identify patients that would benefit from postoperative monitoring in an enhanced or intensive care unit

d) Assessment for Lung Resection
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i. Estimate the impact of the proposed procedure on perioperative outcome using history, physical and laboratory information
ii. Estimate the extent of resection that an individual patient is expected to tolerate utilizing PFTs, ABG, and VO2 max testing
e) Pulmonary Testing
   i. Order appropriate lung function testing to assist with perioperative decision making
   ii. Interpret and use the results of the following to assess risk and appropriately modify perioperative management
      • Flow and volume studies
      • Diffusion measurement
      • Arterial blood gases
      • XRays of chest, neck, airway
      • CT of airway/lungs
   iii. Use the results of the following to assess risk and appropriately modify perioperative management
      • Sleep studies
      • Exercise studies
      • Ventilation/perfusion scan
      • CT chest

26.3 Neurological

a) Intracranial Mass
   i. Assess the implications for perioperative outcome and anesthetic management of intracranial mass lesions based on location, size, and proposed procedure. Manage reversible contributions to increase ICP Identify and assess the severity of increased intracranial pressure
b) Seizure Disorder
   i. Utilize consultation appropriately to identify, diagnose and treat seizure disorders
   ii. Utilize the information from that consultation to anticipate appropriate modifications to perioperative management
   iii. Coordinate the availability of required special resources
   iv. Predict the impact of and appropriately manage anticonvulsant therapy
c) Cognitive Impairment
   i. Assess the ability of the patient to participate in informed consent and cooperate with perioperative interventions
   ii. Obtain appropriate surrogate consent in the event of incapacity
   iii. Assess the need for, impediments to, and optimal methods to reduce perioperative anxiety, including sedation

Coordinate the availability of required special perioperative resources, including environmental and management modifications to enhance cooperation, pain management. Discuss the effects of general anesthesia on cognitive disorders.

d) Neurovascular
   i. Categorize and grade the severity of intracranial hemorrhage
   ii. Estimate the risk of bleeding and/or vasospasm perioperatively
   iii. Assess the implications for perioperative outcome and anesthetic management of intracranial vascular lesions based on location, size, and proposed procedure
e) Peripheral Neuropathy
   i. Identify common causes of perioperative neuropathy
   ii. Utilize appropriate consultation to diagnose peripheral neuropathy
   iii. Discuss the relevance of peripheral neuropathy to choice of anesthetic
f) Spinal Cord
   i. Assess the severity and anesthetic implications of spinal cord impingement and threats to spinal cord perfusion
   ii. Assess the physiologic effects and anesthetic implications of pre-existing spinal cord injury. Assess the risk and anesthetic implication of autonomic hyperreflexia
   iii. Movement disorders
   iv. Identify movement disorders significant for anesthetic management
   v. Utilize appropriate consultation to diagnose and stabilize movement disorders preoperatively
   vi. Identify anesthetic implications of movement disorders, including drug interactions
   vii. Identify anesthetic implications of pharmacotherapy for movement disorders and its withdrawal
g) Myopathies
   i. Utilize appropriate consultation to assess the severity and systemic effects of muscular dystrophies
   ii. Identify risk factors for intra- and postoperative complications in patients with muscular dystrophies
h) Neuromuscular
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i. Identify the anesthetic considerations for myasthenia gravis and develop a perioperative plan including the use of anticholinesterase medication
ii. Identify patients at risk for Eaton-Lambert syndrome

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

j) Neurologic Investigations

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

- CT head, spine
- Xray c-spine
- MRI Transcranial Doppler Imaging, Carotid Doppler, Angiography
- EEG
- EMG

26.4 Gastrointestinal

a) Identify risk factors for preoperative reflux and provide appropriate prophylaxis
b) Use information from consultants to characterize, grade the severity and assess the physiologic and anesthetic implications of hepatic dysfunction
c) Identify the presence and type of infectious hepatitis and assess the infectious risk
d) Identify the physiologic effects, comorbidities, metastatic spread, and anesthetic implications of GI malignancies, Carcinoid syndrome, paraneoplastic syndrome, thrombosis.
e) Assess the anesthetic implications of chemotherapy used and coordinate laboratory/investigation for their systemic effects
f) Use the results of the following to assess risk and appropriately modify perioperative management
   - Abdominal imaging
   - Liver function testing

26.5 Musculoskeletal

a) Grade the severity, mechanical and anesthetic implications and other system involvement of:
   - Rheumatoid arthritis
   - Osteoarthritis
   - Ankylosing spondylitis
   - Osteogenesis imperfecta
   - Osteoporosis bone metastasis, dermatomyosites
b) Assess the anesthetic implications of pharmacology for the above and recommend appropriate perioperative management
c) Interpret and use the results of the following to assess risk and appropriately modify perioperative management
   - CT C-spine
   - Xray C T and L-spine

26.6 Dermatologic

a) Grade the severity, mechanical and anesthetic implications and other system involvement of:
   - Bullous diseases
   - Psoriasis
   - Scleroderma
   - Assess the anesthetic implications of burn injury

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

26.7 Hematologic
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a) Identify the presence abnormalities of hemostasis on preoperative history
b) Specify hematologic disease (von Willebrand, hemophilia etc.)
c) Interpret results of screening tests for hemostasis
d) Utilize laboratory testing to characterize hypercoagulable disorders including:
   i. Protein C, S, antithrombin III deficiencies
   ii. Homocysteinuria
   iii. Heparin induced thrombocytopenia
   iv. DIC V Leiden Factor
e) Utilize appropriate consultation to characterize the type and severity of other abnormalities of hemostasis, and provide preoperative optimization
f) Identify indications for thromboprophylaxis
g) Modify pre-existing anticoagulant/antiplatelet therapy to balance risks of intraoperative bleeding and thrombotic complications
h) Identify, diagnose and treat preoperative anemia using history, physical and laboratory information:
i) Utilize consultation appropriately to evaluate and treat uncommon causes of anemia bone marrow transplantation, patent with hematologic cancer, hemoglobin disorders (thalassemia, IgA deficit, sickle cell disease, porphyria, etc.)
j) Identify and utilize consultation to characterize and treat thrombocytopenia
k) Quantify expected blood loss and coordinate a plan to reduce the likelihood of allogeneic transfusion
l) Explain to patients the indications, risks and benefits of methods of optimizing preoperative haemoglobin and preoperative autologous donation
m) Interpret and use the results of the following to assess risk and appropriately modify perioperative management
   i. CBC
   ii. Anemia investigations excluding bone marrow
   iii. Hemoglobin electrophoresis
n) Use the results of the following to assess risk and appropriately modify perioperative management
   i. Bone marrow biopsy
   ii. Platelet function testing
   iii. Coagulation testing and factor levels
   iv. Thromboelastography

