



PRIMARY CERTIFICATION IN ANESTHESIOLOGY

**This content outline covers the
In-Training, Part 1, BASIC, and ADVANCED Examinations**

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CONTENT OUTLINE

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I. Basic Topics in Anesthesiology

A. Basic Sciences

1. Anatomy

a. Topographical Anatomy As Landmarks

- 1) Neck: Cricothyroid Membrane, Internal and External Jugular Veins, Thoracic Duct, Carotid and Vertebral Arteries, Stellate Ganglion, Cervical Spine Landmarks (Vertebra Prominens, Chassaignac's Tubercle)
- 2) Chest: Pulmonary Lobes, Cardiac Landmarks, Subclavian Vein
- 3) Pelvis and Back: Vertebral Level of Topographical Landmarks, Caudal Space
- 4) Extremities: Relationship of Bones, Nerves, and Arteries
- 5) Dermatome Anatomy: Sensory and Motor

b. Radiological Anatomy

- 1) Chest (Including CT and MRI)
- 2) Brain and Skull (Including CT and MRI)
- 3) Spine (Cervical, Thoracic, Lumbar), Including CT and MRI
- 4) Neck (Including Doppler Ultrasound for Central Venous Access)

c. Clinical Anatomy

1) Upper Extremity

- a) Bones
- b) Vasculature
- c) Innervation

2) Lower Extremity

- a) Bones
- b) Vasculature
- c) Innervation

2. Physics, Monitoring, and Anesthesia Delivery Devices

a. Mechanics

- 1) Pressure Measurement of Gases, Liquids
- 2) Transducers, Regulators, Medical Gas Cylinders
- 3) Principles of Ultrasound: Obtaining an Image, Resolution, Depth, Frequency, Resonance

b. Flow Velocity

- 1) Viscosity-Density; Laminar-Turbulent Flow
- 2) Flowmeters: Rotameter
- 3) Principles of Doppler Ultrasound

- c. Properties of Liquids, Gases, and Vapors
 - 1) Diffusion of Gases
 - 2) Solubility Coefficients
 - 3) Relative and Absolute Humidity
 - 4) Critical Temperature, Critical Pressure
- d. Gas Laws
- e. Vaporizers
 - 1) Vapor Pressure and Calculation of Anesthetic Concentrations
 - 2) Vaporizer Types and Safety Features
- f. Uptake and Distribution of Inhalation Agents
 - 1) Uptake and Elimination Curves; Effect of Ventilation, Circulation, Anesthetic Systems
 - 2) Concentration Effect
 - 3) Second Gas Effect
 - 4) Nitrous Oxide and Closed Spaces
- g. Physics of Anesthesia Machine/ Breathing System
 - 1) Principles: Resistance, Turbulent Flow, Mechanical Deadspace, Rebreathing, Dilution, Leaks, Gas Mixtures, Humidity, Heat
 - 2) Components: Connectors, Adaptors, Mask, Endotracheal Tube, Reservoir Bag Unidirectional Valves, Corrugated Breathing Tubes, Laryngeal Mask Airways, Airway Pressure Relief Valve
 - 3) Characteristics
 - a) Circle Systems: Closed and Semi-Closed; Adult; Pediatric
 - b) Non-Circle Systems: Insufflation; Open; Semi-Open
 - c) Portable Ventilation Devices (Self-Reinflating, Non-Self-Reinflating), Non-Rebreathing Valves
 - d) CO₂ Absorption: Principles, Canisters, Efficiency
 - e) Toxicity: Compound A, Carbon Monoxide
 - 4) Oxygen Supply Systems: FiO₂
 - 5) Waste Gas Evacuation Systems
 - 6) Safety Features (Proportioning Devices, Rotameter Configuration, Pressure Fail-Safe)
- h. Monitoring Methods
 - 1) Neuromuscular Function: Nerve Stimulators, Electromyography (Emg)
 - 2) Ventilation: Respirometers, Inspiratory Force, Spirometry, Flow-Volume Loops
 - 3) Gas Concentrations: O₂, CO₂, Nitrogen, Anesthetic Gases and Vapors
 - 4) Temperature
 - 5) Oxygen: Oximetry, Co-Oximetry, Pulse Oximetry

I.A.2.h

- 6) Blood Pressure - Noninvasive, Invasive
- 7) Heart Function: Heart Tones, Electrocardiogram

i. Instrumentation

- 1) Arterial and Venous Blood Gases: Electrodes for pH, PO₂, PCO₂, Calibration, Temperature Corrections, Errors
- 2) Gas Concentrations: Infrared Absorption, Mass Spectrometry, Raman Scatter Analysis
- 3) Pressure Transducers: Resonance, Damping
- 4) Non-Invasive Blood Pressure (BP) Measurement: Doppler, Oscillometry, Korotkoff Sounds, Palpation
- 5) Blood Warmers, Autotransfusion Devices
- 6) Body Warming Devices: Forced Air, Heating Lamps, Insulation Devices, Warming Blankets, Water-Flow "Second Skin" Devices

j. Ventilators

- 1) Classifications: Flow Generation vs. Pressure Generation
- 2) Principles of Action: Assistors, Controllers, Assist-Control; Pressure-Limited, Volume-Limited; FiO₂ Control; Periodic Sigh, Inverse Ratio, High Frequency Ventilation, Intermittent Mandatory Ventilation (IMV), Synchronized IMV, Pressure Support, Airway Pressure Release Ventilation (APRV), Pediatric Adaptation, Non-Invasive Techniques: Biphaseic Positive Airway Pressure (BIPAP), Others
- 3) Monitors; Pressure (Plateau, Peak), Oxygen, Apnea, Inspiratory/Expiratory Ratio, Dynamic Compliance, Static Compliance

