

ASSOCIATION OF CANADIAN UNIVERSITY DEPARTMENTS OF ANESTHESIA

National Curriculum for Canadian Anesthesia Residency

First Edition

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Table of Contents

1	Airway Evaluation and Management	4
2	Ambulatory Anesthesia	11
3	Autonomic Nervous System.....	14
4	Cardiovascular Anesthesia	16
5	Complications of Anesthesia.....	22
6	Critical Care	25
7	Ear, Nose and Throat Surgery	32
8	Endocrinology.....	36
9	Ethics	38
10	Geriatrics.....	39
11	Hematology.....	42
12	Hepatobiliary.....	46
13	Immunology and Rheumatology	48
14	Infectious Diseases.....	50
15	Monitoring and Equipment	52
16	Neurology/ Neurosurgical Anesthesiology	56
17	Neuromuscular Junction.....	59
18	Obstetrical Anesthesia.....	61
19	Ophthalmology.....	67
20	Orthopedic Surgery	69
21	Pain Management.....	72
22	Pediatric Anesthesia	79
23	Pharmacology.....	83
24	Plastic Surgery	87
25	Post-Anesthetic Care Unit (PACU).....	89
26	Preoperative Consultation	91
27	Regional Anesthesia.....	96
28	Remote Locations	100

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29	Renal / Urologic	102
30	Respiratory Physiology and Thoracic Anesthesia	104
31	Statistics	107
32	Thermoregulation.....	109
33	Transplantation.....	111
34	Volatile Agents	114

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-Mask 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 unrelieved 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

c) 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:

 - Fiberoptic 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. CVC (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. Fiberoptic 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
 - Abortion guidelines for 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 – 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 in 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-Jarisch 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 α_2 -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 antiemetic drugs and the autonomic nervous system
- j) Explain the relation between the tocolytic 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 as 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

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- 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 arteriosus
 - 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

- i. Acute myocardial ischemia
- ii. Myocardial infarction
- iii. Complications of myocardial infarction e.g. dysrhythmia, VSD, CHF, MR, LV, aneurysm, pseudoaneurysm
- iv. Management in the face of recent thrombolytic and anti-platelet therapy
- v. The implications of recent PCI and coronary stent placement
- d) Valvular heart disease
 - i. AS
 - ii. AR
 - iii. MS
 - iv. MR
 - v. PS
 - vi. TR
- e) Cardiac tamponade
- f) Constrictive pericarditis
- g) Cardiomyopathies
 - i. Dilated
 - ii. Restrictive
 - iii. Obstructive (HOCM with or without SAM, Dynamic left ventricular obstruction in the elderly)
- h) Cardiogenic shock
 - i. Right sided CHF, pulmonary hypertension
 - ii. Left sided CHF from diastolic and/or systolic dysfunction
- i) Aberrant conduction (eg: 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 (eg: recombinant Hirudin, Argatroban, bivalirudin)
- i) Anesthesia for procedures in the cath lab (eg: 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.

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- 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.
 - iii. *Achieve National Board of Echocardiography Certification in the performance and interpretation of perioperative transesophageal echocardiography.*

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-/hypocarbica
- 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

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- 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

- 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 Hepatobiliary 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 megacolon
- 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) Hypothyroidism 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. Abruptio 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

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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

- vii. Vocal cord problems
- b) Procedural considerations
 - i. Biopsies, bleeding, obstruction
 - ii. Lasers
 - iii. Positioning
 - iv. Intubation and ventilation challenges
 - Awake intubation, inhalation versus intravenous inductions
 - v. Jet ventilation
 - vi. Rigid versus flexible endoscope

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

- 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 fiberoptic 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 anesthesia 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 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

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) 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 $\dot{V}O_2$ for tissue metabolic processes, $\dot{D}O_2$, oxygen, extraction ratio, $\dot{D}O_2$ 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) Sulfhemoglobin
- 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

- 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 unfractionated 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 (eg. 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 *

e) 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. erythropoietin 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

- 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
- c) Autoimmune diseases
- d) Humoral immunity, role of B-lymphocytes, plasma cells, types of antibodies, antigens, allergens and IgE antibodies
- e) The complement system, the two pathways of activation (classic or immunologic pathway and alternative or non-immunologic pathway), their roles in antigen-antibody activation, autoimmune diseases, and bacterial infections, and the production of C2a and C5a
- f) The four types of hypersensitivity (allergic) responses (type I to type IV reactions)

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 Hemagglutinin 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 care.