26.8 Endocrine/Metabolic

See Endocrinology 8

26.9 Transplanted Organ

See Transplantation 33
27 Regional Anesthesia

The competent Anesthesiologist shall demonstrate an understanding of the anatomy and physiology and an approach regional anesthesia

The subspecialist in regional anesthesia shall demonstrate proficiency in all of the above plus these additional specific objectives. A competent Anesthesiologist shall demonstrate knowledge of the principles of these objectives, but not be expected to perform these objectives

27.1 Pharmacology

The competent Anesthesiologist shall be able to demonstrate a knowledge of the pharmacology of the local anesthetic with respect to:

a) Mechanism of Action
   i. Explain the effects of sodium channel blockade on the action potential
   ii. Explain how local anesthetic blocks the sodium channel
   iii. Explain the mechanism of factors facilitating and hindering local anesthetic effect at the sodium channel

b) Toxicity
   i. Identify the manifestations of systemic toxicity
   ii. Know the different forms of LA toxicity – cardiac toxicity, direct neurotoxicity; methaemoglobinemia; allergy
   iii. Identify and provide appropriate management of local anesthetic toxicity
   iv. Describe the mechanisms of LA neurologic and cardiac toxicity
   v. Know factors influencing the development CNS & CVS toxicity (eg. speed of injection; site of injection; maximal doses; LA potency; hypercarbia; use of vasoconstrictors; cardiac/liver disease)

c) Kinetics
   i. Describe drug, patient and technical factors contributing to speed of onset of local anesthetics
   ii. Describe the drug, patient and technical factors contributing to recover from LA
   iii. Describe the determinants of serum LA concentration, its measurement, and the role of protein binding

d) Structure Activity Relationships
   i. Describe the molecular structure of LA, and the resultant effects on kinetics and dynamics
   ii. Describe the differences between amide & ester local anesthetics with examples of each. Understand the physicochemical properties of potency; protein binding; pKa & pH
   iii. Know the relationship between LA & differential blockade

e) Adjuvants

The Anesthesiologist must be able to explain the rationale for & against adding different adjuvants to LA’s for 1) peripheral 2) neuraxial blocks and be able to describe the mechanism; dose; clinical effects; adverse effects of:

a) Epinephrine
   i. List the clinical indications for and advantages of inclusion of epinephrine in local anesthetic for spinal epidural, regional and local infiltration
   ii. Describe the dose and effect of epinephrine on blockade characteristics when added to local anesthetic in spinal, epidural, regional and local infiltration
   iii. Describe the potential detrimental effects of inclusion of epinephrine in local anesthetic in spinal, epidural, regional and local infiltration
   iv. Describe the mechanisms of the above effects

b) Bicarbonate
   i. Give the arguments for an against the addition of bicarbonate to local anesthetics
   ii. Describe the mechanism of action of potentiation of local anesthetic blockade by bicarbonate

c) Opioids
   i. Discuss the rationale for and against, and clinical effects and adverse effects of opioids to local anesthetics for peripheral regional blockade
   ii. Describe the mechanisms, doses, clinical effects and adverse effects of opioids in neuraxial blockade

d) Alpha-agonists
   i. Discuss the rationale for and against and clinical utility of addition of alpha-agonists to local anesthetics for peripheral regional blockade
   ii. Describe the mechanisms, doses, clinical effects and adverse effects of alpha-agonists in neuraxial blockade

e) NMDA Antagonists
i. Discuss the rationale for and against and clinical utility of addition of NMDA antagonists to local anesthetics for peripheral regional blockade
ii. Describe the mechanisms, doses, clinical effects and adverse effects of NMDA antagonists in neuraxial blockade

27.2 Physiology

The consultant Anesthesiologist must be able to describe the following physiologic principles relevant to regional anesthesia

a) Nerve Conduction
   i. Describe the structural classification of nerve types and the relevance to local anesthetic action
   ii. Explain the generation of nerve action potential, refractory period and recovery
   iii. Describe the structure of nerves

b) Effects of Neuraxial Block
   i. Describe the cardiorespiratory effects of neuraxial blockade
   ii. Describe the differences and similarities between spinal and epidural blockade with respect to mechanism of action, effects of adjuvants and cardiorespiratory physiology
   iii. Describe the effects of neuraxial blockade on coagulation
   iv. Describe the effects of neuraxial blockade on the neurohumoral stress response
   v. Describe the effects of neuraxial blockade on postoperative respiratory effects of surgery
   vi. Describe the effects of neuraxial blockade on intraoperative blood loss (controlled hypotension)
   vii. Know factors influencing spread of spinal/epidural anesthesia

c) The Neuroendocrine Stress Response
   i. Describe the systems affected by the stress response, and the overall impact on each of those systems
   ii. Describe the specific changes within each of the affected systems that leads to the overall functional impact on those systems
   iii. 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