k. Alarms and Safety Features: Operating Room, Electrical, Anesthesia Machine, Ventilators, Capnometer, Oxygen, Hemodynamic Monitors

l. Defibrillators: Automatic Internal, External, Implantable; Energy, Cardioversion, Types of Waveforms (Monophasic, Biphasic); Paddle Size and Position; Automated External Defibrillators (AEDs)

m. Electrical; Fire and Explosion Hazards; Basic Electronics

- 1) Source of Ignition; Static
- 2) Prevention: Grounding, Isolation Transformers
- 3) Macro and Micro Current Hazards
- 4) Safety Regulations; National Fire Protection Association (NFPA) Standards
- 5) Risk Factors for Intraoperative Fire

3. Mathematics

- a. Simple Math: Logarithms; Graph of Simple Equations; Exponential Function, Analysis of Biologic Curves
- b. Statistics: Sample and Population; Probability; Mean, Median, and Mode; Standard Deviation and Error; T-Test; Chi-Square; Regression Analysis/Correlation; Analysis of Variance, Power Analysis, Meta-Analysis, Confidence Intervals, Odds Ratio, Risk Ratio, Bland-Altman Plot

4. Pharmacology

a. General Concepts

- 1) Pharmacokinetics and Pharmacodynamics, Protein Binding; Partition Coefficients; PKA; Ionization; Tissue Uptake; Compartmentalization and Exponential Models
 - a) Pharmacokinetics of Neuraxial Drug Administration: Epidural and Subarachnoid
 - b) Tolerance and Tachyphylaxis
- 2) Termination of Action
 - a) Elimination; Biotransformation; Context-Sensitive Half-Time
 - b) Impact of Renal Disease
 - c) Impact of Hepatic Disease
- 3) Drug Interactions
 - a) Enzyme Induction and Inhibition
 - b) Hepatic Blood Flow
 - c) Drug-Drug Binding
 - d) Alternative and Herbal Medicines: Perioperative Implications
- 4) Drug Reactions (Anaphylactoid, Anaphylaxis, Idiosyncratic)

b. Anesthetics-Gases and Vapors

- 1) Physical Properties
- 2) Mechanism of Action
- 3) Effects on Central Nervous System (CNS)
- 4) Effects on Cardiovascular System
- 5) Effects on Respiration
- 6) Effects on Neuromuscular Function
- 7) Effects on Renal Function
- 8) Effects on Hepatic Function
- 9) Effects on Hematologic and Immune Systems
- 10) Biotransformation and Toxicity
- 11) Minimum Alveolar Concentration (MAC), Factors Affecting Mac
- 12) Trace Concentrations, OR Pollution, Personnel Hazards
- 13) Comparative Pharmacodynamics

c. Anesthetics-Intravenous (Opioid and Non-Opioid Induction and Anesthetic Agents)

- 1) Opioids
 - a) Mechanism of Action
 - b) Pharmacokinetics and Pharmacodynamics
 - (1) Intravenous

(2) Epidural and Intrathecal

- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications

2) Barbiturates

- a) Mechanism of Action
- b) Pharmacokinetics and Pharmacodynamics
- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications

3) Propofol

- a) Mechanism of Action
- b) Pharmacokinetics and Pharmacodynamics
- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications

4) Etomidate

- a) Mechanism of Action
- b) Pharmacokinetics and Pharmacodynamics
- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications

5) Benzodiazepines

- a) Mechanism of Action
- b) Pharmacokinetics and Pharmacodynamics
- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications
- i) Antagonism

6) Ketamine

- a) Mechanism of Action
- b) Pharmacokinetics and Pharmacodynamics
- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications

7) Dexmedetomidine

- a) Mechanism of Action
- b) Pharmacokinetics and Pharmacodynamics
- c) Metabolism and Excretion
- d) Effect on Circulation
- e) Effect on Respiration
- f) Effect on Other Organs
- g) Side Effects and Toxicity
- h) Indications and Contraindications

d. Anesthetics - Local

- 1) Uptake, Mechanism of Action
- 2) Biotransformation and Excretion
- 3) Comparison of Drugs and Chemical Groups
- 4) Prolongation of Action
- 5) Local Anesthetic Side Effects
 - a) CNS: Seizures, Cauda Equina Syndrome, Transient Neurological Symptom

- b) Cardiac
- c) Allergy
- d) Preservatives/Additives
- e) Methemoglobinemia
- f) Local Anesthetic Systemic Toxicity
 - i. American Society for Regional Anesthesia Checklist for Local Anesthetic Systemic Toxicity
 - ii. Intravenous Lipid Emulsion for Local Anesthetic Systemic Toxicity
- e. Muscle Relaxants (Depolarizing, Non-Depolarizing)
 - 1) Mechanism of Action
 - 2) Pharmacokinetics and Pharmacodynamics, Abnormal Responses
 - 3) Prolongation of Action; Synergism
 - 4) Metabolism and Excretion
 - 5) Side Effects and Toxicity
 - 6) Indications and Contraindications
 - 7) Antagonism of Blockade
 - 8) Drug Interactions (Antibiotics, Antiepileptics, Lithium, Magnesium, Inhalational Anesthetics)