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 unites (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 $1/10^{\text{th}}$ 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 effect measurement of MEPs

15.1.5 Measurement Utilizing Light

The Anesthesiologist must demonstrate an 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
 - 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
 - ii. Basic anatomy of the central nervous system, including the spinal cord and meninges
 - iii. Anatomy of the Circle of Willis
 - iv. Vascular supply to the spinal cord
 - v. 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 herniation
 - 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

- 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. Meningomyelocele
 - 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 meningomyelocele
 - ii. Craniectomy 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

- iv. Seizure
 - v. Postoperative failure to awaken
- 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. Butyrylcholinesterase 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. Sugammadex ®
- 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) Myasthenia 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 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

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) 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 intravitreal gas bubble
- e) Cataract surgery
- f) Oculoplastics
 - i. Blepharoplasty
 - ii. DCR

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- 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 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 pharmacodynamics 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

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- ii. Develop protocols and policies to govern the administration of antidepressants 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 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. Anatomy – 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, Bicavopulmonary 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 Nueromuscular 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
- f) Patients with Infectious diseases
 - i. Septic shock
 - ii. Communicable diseases
 - HIV
 - Hepatitis
 - TB
- g) Patients with Endocrine/metabolic diseases
 - i. Diabetes

- ii. Thyroid diseases
- iii. Mucopolysaccharidoses
- iv. Obesity
- v. *Mitochondrial diseases*
- h) Patients with Hematologic diseases/malignancies
 - i. Anemias including Sickle cell disease, Thalasemia
 - 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. *Peirre 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. *Gastroschisis*
 - 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 transplant surgery*
 - *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. Tympanoplasty
 - 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)

- 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. Myelomeningocele repair
- g) Urology
 - i. Circumcision, Hypospadias repair
 - ii. Ureteric reimplantation
 - iii. Cystoscopy
 - iv. Nephrectomy
 - v. Insertion Peritoneal Dialysis catheter
 - vi. *Renal transplant*
 - vii. *Bladder exstrophy 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 exprematures
- ii. Un-cooperative patient
- iii. Delirium
- iv. Post extubation stridor
- v. Pain
- vi. Nausea and vomiting
- vii. Laryngospasm
- viii. Anaphylaxis

23 Pharmacology

The competent 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 I 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 injections 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 anesthesiologist 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) Remifentanyl
- c) Sufentanyl
- d) Alfentanyl
- 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

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.

- 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 Replantation

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

- a) The general and regional anesthetic options for limb replantation
- 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 pedicle 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 mastopexy
- 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
- o) Cardiovascular Testing
 - i. Interpret and use the results of the following to assess risk and appropriately modify perioperative management
 - ECG
 - ii. Use the results of the following to assess risk and appropriately modify perioperative management
 - Echocardiography
 - Stress testing, dobutamine stress echocardiography
 - Perfusion imaging
 - Coronary angiography
 - Ventriculography

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
 - Mediastinal mass
 - Bronchopleural fistula
 - Tracheo-esophageal fistula
 - Tracheal stenosis
 - Anatomic/structural abnormalities congenital and acquired
 - Difficult airway and congenital 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
 - viii. Be able to manage side effects and complications of intubation e.g. 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 +/- 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

- 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

- 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, dermatomyositis
- 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

- 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, patient 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 Thromboelastography
 - iv.

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; methaemoglobinaemia; 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 and 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

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.

- 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

- 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 nerve 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) Contrast 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 excretion 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 an orifice, Reynolds number
 - ii. Respiratory system resistance
 - iii. Gas trapping
 - iv. Airway closure, closing capacity and closing volumes
 - v. Flow-related airway collapse
 - vi. Neuromuscular 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

- x. End expiratory CO₂
- xi. Carbon dioxide output
- xii. Measurement of carbon dioxide
- xiii. Physiologic effects of hypercapnia and hypocapnia

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 thoractomy 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) α and P value (level of statistical significance) vs. β 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 (α)
 - 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:

- 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 intra operative 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 transesophageal 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

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- 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 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 F_A/F_I

- a) F_A/F_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. 1st 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

- i) Diffusion between tissues
- j) Metabolism
- k) Exhalation
- l) Diffusion hypoxia

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
 - 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 thymidylsynthetase by nitrous oxide
 - viii. NIOSH standards
 - ix. Effect on Uterine Smooth Muscle

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.

- 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)