27.3 Technology

The Anesthesiologist must demonstrate an understanding of the technology available for identification of nerves for the performance of plexus and peripheral nerve blocks

a) Nerve Stimulation
   i. Describe the rationale for the use of stimulations for locating nerves
   ii. Discuss the advantages, disadvantages and limitations of nerve stimulation as a means of locating nerves
   iii. List and explain the characteristics of the ideal nerve stimulator
   iv. Describe the response characteristics of different nerve fibers to stimulation
   v. Use stimulation to safely and effectively perform regional blocks
   vi. Different types of needles – insulated vs. non-insulated needles

b) Ultrasound
   i. Describe the relative advantages, disadvantages and limitations of ultrasound as a method of locating nerves
   ii. Describe the basic physics principles of ultrasound and their clinical relevance in identifying different anatomic structures
   iii. Choose the appropriate ultrasound probe and machine settings to properly identify the desired structure
   iv. List and explain the characteristics of the ideal ultrasound machine
   v. Identify the ultrasonographic anatomy relevant to nerve localization
   vi. Use ultrasound to safely and effectively perform regional blocks
   vii. Static vs. dynamic use of ultrasound
   viii. In-plane vs. Out-of-plane techniques

27.4 Clinical Application of Regional Anesthesia

The competent Anesthesiologist must demonstrate an ability to perform the following specific objectives for all regional anesthetic techniques relevant to his/her level of training as indicated below, and in the context of anesthetic care situations within his/her sphere of practice:

a) Anesthetic Planning
   i. Generate and implement an anesthetic plan including appropriate options, contingency plans and expectations
   ii. Select an appropriate regional anesthetic technique(s) for anesthetic care
iii. 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.

iv. Discuss regional PLUS GA vs. GA vs. regional.

v. Discuss the use of regional techniques pre vs. post induction of general anesthesia.

vi. Regional techniques in pediatric anesthesia.

b) Nerve Localization

i. Describe anatomic landmarks for performance of blocks.

ii. Utilize nerve stimulation for identification of plexuses and peripheral nerves for regional anesthetic techniques within his/her scope of practice.

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

27.5 Contraindications and Complications

The Anesthesiologist must demonstrate a knowledge of the limitations of regional anesthesia including contraindications and complications.

a) Contraindications to Regional Anesthesia

i. Identify and, where appropriate, manage relative and absolute contraindications to regional anesthetics.

b) Anticoagulation and Regional Anesthesia

i. Have an approach to regional anesthesia in the patient with abnormal coagulation parameters.

ii. 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.

iii. Assess the appropriate timing of regional anesthetic procedures relative to anticoagulation therapy.

iv. Appropriately modify the anticoagulation, anesthetic plan or both in order to minimize overall risk and improve outcome.

v. Interact with surgeons and administrators to create policies governing the interaction of anticoagulation and anesthetic/analgesic management.

c) Complications of Regional Anesthesia

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

   - Failed block
   - Intravascular injection of local anesthetic
   - Overdose
   - Epidural hematoma & abscess
   - Anterior spinal artery syndrome
   - PDPH
   - Post-operative neuropathy
   - Inadvertent spinal/subdural block

27.6 Spectrum of Anesthesia Techniques

The Anesthesiologist must demonstrate an understanding of the spectrum of regional anesthetic techniques and the ability to perform those relevant to his/her level of training.

The Anesthesiologist must demonstrate knowledge of basic surface anatomy & palpable landmarks and the dermatomal & peripheral nerve distribution as applicable to each specific block.

He/she must be able to describe site-specific equipment; indications; contraindications & drug selection for each block.

a) Neuraxial Blocks

i. Spinal – single shot midline and paramedian

ii. Continuous intrathecal catheter

iii. Epidural

   - Cervical
   - T1-4
   - T4-8
   - T8-L-5
   - Caudal
   - Tunneled epidural at any level

b) Upper Extremity Blocks
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i. Interscalene
ii. Supraclavicular
iii. Infraclavicular
iv. Axillary
v. Continuous – Any of the above
vi. At the elbow
   • Median nerve
   • Musculocutaneous nerve
   • Radial nerve
vii. At the wrist and hand
   • Ulnar nerve
   • Median nerve

c) Radial Nerve
   i. Digital nerves

d) Lower Extremity Blocks
   i. Lumbar plexus
   ii. Psoas compartment
   iii. Femoral nerve block/3 – in – 1 block

e) Sciatic block
   i. Proximal to thigh
   ii. Popliteal
   iii. Continuous (any of the above)
   iv. Ankle block

f) All Limbs – IVRA (Bier block)


g) Trunk Blocks
   i. Parvertebral block
   ii. Intercostal nerve block
   iii. Continuous either of the above
   iv. Ilioinguinal/iliohypogastric
   v. Penile block

h) Head and Neck Blocks
   i. Supraorbital nerve block
   ii. Mental nerve block
   iii. Mandibular never block
   iv. Occipital nerve block
   v. Superficial cervical plexus
   vi. Retrobulbar & peribulbar blocks
   vii. Nasal block
   viii. Deep cervical plexus block

i) Airway Blocks

j) Topicalization
   i. Superior laryngeal
   ii. Lingual nerve
   iii. Transtracheal block
28 Remote Locations

The Anesthesiologist must demonstrate an understanding of the considerations related to providing anesthetic care in non-traditional locations e.g. MRI, Cardiac Catheterization Laboratories, Image Guided therapy suites and endoscopy suites

28.1 Physical Requirements

The Anesthesiologist must demonstrate an understanding of the physical requirements for provision of anesthesia in remote locations:

a) The anesthetizing location must conform to electrical code and excess anesthetic gas scavenging
b) Medical gas pipelines must meet the same standards as a regular operating room
c) The anesthetic machine must conform to CAS standards
d) Standard CAS monitors are required
e) Standard emergency drugs and equipment must be readily available
f) Anesthetic machines, monitoring and scavenging are the same as would be expected in a regular operating room. Including resuscitation equipment etc.