B. Clinical Sciences: Anesthesia Procedures, Methods, and Techniques

1. Evaluation of the Patient and Preoperative Preparation

a. Physical Examination Including Airway Evaluation

b. Laboratory Evaluation

- 1) American Society of Anesthesiologists (ASA) Preoperative Testing Guidelines
- 2) American College of Cardiology/American Heart Association Guidelines for Perioperative Cardiovascular Evaluation

c. ASA Physical Status Classification

d. Preparation for Anesthesia/Premedication

- 1) Interaction with Chronic Drug Therapy; Interaction with Anesthetic Agents
- 2) Adverse Reactions to Premedications; Patient Variability, Dose Response Curves, Side Effects
- 3) Specific Problems in Disease States: Hyperthyroidism and Hypothyroidism, Drug Abuse, Glaucoma, Uremia, Increased CSF Pressure, Chronic Steroid Ingestion, Obesity, Obstructive Sleep Apnea, Depression, COPD, Hypertension
- 4) Pediatric and Geriatric Doses, Routes of Administration
- 5) Role in Patients with Allergies
- 6) NPO and Full Stomach Status; Implications for Airway Management, Choice of Anesthesia Technique and Induction of Anesthesia; Gastric Emptying Time; Preoperative; Full Stomach and Induction of Anesthesia; Practice Guidelines for Preoperative Fasting
 - a) Alteration of Gastric Fluid Volume and pH, Sphincter Tone

I.B.1.d

- 7) Continuation vs. Discontinuation of Chronic Medications: Antihypertensives, Anti-Anginal, Antihyperglycemics, Antidepressants, Platelet Inhibitors, Etc.
- 8) Prophylactic Cardiac Risk Reduction: Beta-Adrenergic Blockers, Etc.
- 9) Prophylactic Antibiotics
 - a) Indications
 - b) Risks of Administration
 - c) Drug Interactions

2. Regional Anesthesia

- a. General Topics: Premedication, Patient Position, Equipment, Monitoring and Sedation
- b. Spinal, Epidural, Caudal, Combined Spinal/Epidural
 - 1) Indications, Contraindications
 - 2) Sites of Actions
 - 3) Factors Influencing Onset, Duration, and Termination of Action
 - 4) Systemic Toxicity, Test Dose
 - 5) Complications; Precipitating Factors, Prevention, Therapy, Implications of Anticoagulants and Platelet Inhibitors: American Society of Regional Anesthesia and Pain Medicine (ASRA) Guidelines
 - 6) Physiologic Effects (GI, Pulmonary, Cardiac, Renal)
- c. IV Regional: Mechanism, Agents, Indications, Contraindications, Techniques, Complications
- d. Transversus Abdominis Plane Blocks: Indications, Risks, Side Effects

3. General Anesthesia

- a. Stages and Signs of Anesthesia; Awareness Under Anesthesia
- b. Techniques: Inhalational, Total Intravenous, Combined Inhalational/Intravenous
- c. Airway Management
 - 1) Assessment/Identification of Difficult Airway: Anatomic Correlates, Mallampati Classification, Range of Motion
 - 2) Techniques for Managing Airway: Awake vs. Asleep, Use vs. Avoidance of Muscle Relaxants, Drug Selection, Retrograde Intubation Techniques, ASA Difficult Airway Algorithm
 - 3) Devices: Flexible Fiberoptic, Rigid Fiberoptic, Transillumination, Laryngoscope Blades, Alternative Intubating Devices, Video Laryngoscopes
 - 4) Alternatives and Adjuncts: Laryngeal Mask Airway (Traditional and Modified), Esophageal Obturator Airways, Occlusive Pharyngeal Airways
 - 5) Transcutaneous Or Surgical Airway: Tracheostomy, Cricothyroidotomy, Translaryngeal Or Transtracheal Jet Ventilation
 - 6) Endobronchial Intubation: Double-Lumen Endobronchial Tubes; Bronchial Blockers, Placement and Positioning Considerations, Postoperative Considerations
 - 7) Intubation and Tube Change Adjuncts: Bougies, Jet Stylettes, Soft and Rigid Tube Change Devices; Complications

8) Endotracheal Tube Types: Tube Material (Polyvinyl Chloride, Silicone, Laser-Resistant, Silver Impregnated, Other), Tube Tip Design (Murphy Eyes, Flexible Tip, Moveable Tip, Short-Bevel), Cuff Design (High vs. Low Volume/Pressure, Cuffed Vs Uncuffed, Cuff Shape), Cuff Pressure Management (Lanz Valves, Active Management, Pilot Balloon, Inflation Valve), Specific Tube Types (Wire-Reinforced, Nasal and Oral Rae®, Microlaryngeal, Supraglottic Secretion Suctioning, Other), Microlaryngoscopy; Laser Safe

d. ASA Monitoring Standards

4. Monitored Anesthesia Care and Sedation

a. Techniques

b. Risks and Complications

c. ASA Guidelines for Sedation, Sedation Guidelines for Non-Anesthesiologists

d. Indications/Contraindications

5. Intravenous Fluid Therapy During Anesthesia

a. Water, Electrolyte, Glucose Requirements and Disposition

b. Crystalloid vs. Colloid

c. Fluid Requirements and Fluid Deficit Calculations

d. Normal Saline vs. Lactated Ringers' vs. Plasmalyte vs. D5W

e. Enhanced Recovery After Surgery Protocol for Fluid Therapy

6. Complications (Etiology, Prevention, Treatment)

a. Trauma

1) Upper Airway, Epistaxis

2) Larynx, Trachea, and Esophagus

3) Eyes: Corneal Abrasions, Blindness, Post-op visual loss

4) Vascular; Arterial and Venous Thrombosis; Thrombophlebitis; Sheared Catheter, Intra-Arterial Injections, Air Embolism, Cardiac/Vascular Perforations, Pulmonary Artery Rupture