28.2 Personnel

The Anesthesiologist must demonstrate an understanding of the personnel required to provide safe anesthesia

a) Appropriate ancillary help must be available to the anesthesiologist

28.3 The Nature of the Remote Locations

The Anesthesiologist must 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

a) Radiation exposure: Patients and staff
b) Anesthetic considerations
   i. Limited access to patient
   ii. Movement of radiological equipment
   iii. Temperature management
c) Contract media complications
   i. Anaphylaxis
   ii. Interaction with Metformin
   iii. Renal failure
d) Temperature regulation.
e) Variety of procedures and their implications
   i. Biopsies
   ii. Angiography
   iii. AAA stent graft
   iv. Carotid artery stent
   v. Kyphoplasty/vertebroplasty
   vi. TIPS (transjugular intrahepatic portosystemic shunt)
   vii. Cerebral Aneurysm / AV malformation coiling
   viii. Radiofrequency ablation
   ix. E.G. vascular access procedures, biopsies, drain insertion angiography

28.3.2 MRI

a) Implications of magnetic field
b) Patient selection
c) MRI compatible anesthesia equipment and monitors
d) Management of resuscitation
e) Noise  
f) Management of patient claustrophobia

28.3.3 Cardiac Catheterization Laboratory

a) Considerations as per Interventional Radiology  
b) Specific considerations for cardiac patients  
   i. Pediatric congenital heart disease  
   ii. Adult valvular heart disease  
   iii. Coronary artery disease  
   iv. Cardiomyopathies  
   v. Dysrhythmias – pacemakers and ICD’s  
c) Type of procedure: diagnostic vs. therapeutic  
   i. AICD  
   ii. Electrophysiologic Studies  

28.3.4 Endoscopy Suites

a) Implications of bowel preparation on hydration and electrolytes  
b) Shared airway e.g. upper endoscopy

28.4 Electroconvulsive Therapy

a) Indications  
b) Contraindications  
c) Complications and management  
   - Bradycardia  
   - Tachycardia  
   - Hypertension  
   - Failure of seizure

28.5 Post Procedure Disposition

The Anesthesiologist must demonstrate knowledge with respect to postanesthetic care of these patients

a) Location  
   i. Local vs. OR PACU  
b) Discharge planning  
c) Anticipation of complications  
d) Lack of anesthesia 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 competent anesthesiologist must demonstrate knowledge and understanding of anesthesia and the renal system.

29.1 Basic Science
The Anesthesiologist must demonstrate knowledge of the anatomy and physiology of the renal excretory system

a) Functional Anatomy of the Kidneys, Ureters, and Bladder
   i. Description of the nephron
   ii. Description of the renal circulation and its regulation
b) Physiology of Urine Formation
   i. Sodium filtration and reabsorption
   ii. Water filtration and reabsorption
   iii. Physiologic control of glomerular filtration and solute reabsorption
c) Neurohumoral Regulation of Renal Function
   i. Aldosterone
   ii. Antidiuretic hormone
   iii. Atrial natriuretic peptide
   iv. Prostaglandins
d) Neuroendocrine Response to Stress of Trauma and Surgery
e) Effects of Anesthesia on Renal Function
f) Evaluation and Interpretation of Renal Function Tests
   i. BUN, creatinine, ratio, clearance
   ii. Urinalysis: Na, osmolarity, proteinuria, hematuria, urine sediment
g) Pharmacology of the Renal System
   i. Potential nephrotoxic agents
   ii. Renal exertion of anesthetic drugs
   iii. Pharmacology and classification of diuretics

29.2 Renal Protection
The Anesthesiologist must have 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.

29.3 Pathology
The Anesthesiologist must demonstrate knowledge of pathologies related to the renal system:

a) Chronic Renal Failure
   i. Clinical characteristics / the uremic syndrome
   ii. Dialysis treatment: indications, types, physiologic effects and complications
   iii. Anesthetic management of the patient with chronic renal failure:
      - Preoperative evaluation / optimization
      - Monitoring
      - Selection of anesthetic agents
b) Acute Renal Failure
   i. Pathophysiology of oliguria
      - Types
      - Diagnostic tests
      - Management
c) Hepatorenal Syndrome
   i. Pathophysiology
   ii. Treatment
   iii. Response to liver transplant

29.4 Anesthesia for Urologic Procedures
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.

The competent anesthesiologist must be able to demonstrate understanding of the considerations of, and to independently provide anesthetic care for patients presenting for the following procedures:

a) Transurethral Resection of the Prostate
   i. List the complications of TURP
   ii. Describe the TURP syndrome and its treatment

b) Prostatectomy: Open and Laparoscopic Lithotripsy
   i. Percutaneous ultrasonic lithotripsy
   ii. Extracorporeal shock wave lithotripsy (ESWL)

c) Endourologic Procedures
   i. Urethral
   ii. Bladder
   iii. Ureteral

d) Nephrectomy

e) Renal Transplant
30 Respiratory Physiology and Thoracic Anesthesia

The competent Anesthesiologist must demonstrate an in depth knowledge with respect to anatomy and physiology of the respiratory system

30.1 Respiratory Anatomy and Physiology

30.1.1 Anatomy of Respiratory Tract

i. Anatomy of the airway and upper airway muscles
ii. Anatomy of the Tracheobronchial tree
iii. Functional histology and anatomy of the alveolus
iv. Pulmonary and bronchial circulation
v. Pulmonary lymphatics

30.1.2 Pulmonary Physiology

a) Pulmonary Mechanics: Elastic Forces and Lung Volumes
   i. Elastic recoil of the lungs and chest wall
   ii. Surface tension, surfactant, and its effects on lung mechanics
   iii. Alveolar, intrapleural and transmural pressures and their relationship
   iv. Hysteresis
   v. Lung and chest wall compliance and elastance
   vi. Static compliance versus dynamic compliance
   vii. Lung volumes, FRC
   viii. Physiologic changes with aging
   ix. Principles of measurement of lung volumes, lung compliance

b) Pulmonary Mechanics: Respiratory System Resistance
   i. Principles of gas flow and resistance: laminar flow, turbulent flow, flow through and orifice, Reynolds number
   ii. Respiratory system resistance
   iii. Gas trapping
   iv. Airway closure, closing capacity and closing volumes
   v. Flow-related airway collapse
   vi. Neumoskeletal control of airway diameter
   vii. Pharmacology affecting airway resistance
   viii. Measurement of airway resistance and closing capacity

c) Control of Breathing
   i. Central nervous system control of respiratory drive
   ii. Peripheral receptors and respiratory drive
   iii. Lung reflexes
   iv. Carbon dioxide and respiratory control
   v. Oxygen, respiratory control and the response to hypoxia
   vi. Effects of drugs on respiratory drive
   vii. Methods of assessing control of breathing and sensitivity to hypoxia

d) Pulmonary Ventilation
   i. Functional anatomy of the muscles of respiration
   ii. Postural effects on respiratory muscle function
   iii. Work of breathing
   iv. Work against resistance
   v. Work against elastic recoil
   vi. Measurement of ventilation
   vii. Neuronal control of respiratory muscle function
   viii. Respiratory muscle fatigue

e) Pulmonary circulation
   i. Pulmonary blood flow and blood volume
   ii. Pulmonary vascular pressures
   iii. Pulmonary vascular resistance
   iv. Control of vascular tone – cellular mechanisms and neural control
   v. Control of vascular tone – pharmacology
   vi. Effects of hypoxia and hypoxic pulmonary vasoconstriction
vii. Effects of lung volume
viii. Effect of lung inflation on pulmonary blood flow, pulmonary vascular resistance, and cardiac output
ix. Principles of measurement of pulmonary flow, cardiac output and pulmonary vascular resistance

f) Distribution of Pulmonary Blood Flow and Ventilation
   i. Distribution of ventilation
   ii. Anatomical distribution of ventilation
   iii. Gravitational effects on compliance and ventilation distribution
   iv. Gravitational effects on pleural pressure
   v. Distribution related to rate of alveolar filling – time constants
   vi. Distribution of perfusion
   vii. Gravitational effects on perfusion distribution
   viii. Gravity independent determinants of regional blood flow, (cardiac output, lung volume)
   ix. West’s four zones of the lung
   x. Ventilation: perfusion matching – V/Q ratio
   xi. Alveolar gas tensions
   xii. Dead space – anatomical and physiological
   xiii. Quantification of dead space
   xiv. Bohr, (dead space), equation
   xv. Venous admixture or shunt
   xvi. Effect of V/Q ratio on arterial PO2
   xvii. Measurement of ventilation / perfusion matching
   xviii. Alveolar air equation
   xix. Measurement of dead space

g) Gas Diffusion
   i. Diffusion of oxygen from alveolus to RBC
   ii. Diffusion of oxygen within the RBC and uptake by hemoglobin
   iii. Diffusion of carbon monoxide by hemoglobin and measurement of diffusing capacity
   iv. Factors affecting diffusing capacity

h) Oxygen
   i. The oxygen cascade
   ii. Factors affecting alveolar oxygen tension
   iii. The shunt equation
   iv. Oxygen carriage in the blood
   v. Oxygen delivery and oxygen consumption and its measurement
   vi. Physical solution
   vii. Hemoglobin
   viii. The oxyhemoglobin dissociation curve and factors affecting affinity of hemoglobin for oxygen
   ix. Abnormal forms of hemoglobin
   x. Oxygen stores
   xi. The role of oxygen in the cell
   xii. Energy production
   xiii. Aerobic and anaerobic metabolism
   xiv. Oxidative phosphorylation
   xv. Critical oxygen tension
   xvi. cyanosis
   xvii. Methods of oxygen delivery
   xviii. Oxygen toxicity
   xix. Measurement of oxygen levels – blood gases, pulse oximetry, tissue PO2
   xx. Mechanisms and Effects of hypoxia
   xxi. V/Q mismatch, shunt, decreased FiO2, hypoventilation
   xxii. Mechanisms of hypoxia under anesthesia
   xxiii. Physiologic effects of hypoxia

i) Carbon Dioxide
   i. Carriage of carbon dioxide in the lung
   ii. Physical solution
   iii. Carbonic acid and effect of carbonic anhydrase
   iv. Bicarbonate ion
   v. Carbamino carriage
   vi. Haldane effect
   vii. Distribution of CO2 in the blood
   viii. Factors affecting carbon dioxide tension
   ix. Alveolar CO2 – effect of ventilation
30.1.3 Non-respiratory Functions of the Lung

i. Filtration
ii. Biological hazards
iii. Metabolism of endogenous compounds
iv. Pulmonary interstitial fluid mechanics
v. Starling equation

30.2 Physics of Gas Delivery

See monitoring and equipment 15.2.1

30.3 Inhaled Anesthetics

See Volatiles 34

30.4 Thoracic Anesthesia

The competent Anesthesiologist must demonstrate the knowledge and ability to provide care of patients presenting for thoracic surgery with respect to:

a) Preoperative assessment and optimization of the patient for thoracic surgery
b) Chest radiology
c) Fiberoptic bronchoscopy
d) Physiology of the lateral decubitus position, the open chest and one lung ventilation
e) Regional anesthesia for thoracic surgery
f) Anesthetic management for thoracotomy and pulmonary resection
g) Anesthesia for esophageal and mediastinal surgery, including management of patients with a mediastinal mass
h) Management of thoracic trauma
i) Lung isolation for management of hemoptysis and bronchopleural fistula

30.5 Thoracic Surgical Procedures

The Anesthesiologist must demonstrate an ability to independently, provide anesthetic management for:

a) Tracheostomy
b) Rigid and fiberoptic bronchoscopy
c) Bronchoscopy and Mediastinoscopy
d) One-lung ventilation
e) Lobectomy/Pneumonectomy
f) Esophageal resection
g) Video assisted thoracoscopy
h) Endobronchial surgery, including laser resection
i) Transthoracic vertebral surgery
j) Management of post-thoracotomy pain
k) Management of post-thoracotomy complications
31 Statistics

31.1 Definition of terms

The consultant Anesthesiologist should be able to define the following statistical terms and state their differences where appropriate:

a) Mean; median; mode
b) Standard deviation (SD); standard error of the mean (SEM); 95% confidence interval (95% CI)
c) Type of data: continuous (ordinal/interval/ratio) vs. categorical (nominal)
d) Distribution of data: normal (Gaussian) vs. non-normal
e) $a$ and $P$ value (level of statistical significance) vs. $\beta$ and statistical power (1-$\beta$)
f) Type I error vs. type II error
g) One vs. two sample tests; multiple sample tests
h) One-tailed vs. two-tailed tests and when to use them
i) Linear regression vs. correlation
j) Bias