5) Neurological: Pressure Injuries of Mask, Tourniquet, Body Position, Intraneural Injections, Retractors, Peripheral Neuropathies

6) Burns

b. Chronic Environmental Exposure; Fertility, Teratogenicity, Carcinogenicity, Scavenging

c. Temperature

1) Hypothermia: Etiology, Prevention, Treatment, Complications (Shivering, O₂ Consumption), Prognosis

2) Nonmalignant Hyperthermia; Complications, Treatment

d. Bronchospasm

e. Anaphylaxis

1) Latex Allergy

2) Other

- f. Laryngospasm
- g. Postobstructive Pulmonary Edema
- h. Aspiration of Gastric Contents
- i. Malignant Hyperthermia

- 1) Genetics
- 2) Pathophysiology

7. Postoperative Period

a. Pain Relief

1) Pharmacologic

- a) Drugs: Opioids, Agonist-Antagonists, Local Anesthetics, Alpha-2 Agonists, Nonsteroidal Anti-Inflammatory Drugs (NSAIDs), N-Methyl-D-Aspartate (NMDA) Receptor Blockers, tricyclic antidepressants (TCA), selective serotonin reuptake inhibitor (SSRI)
- b) Routes: Oral, Subcutaneous (SC), Transcutaneous, Transmucosal, Intramuscular (IM), Intravenous (IV), Including Patient-Controlled Analgesia (PCA), Epidural, Spinal, Interpleural, Other Regional Techniques

- 2) Other Techniques; Transcutaneous Electrical Nerve Stimulation (TENS); Cryotherapy; Acupuncture, Hypnosis

b. Respiratory Consequences of Anesthesia and of Surgical Incisions

c. Cardiovascular Consequences of General and Regional Anesthesia: Differential Diagnosis and Treatment of Postoperative Hypertension and Hypotension

d. Nausea and Vomiting

- 1) Physiology; Etiology; Risk Factors, Preventive Strategies
- 2) Use of Antacids, Histamine-2 (H2) Blockers, Metoclopramide, Transdermal Scopolamine, Droperidol, Serotonin Antagonists, Proton Pump Inhibitors, Dexamethasone, Multimodal Therapy, Acupressure/Acupuncture

e. Neuromuscular Consequences: Residual Paralysis, Muscle Soreness, Recovery of Airway Reflexes

f. Neurologic Consequences of Anesthesia: Confusion, Delirium, Cognitive Dysfunction, Failure to emerge from anesthesia

C. Organ-Based Basic and Clinical Sciences

1. Central and Peripheral Nervous Systems

a. Physiology

1) Brain

- a) Cerebral Cortex; Functional Organization
- b) Subcortical Areas: Basal Ganglia, Hippocampus, Internal Capsule, Cerebellum, Brain Stem, Reticular Activating System
- c) Cerebral Blood Flow

(1) Effect of Perfusion Pressure, P_h , P_aCO_2 , P_aO_2 , and Cerebral Metabolic Rate for O_2 ($CMRO_2$); Inverse Steal; Gray vs. White Matter

- (2) Autoregulation: Normal, Altered, and Abolished
- (3) Pathophysiology of Ischemia/Hypoxia: Global vs. Focal, Glucose Effects, Effects of Brain Trauma or Tumors
- d) Cerebrospinal Fluid
 - (1) Formation, Volume, Composition, Flow and Pressure
 - (2) Blood-Brain Barrier, Active and Passive Molecular Transport Across, Causes of Disruption
 - (3) Relation to Blood Chemistry and Acid-Base Balance
- e) Cerebral Protection
 - (1) Hypothermia
 - (2) Anesthetic and Adjuvant Drugs
- 2) Spinal Cord
 - a) General Organization
 - b) Spinal Reflexes
 - c) Spinal Cord Tracts
 - d) Evoked Potentials
- 3) Neuromuscular and Synaptic Transmission
 - a) Morphology; Receptors, Receptor Density
 - b) Membrane Potential; Mechanism
 - c) Action Potential; Characteristics, Ion Flux
 - d) Synapse; Transmitters, Precursors, Ions, Termination of Action, Transmission Characteristics, Presynaptic and Postsynaptic Functions
- 4) Skeletal Muscle Contractions; Depolarization, Role of Calcium, Actin/Myosin; Energy Source and Release
- 5) Pain Mechanisms and Pathways
 - a) Nociceptors and Nociceptive Afferent Neurons, Wind-Up Phenomenon
 - b) Dorsal Horn Transmission and Modulation
 - c) Spinal and Supraspinal Neurotransmission and Modulation; Opioid Receptors
 - d) Autonomic Contributions to Pain; Visceral Pain Perception and Transmission
 - e) Social, Vocational and Psychological Influences on Pain Perception
 - f) Gender and Age Differences in Pain Perception
- 6) Autonomic Nervous System
 - a) Sympathetic: Receptors; Transmitters, Synthesis; Storage; Release; Responses; Termination of Action
 - b) Parasympathetic: Receptors; Transmitters; Synthesis; Release; Responses; Termination of Action
 - c) Ganglionic Transmission

d) Reflexes: Afferent and Efferent Limbs

7) Temperature Regulation

- a) Temperature Sensing; Central, Peripheral
- b) Temperature Regulating Centers; Concept of Set Point
- c) Heat Production and Conservation
- d) Heat Loss; Mechanisms
- e) Body Temperature Measurement; Sites; Gradients
- f) Effect of Drugs/Anesthesia on Temperature Regulation

b. Anatomy

1) Brain

a) Cerebral Cortex

- (1) Cerebellum, Basal Ganglia, Major Nuclei and Pathways
- (2) Brain Stem
 - (a) Respiratory Centers
 - (b) Reticular Activating System
- (3) Cerebral Circulation; Circle of Willis, Venous Sinuses and Drainage

2) Spinal Cord and Spine

- a) Variations in Vertebral Configuration
- b) Spinal Nerves (Level of Exit, Covering, Sensory Distribution)
- c) Blood Supply
- d) Sacral Nerves: Innervation of Pelvic Structures

3) Meninges: Epidural, Subdural and Subarachnoid Spaces

4) Parasympathetic Nervous System: Location of Ganglia, Vagal Reflex Pathways

5) Sympathetic Nervous System: Ganglia, Rami Communicantes, Sympathetic Chain

- a) Cranial Nerves
- b) Carotid and Aortic Bodies, Carotid Sinus
- c) Ganglia, Rami Communicantes, Sympathetic Chain
- d) Nociception
 - (1) Peripheral Nociceptors: Transduction
 - (2) Afferent Pathways: Neurons, Dorsal Horn, CNS Pathways

2. Respiratory System

a. Physiology: Lung Functions and Cellular Processes

1) Lung Volumes

- a) Definitions; Methods of Measurement; Normal Values; Time Constants

b) Spirometry; Static and Dynamic Volumes; Deadspace; Nitrogen Washout, O₂ Uptake, CO₂ Production, Exercise Testing

2) Lung Mechanics

a) Static and Dynamic Compliance, Pleural Pressure Gradient, Flow-Volume Loops and Hysteresis, Surfactant, Laplace Law

b) Resistances; Principles of Gas Flow Measurement

c) Methods of Measurement

d) Work of Breathing

e) Regulation of Airway Caliber

3) Ventilation - Perfusion

a) Distribution of Ventilation

b) Distribution of Perfusion, Zones, Hypoxic Pulmonary Vasoconstriction

c) Alveolar Gas Equation

4) Diffusion

a) Definition, Pulmonary Diffusion Capacity

b) Apneic Oxygenation, Diffusion Hypoxia

5) Blood Gas

a) O₂ Transport; O₂ Physical Solubility; Oxyhemoglobin (Hb-O₂) Saturation, Hb-O₂ Dissociation Curve; 2,3-Diphosphoglycerate (2,3-DPG), P₅₀, Respiratory Enzymes; Hemoglobin (Hb) As A Buffer

b) CO₂ Transport; Blood CO₂ Content; Carbonic Anhydrase; CO₂ Dissociation Curve; Bohr Effect, Haldane Effect

c) Systemic Effects of Hypercarbia and Hypocarbia

d) Systemic Effects of Hyperoxia and Hypoxemia

e) Basic Interpretation of Arterial Blood Gas

6) Control of Ventilation

a) Respiratory Center

b) Central and Peripheral Chemoreceptors; Proprioceptive Receptors; Respiratory Muscles and Reflexes; Innervation

c) CO₂ and O₂ Response Curves

7) Non-Respiratory Functions of Lungs: Metabolic, Immune

8) Perioperative Smoking

a) Physiologic effects

b) Cessation of smoking

b. Anatomy

1) Nose

2) Pharynx: Subdivisions; Innervation

3) Larynx

- a) Innervation; Muscles; Blood Supply; Cartilages
- b) Vocal Cords, Positions with Paralysis
- c) Differences Between Infant and Adult

4) Trachea

- a) Structure and Relationships in Neck and Chest

5) Muscles of Respiration, Accessory Muscles

c. Pharmacology

1) Bronchodilators

- a) β -agonists
- b) Anticholinergics

2) Antiinflammatory medications

- a) Steroids
- b) Leukotriene modifier drugs
- c) Mast cell stabilizers
- d) Immunoglobulin E (IgE) blockers

3. Cardiovascular System

a. Physiology

1) Cardiac Cycle

- a) Control of Heart Rate
- b) Synchronicity of Pressure, Flow, ECG, Sounds, Valve Action
- c) Impulse Propagation
- d) Normal ECG
- e) Electrophysiology; Ion Channels and Currents

2) Ventricular Function

- a) Frank-Starling Law; Preload and Afterload, Intracardiac Pressures
- b) Force, Velocity, Length, Rate of Shortening
- c) Myocardial Contractility, Measurement Limitations
- d) Cardiac Output: Determinants and Regulation
- e) Myocardial Oxygen Utilization
- f) Systolic and Diastolic Function
- g) Cardiac Output: Fick Principle

3) Venous Return

- a) Vascular Compliance/Venous Capacitance; Controlling Factors
- b) Muscle Action; Intrathoracic Pressure; Body Position