The consultant Anesthesiologist should be able to define the following statistical terms and concepts, and independently compute corresponding values:

k) Sensitivity
l) Specificity
m) Positive predictive value
n) Negative predictive value
o) Incidence
p) Prevalence
q) Odds ratio
r) Relative risk
s) Absolute risk
t) Number needed to treat (NNT)
u) Number needed to harm (NNH)
v) Intention-to-treat analysis

31.2 Statistical tests

The consultant Anesthesiologist should know when the following statistical tests should be used for the following data types:

a) Comparisons of two groups
   i. Continuous Gaussian data: Student’s $t$ test (parametric testing)
   ii. Continuous non-Gaussian data: Mann-Whitney $U$ test/Wilcoxon rank-sum test (non-parametric testing)
   iii. Categorical data: Fisher’s exact test or chi-square test (contingency tables)

31.3 Study Characteristics

The consultant Anesthesiologist should be able to perform the following:

a) State the variables required for an a priori power analysis/sample size projection:
   i. Desired level of statistical significance ($a$)
   ii. Desired power (1 – $\beta$)
   iii. Minimum clinically important difference to be detected
b) Evaluate statistical and clinical significance of the findings
   i. Correctly interpret $P$ values
   ii. Correctly interpret measures of data scatter/dispersion/variance (e.g. standard deviation)
   iii. State the difference between primary and secondary outcome variables
iv. Define and state the differences between the following types of experimental design

c) Systematic reviews of the literature and meta-analyses
   i. Experimental studies
   ii. Non-randomized and quasi-randomized controlled trials
   iii. Randomized controlled clinical trials (RCTs)
       - Double-blinded
       - Single-blinded
       - Non-blinded

iv. Observational analytic studies (retrospective or prospective)
   - Cross-sectional studies
   - Case-control studies
   - Cohort studies

v. Descriptive studies
   - Surveys

d) To know about but not expected to manage on his/her own, the consultant Anesthesiologist should know about the following methods/tools and be able to explain their purpose:

   i. Univariate and multivariate statistics
   ii. Kaplan-Meyer analysis and comparison of survival curves (logrank test)
32 Thermoregulation

Demonstrate a knowledge and understanding of the physiology and pathophysiology of the thermoregulation and its’ relevance in anesthesia

32.1 Basic Science

a) The Anesthesiologist will be able to define mild, moderate and deep hypothermia
b) The Anesthesiologist must demonstrate an understanding of the mechanisms of heat loss during anesthesia
   i. Convection
   ii. Conduction
   iii. Radiation
   iv. Evaporation
   v. Decreased heat production/metabolism
   vi. Prepping, draping/exposure
   vii. IV fluid & blood products
   viii. Vasodilation/Central neural blockade

32.2 Principles of temperature measurement

a) Sites
b) Accuracy

32.3 Thermoregulation

a) Body Temperature Regulation
   i. Neonate
   ii. Child
   iii. Adult
   iv. Elderly patient
b) Physiological changes with hypothermia
   i. Cardiovascular
   ii. Respiratory
   iii. CNS
   iv. Metabolic/endocrine/trauma
   v. Musculoskeletal
   vi. Renal
   vii. Haematological
   viii. GI

c) Effect of temperature on gases
   i. Solubilities
   ii. Temperature compensation of ABGs

32.4 Intraoperative heat loss

The Anesthesiologist should be competent in description, mechanism, effectiveness, and complications of the following techniques:

a) Methods of prevention of heat loss and raise of body temperature under anesthesia
   i. Ambient temperature
   ii. Humidification and circle systems
   iii. Fluid and blood warmers
   iv. Warming blankets
   v. Reflection blankets
   vi. Core re-warming including CPB, bladder, peritoneal and other forms of dialysis
   vii. Body thermal gradients & complications of re-warming

b) Adverse consequences of hypothermia including the following:
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i. Delayed awakening
ii. Delayed drug metabolism
iii. Shivering including increased oxygen consumption
iv. Hypotension during re-warming
v. Impaired wound healing and infection
vi. Cardiac complications (arrhythmias, ischemia, hypertension, poor peripheral perfusion)
vii. Bleeding
viii. Augmented hormonal and metabolic “Stress response”
ix. Decreased patient comfort

32.5 Deliberate or therapeutic hypothermia

i. cardiac surgery
ii. neurosurgery
iii. vascular surgery
iv. critically ill patient.
v. following cardiac arrest

32.6 Resuscitation Medicine

i. a) Implications of accidental hypothermia in non-anesthetized patients: Emergency Room or Intensive Care Unit
ii. b) Alterations in ACLS protocols in severe hypothermia
iii. c) Management of re-warming patients with severe hypothermia
33 Transplantation

33.1 Multiple organ donation

a) Preoperative evaluation and intraoperative management of organ donors.
b) Define brain death, criteria for certifying brain death and various tests performed to confirm the diagnosis.
c) Describe organ dysfunction after brain death especially cardiopulmonary complications, coagulopathy, temperature changes and diabetes insipidus.
d) Describe the intraoperative management of multi-organ donors.
   i. Multi-organ brain dead donors
   ii. Living related donors for kidney & liver
   iii. Donation after cardiac death (DCD)

33.2 Organ recipients

a) Management recipients for organ transplantation.
b) Understand basic principles of Immunosuppression and graft rejection.
c) Reperfusion injury.
d) Management of Hyperkalemia.
e) Understand post transplant complications including rejection, infection, Immunosuppression and be able to conduct anesthesia for surgical procedures in patients after organ transplantation.
f) Transfusion medicine and coagulation management: See Hematology 11.6.
g) Monitoring:

Able to insert the trancesophageal echocardiography probe and recognize normal cardiac structures and common pathological echocardiographic findings, e.g. mitral regurgitation, aortic stenosis, wall motion abnormalities, cardiac tamponade, perform a bubble contrast study, etc.