- c) Blood Volume and Distribution
- 4) Blood Pressure
 - a) Systolic, Diastolic, Mean, and Perfusion Pressures
 - b) Intracardiac, Pulmonary, Venous
 - c) Systemic and Pulmonary Vascular Resistance, Viscosity
 - d) Baroreceptor Function
- 5) Microcirculation
 - a) Capillary Diffusion; Osmotic Pressure, Starling's Law
 - b) Pre-Post Capillary Sphincter Control
 - c) Viscosity; Rheology
- 6) Regional Blood Flow and Its Regulation
 - a) Cerebral and Spinal Cord
 - b) Coronary
 - c) Pulmonary
 - d) Renal
 - e) Splanchnic – Hepatic
 - f) Muscle and Skin
 - g) Uterine and Placental
- 7) Regulation of Circulation and Blood Volume
 - a) Central: Vasomotor Center, Hypothalamic-Pituitary-Adrenal Axis
 - b) Peripheral: Receptors and Reflexes
 - c) Hormonal Control
 - d) Mixed Venous Oxygen Tension and Saturation
- 8) Basics of Cardiopulmonary Resuscitation; Medications, Defibrillators, Advanced Cardiac Life Support (ACLS) Algorithms
- b. Anatomy
 - 1) Normal Anatomy of Heart and Major Vessels
 - a) Coronary Circulation
 - b) Heart Conduction System
- c. Pharmacology
 - 1) Digitalis; Actions and Toxicity
 - 2) Inotropes
 - 3) Phosphodiesterase III Inhibitors (Inodilators): Milrinone, Others
 - 4) Antiarrhythmics
 - 5) Antianginal Drugs

- 6) Vasodilators: Nitroprusside, Nitroglycerin, Hydralazine, Nesiratide, Calcium Channel Blockers, Others
 - 7) Angiotensin Converting Enzyme Inhibitors and Angiotensin Blockers
 - 8) Electrolytes (Potassium, Magnesium, Phosphorus, Calcium): Cardiovascular Effects
 - 9) Non-Adrenergic Vasoconstrictors: Vasopressin and Congeners
4. Gastrointestinal / Hepatic Systems
- a. Physiology: Hepatic Function
 - 1) Dual Blood Supply and Its Regulation
 - 2) Metabolic and Synthetic Functions
 - 3) Excretory Functions
 - 4) Mechanisms of Drug Metabolism and Excretion, Cytochrome P450
 - b. Enhanced Recovery After Surgery for Colorectal Surgery
5. Renal and Urinary Systems/ Electrolyte Balance
- a. Physiology
 - 1) Blood Flow, Glomerular Filtration, Tubular Reabsorption and Secretion
 - 2) Renal Function Tests
 - 3) Hormonal Regulation of Extracellular Fluid
 - 4) Hormonal Regulation of Osmolality
 - 5) Regulation of Acid-Base Balance
 - 6) Drug Excretion
 - 7) Water and Electrolytes: Distribution and Balance; Compartments
 - 8) Renin-Angiotensin-Aldosterone System
 - b. Pharmacology
 - 1) Diuretics
 - a) Mechanism of Action
 - b) Comparison of Drugs
 - c) Effect on Electrolytes and Acid-Base Balance
 - d) Adverse Effects
 - 2) Dopaminergic Drugs
6. Hematologic System
- a. Pharmacology
 - 1) Anticoagulants, Antithrombotics, and Anti-Platelet Drugs
 - a) Mechanism of Action
 - b) Comparison of Drugs
 - c) Drug Interaction

- d) Monitoring of Effects
 - e) Side Effects and Toxicity
 - f) Alternatives to Transfusion: Hemodilution, Sequestration, Autotransfusion, Blood Substitutes, Erythropoietin
- 2) Immunosuppressive and Anti-Rejection Drugs
- b. Transfusions
- 1) Indications
 - 2) Blood Preservation, Storage
 - 3) Blood Filters and Pumps
 - 4) Effects of Cooling and Heating; Blood Warmers
 - 5) Blood Components, Volume Expanders
 - 6) Preparation for Transfusion: Type and Cross, Type and Screen, Uncrossmatched Blood, Autologous Blood, Designated Donors
 - 7) Synthetic and Recombinant Hemoglobins
- c. Reactions to Transfusions
- 1) Febrile
 - 2) Allergic
 - 3) Hemolytic: Acute and Delayed
- d. Complications of Transfusions
- 1) Infections: Hepatitis, Human Immunodeficiency Virus (HIV), Cytomegalovirus (CMV), Others
 - 2) Citrate Intoxication
 - 3) Electrolyte and Acid Base Abnormalities
 - 4) Massive Transfusion: Coagulopathies, Hypothermia
 - 5) Pulmonary
 - a) Transfusion-Related Acute Lung Injury
 - b) Transfusion-Related Circulatory Overload
 - 6) Immunosuppression
7. Endocrine and Metabolic Systems
- a. Physiology
- 1) Hypothalamus, Pituitary; Thyroid; Parathyroid, Adrenal Medulla, Adrenal Cortex and Pancreas
- b. Biochemistry of Normal Body Metabolism
- 1) Carbohydrates
 - a) Aerobic and Anaerobic Utilization; Chemical Processes, Enzymes
 - b) Relationship to Hormones; Insulin; Human Growth Hormone, Glucocorticoids; Glucagon, Epinephrine
 - c) Effect of Stress