The sub-specialist Anesthesiologist will demonstrate an ability to independently provide anesthetic care for recipients in heart, lung and/or liver transplantation.

33.3 Heart Transplantation

a) Patient Care

The Anesthesiologist must demonstrate an ability to:

   i. Conduct a preoperative evaluation of the patient presenting for cardiac transplantation.
   ii. Understand the effects of end stage cardiac failure on other organ functions.
   iii. Determine the cardiovascular and pulmonary monitoring requirements for optimal anesthesia care.
   iv. Understand the principles of myocardial preservation.
   v. Know the principles of extracorporeal circulation including ECMO, circulatory assist devices and circulatory arrest.
   vi. Monitor the patient during cardiopulmonary bypass, and be able to separate a patient from cardiopulmonary bypass.
   vii. Manage coagulation issues and blood component therapy.
   viii. Monitor, diagnose and treat perioperative myocardial ischemia, cardiac arrhythmias and, left & right ventricular dysfunction.
   ix. Monitor, diagnose and treat acute pulmonary dysfunction and pulmonary hypertension in the peri-operative period.
   x. Transport critically ill patients to and from the O.R. safely.

b) Medical Knowledge

   i. Perform a preoperative cardiac evaluation: History, medications, physical and airway examination, laboratory evaluation, CXR, EKG, stress testing, Echocardiography, cardiac catheterization data.
   ii. Describe cardiac physiology: Cardiac cycle, pressure volume loops, systolic and diastolic function, preload, afterload, contractility.
   iii. 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.
iv. Demonstrate an understanding of the effects of cardiac deafferentation and deafferentation (Denervation physiology)

v. Describe relevant cardiovascular pharmacology
   - Inotropes and vasopressors agents
   - Beta-blockers
   - Calcium channel antagonists
   - Angiotensin converting enzyme inhibitors
   - Peripheral vasodilators
   - Antihypertensives
   - Pulmonary vasodilators
   - Antiarrhythmic drugs
   - Diuretics
   - Thrombolytics: TPA, uro- or streptokinase
   - Anticoagulants: Heparin and substitutes, warfarin, anti-platelet drugs
   - Heparin reversal agents – Protamine, heparinase
   - Antifibrinolytics: Epsilon aminocaproic acid, tranexamic acid, aprotinin
   - Miscellaneous: Magnesium, DDAVP, Potassium

vi. Describe relevant anesthetic pharmacology in relation to cardiac function and preconditioning

vii. Extra corporeal membrane Oxygenation

viii. CardioPulmonary Bypass (CPB)
   - Initiating and weaning from CPB
   - Myocardial protection during CPB
   - Problems during weaning from cardiopulmonary bypass

ix. Mechanical support as a bridge to transplantation: Types, indications/contraindications, complications and limitations

x. Circulatory assist devices
   - Intra-aortic balloon pump counter pulsation (IABP): indications, contraindications, insertion techniques and complications

xi. Management of right heart failure, specific pulmonary vasodilators

xii. Independently manage anesthesia for surgical procedures after heart transplantation

33.4 Lung Transplantation
The consultant Anesthesiologist must demonstrate an understanding of:

a) Preoperative assessment of a patient before lung transplantation
b) Anesthetic management of lung transplant recipient
c) Monitoring during lung transplantation
d) Management of one lung ventilation, indications for cardiopulmonary bypass
e) Anesthesia for surgical procedures after lung transplantation
f) Outcomes

The sub-specialist Anesthesiologist must demonstrate an ability to independently provide anesthetic care for the patient undergoing lung transplantation.

33.5 Liver Transplantation
The Anesthesiologist must demonstrate an understanding of the management of a patient undergoing liver transplantation:

a) Medical Knowledge - Basic Science

The Anesthesiologist must demonstrate an understanding of:

   i. The pharmacology of various drugs in patients with end stage liver disease
   ii. Hepatic physiology
   iii. Antifibrinolytic agents
   iv. Interpret arterial blood gases and acid base balance
   v. Interpret hemodynamic parameters
   vi. Physiology and monitoring of Coagulation system
   vii. Stages of liver transplantation
   viii. Transfusion medicine
ix. Veno-venous bypass
x. Immunosuppression and graft rejection

b) Clinical Knowledge
   i. Causes of liver dysfunction
   ii. Indications and contraindications for liver transplantation
   iii. Effect of liver failure on all organ systems
   iv. Scoring systems for severity of liver disease
   v. Treatment of Hyperkalemia
   vi. Transfusion medicine

c) Patient Care

The sub-specialist Anesthesiologist must be able to provide anesthetic care for patients undergoing liver transplant surgery and are expected to demonstrate and ability to:

i. Perform preoperative evaluation of patients with end-stage liver disease

ii. Manage recipients of cadaveric or living related liver transplant
   - Formulate anesthetic plan
   - Appropriate preparation
   - Manage patients during three phases of liver transplantation
   - Interpret different coagulation parameters and treat coagulopathies
   - Assess and manage blood volume status
   - Treat hyperkalemia and correct other electrolyte abnormalities
   - Treat reperfusion syndrome
   - Prevent and treat anemia
   - Prevent infection
   - Maintain normothermia
   - Transport and hand over the post transplant patient to the ICU staff
   - Management of patients for living donor hepatectomy and major liver resection
34 Volatile Agents

The competent Anesthesiologist must demonstrate an understanding of the volatile anesthetics with regard to safety, and efficacy, toxicity, and inertness of halogenated gases currently in use. He/she must be able to discuss the theories of the mechanism of action of inhaled anesthetics.

a) Nitrous Oxide
b) Ether, chloroform, trichloroethylene, methoxyflurane, cyclopropane
c) Halothane, enflurane, isoflurane, desflurane, sevoflurane

34.1 Physical Characteristics

The competent Anesthesiologist will be able to explain the following Pharmacokinetic concepts:

a) Physical characteristics of gases
   i. Chemical potential (escaping tendency)
   ii. Vapour pressure
   iii. Boiling point
   iv. Mixtures
   v. Gases in solutions
   vi. Gas-liquid interface
   vii. Tension or partial pressure
   viii. Fractional volume
   ix. Solubility

b) Properties of Inhaled Anesthetics
   i. Bidirectional transfer and equilibration
   ii. Relative lack of absorption by tissues
   iii. Metabolism

c) Uniqueness of Inhaled Anesthetics
   i. Route of administration
   ii. Bidirectionality and equilibrium
   iii. Adjustability

34.2 Uptake and Distribution

He/she must demonstrate a thorough understanding of the concepts underlying uptake and distribution and the factors which increase and decrease the rate of rise of $\frac{F_{\text{a}}}{F_{\text{i}}}$

a) $\frac{F_{\text{a}}}{F_{\text{i}}}$
   i. Effect of fresh gas flow
   ii. Capacity of circuit
   iii. Effect of fractional concentration or pressure of gas
   iv. Effect of time and time constant
   v. $1^{\text{st}}$ order kinetic
   vi. Effect of circuit absorbents
   vii. Theory with and without uptake
   viii. Effect of FRC
   ix. Effect of ventilation perfusion mismatching
   x. Concentration effect
   xi. Overpressurization
   xii. Second Gas effect

b) Compartment model
c) Vessel Rich group/Muscle/Fat/Vessel – poor group
d) Gradient from machine to brain
e) Partition coefficients
   i. blood gas
   ii. Blood brain
f) Clinical differences between prolonged and short anesthesia
g) Elimination
h) Percutaneous and visceral
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34.3 **Toxicity**
The Anesthesiologist must be able to discuss the metabolism and biotransformation of volatile agents

a) Desflurane and Carbon Monoxide
b) Effect of hepatic and renal disease on metabolism
c) Sevoflurane and compound A
d) Fluoride production
e) Clinical overview of agents

34.4 **Occupational Exposure**
The Anesthesiologist must demonstrate an understanding of the Occupational and Environmental concerns in the use of volatile anesthetic agents

34.5 **Pharmacology**
The Anesthesiologist must demonstrate knowledge with respect to the following issues related to use of the various agents:

a) Halothane
   i. Solubility and metabolism
   ii. Controversy over its’ continued use
b) Enflurane and Isoflurane
   i. Fluoride production
   ii. Seizure activity on EEG
   iii. Coronary Steal controversy
c) Desflurane
   i. Blood gas solubility
   ii. Relative lack of Low potency, stability, pungency, high vapour pressure
   iii. Peculiarity of vaporizer
   iv. Tachycardia and hypertension
   v. Low metabolism
   vi. Effect of dry CO2 absorbent and CO production
   vii. A role in outpatient surgery
d) Sevoflurane
   i. Acceptability as inhalational induction agent
   ii. Solubility
   iii. Coronary vasodilation and pre-conditioning
   iv. Non-production of antibody formation
   v. CO production and heat
   vi. Compound A low flow anesthesia
   vii. Nephrotoxicity controversy - Fluoride
e) Nitrous Oxide
   i. Characteristics
   ii. Role as adjuvant
   iii. Controversies
   iv. Effect of PONV
   v. Inactivation of B12 metabolism
   vi. Effect on closed, and potential air spaces
   vii. Environmental considerations

34.6 **Clinical Effects**
The competent Anesthesiologist will be able to discuss the following with respect to clinical utility of volatile agents:

a) MAC
   i. Definitions, types (MAC awake, MAC movement, MAC aware, MAC BAR)
   ii. What factors increase and decrease MAC
iii. MAC for commonly used agents

b) Induction
   i. Volatile induction
   ii. Appropriate agents
   iii. Risks and benefits

c) Maintenance
   i. Safety
   ii. Adjustability
   iii. Generalizability of use regardless of age, habitus
   iv. Cardiac and cerebral blood flow
   v. Predictable recovery
   vi. Absence of analgesia
   vii. PONV
   viii. CO and Hepatitis

d) Central Nervous System
   i. CMRO2 – effect on EEG
   ii. CBF
   iii. ICP
   iv. Autoregulation and Uncoupling
   v. Role of individual agents
   vi. Role of nitrous oxide
   vii. Effect on CSF production
   viii. Effect on response to hyper and hypocarbia
   ix. Cerebral protection

e) Circulatory System
   i. Hemodynamics
   ii. Cardiac Index
   iii. CVP
   iv. Systemic vascular resistance, pulmonary vascular resistance
   v. Contractility
   vi. Other effects
   vii. Distribution of blood flow
   viii. Halothane, sensitization of myocardium
   ix. Relation to adrenaline

f) Pulmonary System
   i. Effects in spontaneously breathing patients
   ii. Resting PCO2
   iii. Mechanics of ventilation
   iv. Response to CO2
   v. Response to hypoxia
   vi. Smooth muscle tone and bronchodilations
   vii. Mucociliary function
   viii. Pulmonary vascular resistance (HPV) and relevance to OLV

g) Liver
   i. Relevance of hepatic blood supply and architecture of the liver
   ii. Effects of volatile agents
      1. Mechanisms for Halothane Hepatitis
   iii. Antibody formation
   iv. Mechanism for
   v. Epidemiology
   vi. Non-antibody mediated mild form

h) Neuromuscular System and Malignant Hyperthermia
   i. Effect on skeletal muscle
   ii. Triggering of MH response; relative potency of different agents
   iii. Investigation for MH
   iv. Reproductive and genetic effects
   v. Limitation of animal studies
   vi. Low grade long term exposure

i) Effects of Volatile Agents in Pregnant Patients
   vii. Effect of methionine synthetase and thymidyl synthetase by nitrous oxide
   viii. NIOSH standards
   ix. Effect on Uterine Smooth Muscle
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x. Effect on fetus
xi. Effect on fetal loss
xii. Toxicity

j) Nitrous Oxide

xiii. Effect of SNS
xiv. Coronary Steal (see above)
 xv. Preconditioning and Cardioprotection
xvi. Autonomic effects
xvii. Effect on baroreflexes
xviii. Effect on Sympathetic Outflow (Desflurane)