2) Proteins

- a) Functions, Hormones, Antibodies
- b) Cyclic Adenosine Monophosphate (cAMP); Cyclic Guanosine Monophosphate (cGMP)
- c) Lipids: Triglycerides, Lipoproteins, Cholesterol
 - (1) Specific Organ Metabolism (Brain, Heart, Liver, Muscle)

8. Neuromuscular Diseases and Disorders

a. Physiology of Neuromuscular Transmission

- 1) Prejunctional Events: Acetylcholine Synthesis and Release, Modulation By Nicotinic and Muscarinic Prejunctional Receptors
- 2) Postjunctional Events: Acetylcholine Binding to Acetylcholine Receptors, Ion Flow Through Acetylcholine Receptor

b. Anatomy of the Neuromuscular Junction

- 1) Prejunctional Components: Motor Neurons, Neuronal Transport System, Synaptic Vesicles
- 2) Postjunctional Components: Muscle Cell, Acetylcholine Receptor
- 3) Perijunctional voltage-gated channels

D. Special Problems Or Issues in Anesthesiology

1. Physician Impairment Or Disability: Substance Abuse, Fatigue, Aging, Visual and Auditory Impairment, American Disabilities Act

2. Ethics, Practice Management, and Medicolegal Issues

- a. Professionalism and Licensure
- b. Ethics, Advance Directives/Do Not Resuscitate (DNR) Orders; Suspended DNR, Patient Privacy Issues, e.g., Health Insurance Portability and Accountability Act (HIPAA)
- c. Informed consent (principles, components)
- d. Patient Safety
 - 1) Medication Errors: Assessment and Prevention
 - 2) Disclosure of Errors to Patients
- e. Core Competencies

II. Advanced Topics in Anesthesiology

A. Basic Sciences

1. Physics, Monitoring, and Anesthesia Delivery Devices

a. Monitoring Methods

- 1) Vascular Pressures: Arterial (Invasive/Noninvasive Differences), Central Venous (CVP), Pulmonary Arterial (PAP), Pulmonary Artery Occlusion (PAOP), Left Atrial (LAP), Left Ventricular End-Diastolic (LVEDP)
- 2) Heart Function: Heart Tones, Electrocardiogram (ECG), Echocardiography, Doppler, Cardiac Output
- 3) Brain and Spinal Cord Function: Electroencephalogram (EEG) (Raw and Processed), Depth of Anesthesia Monitors (Bispectral, Other), Evoked Potentials, Wake-Up Test, Intracranial Pressure (ICP), Jugular Venous Oxygen Saturation, Near Infrared Spectroscopy (Cerebral Oximetry), Transcranial Doppler
- 4) Mixed Venous Oxygen Saturation (SvO₂)
- 5) Awareness Monitors

b. Instrumentation

- 1) Cardiac Output: Fick, Dye Dilution, Thermodilution, Doppler, Impedance, Pulse Wave Analysis, Stroke Volume Assessment
- 2) Echocardiography: Technical Aspects, Complications
- 3) Coagulation Monitors
- 4) Ultrasound-Guided Placement of Invasive Catheters (Arterial, Central Venous) and Nerve Blocks

c. Ventilators

- 1) Continuous Positive Airway Pressure (CPAP) and Positive End-Expiratory Pressure (PEEP); Nasal CPAP
- 2) Nebulizers, Humidifiers, Drug Delivery Systems (Nitric Oxide, Others)

d. Pacemakers

- 1) Temporary Transvenous; Permanent (Epicardial, Endocardial), Transcutaneous
- 2) Types: Fixed Rate, Biventricular Synchronized, Ventricular, Atrial, Atrio-Ventricular (A-V) Sequential
- 3) Standard Nomenclature
- 4) Reasons for Failure or Malfunction

e. Electrical; Fire and Explosion Hazards

- 1) Basic Electronics
- 2) Lasers, Laser Safety, Laser-Safe Endotracheal Tubes

- II.A.1
 - f. Drug Delivery Devices: Patient-Controlled Intravenous and Epidural Analgesia, Epidural and Subarachnoid Continuous Drug Delivery Devices
 - 2. Pharmacology
 - a. General Concepts
 - 1) Pharmacogenetics
 - a) Malignant Hyperthermia (Including Diagnosis and Therapy)
 - b) Butyrylcholinesterase (Pseudocholinesterase) Deficiency
 - c) Prolonged Qt Syndrome
 - d) Genetic Factors in Drug Dose-Response Relationships
 - 2) Addiction
 - a) Physiology and Pharmacology
 - b) Patient Addiction: Anesthetic Implications
 - c) Addiction vs. Tolerance
- B. Clinical Sciences: Anesthesia Procedures, Methods, and Techniques
 - 1. Regional Anesthesia
 - a. Peripheral and Autonomic Nerve Blocks: Indications, Contraindications, Techniques, Clinical Assessment, Complications, Use of Nerve Stimulators, Use of Ultrasound
 - 1) Head and Neck
 - 2) Upper Extremity/Brachial Plexus
 - 3) Trunk and Perineum
 - 4) Lower Extremity
 - 2. Special Techniques
 - a. Controlled Hypotension; Choice of Drugs, Use of Posture, Ventilation
 - b. Controlled Hypothermia; Techniques, Systemic Effects, Shivering, Rewarming, Complications
 - c. Hyperbaric Oxygen and Anesthesia Care
 - d. High Altitude Anesthesia
- C. Organ-Based Advanced Clinical Sciences
 - 1. Central and Peripheral Nervous Systems
 - a. Physiology
 - 1) Metabolism: Substrates, Aerobic and Anaerobic
 - 2) Intracranial Pressure
 - a) Brain Volume, Elastance and Compliance
 - b) Increased ICP, Herniation
 - 3) Electroencephalography (EEG)
 - a) Wave Patterns, Frequency and Amplitude, Raw and Processed, Spectral Edge

- b) Sleep, Convulsions; O₂ and CO₂; Hypothermia; Brain Death
- c) Depth of Anesthesia; Burst Suppression, Electrical Silence, Specific Anesthetic and Drug Effects

4) Evoked Responses

- a) Morphology, Effects of Ischemia and Anesthetics
- b) Sensory: Somatosensory, Visual, Brainstem Auditory
- c) Motor

b. Anatomy

1) Regional Anesthesia; Main Nerve Blocks (Includes Techniques and Comparisons of Techniques)

- a) Autonomic: Stellate, Celiac, Lumbar Sympathetic
- b) Head and Neck: Retrobulbar/Peribulbar, Facial, Trigeminal Nerve and Branches, Cervical Plexus, Glossopharyngeal, Superior Laryngeal, Transtracheal, Occipital
- c) Extremities: Brachial Plexus (Interscalene, Supraclavicular, Infraclavicular, Axillary), Ulnar, Radial, Median, Musculocutaneous, Sciatic, Femoral, Lateral Femoral Cutaneous, Obturator, Lumbar Plexus (PSOAS Block), Popliteal Fossa, Ankle Block
- d) Trunk: Intercostal, Paravertebral Somatic, Ilio-Inguinal, Genito-Femoral
- e) Spine: Epidural (Cervical, Thoracic, Lumbar, Caudal, Transforaminal), Spinal (Subarachnoid), Combined Spinal-Epidural, Facet

c. Pharmacology

1) CNS Drugs for Non-Anesthetic Use (Major Actions, Comparison of Drugs; Effect on Respiration; Circulation, Adverse Effects)

- a) Pre- and Postanesthetic Medications
 - (1) Opioids
 - (2) Opioid Antagonists, Agonist-Antagonists
- b) Alpha-2 Agonists: Clonidine, Dexmedetomidine
- c) Tranquilizers: Butyrophenones; Benzodiazepines
- d) Anticonvulsants: Phenytoin, Carbamazepine, Gabapentin, Barbiturates, Others
- e) Antidepressants, Anti-Parkinson Drugs
- f) Arousal Agents: Physostigmine, Benzodiazepine Antagonists
- g) Antiemetics and Aspiration Prophylaxis: Phenothiazines; Butyrophenones; Metoclopramide; Anticholinergics; Serotonin Antagonists, Antihistamines (H1 Blockers, H2 Blockers, Mixed Blockers), Antacids, Proton Pump Inhibitors
- h) Substance Abuse and Addiction; Dependence
 - (1) Chronic Opioid Dependence and Therapy
 - (2) Pharmacologically-Assisted Opioid withdrawal

2) Autonomic Drugs

- a) Sympathetic

- (1) Transmitters and Types of Receptors
- (2) Target Organ Effects; Metabolic Effects
- (3) Agonists: Peripheral and Central Actions, Direct and Indirect Actions, Alpha vs. Beta vs. Mixed Agonists, Alpha and Beta-Receptor Subtype-Selective Agonists
- (4) Antagonists: Alpha and Beta Blockers, Selective Blockers, Ganglionic Blockers
- (5) Tocolytic Applications

b) Parasympathetic

- (1) Transmitters
- (2) Muscarinic Effects
- (3) Nicotinic Effects
- (4) Agonists: Cholinergic and Anticholinesterases
- (5) Antagonists

d. Clinical Science

1) Central Nervous System

a) Seizures

b) Coma: Traumatic, Infectious, Toxic-Metabolic, Cerebrovascular Accident (CVA), Cerebral Hypoxia

- (1) Glasgow Coma Scale, Management of Traumatic Brain Injury
- (2) Therapeutic Barbiturate Coma

c) Drug Intoxication (CNS Drugs, Carbon Monoxide, Insecticides, Nerve Gases)

d) Paraplegia, Quadriplegia, Spinal Shock, Autonomic Hyperreflexia

- (1) Airway Management in the Patient with Cervical Spine Disease

e) Tetanus

f) Special Problems of Anesthesia for Neurosurgery

- (1) Increased Intracranial Pressure: Tumors, Hematomas, Hydrocephalus
- (2) Positioning: Prone, Sitting, Other, Head Stabilization in Tongs
- (3) Air Embolism
- (4) Cerebral Protection from Hypoxia, Ischemia, Glucose Effects
- (5) Aneurysms and A-V Malformations, Cerebral Vasospasm
- (6) Interventional Neuroradiology; Coils and Embolization
- (7) Pituitary Adenomas, Trans-Sphenoidal Hypophysectomy
- (8) Anesthetic and Ventilatory Effects on Cerebral Blood Flow and Metabolism
- (9) Fluid Management: Hypertonic Vs Isotonic Saline vs. Balanced Salt Solutions

(10) Spinal Fluid Drainage

(11) Stereotactic and Gamma-Knife Techniques, Deep Brain Stimulator Placement, Intra-Operative Wake-Up Techniques

(12) Ventriculostomy

(13) Awake Craniotomy

2. Respiratory System

a. Physiology: Lung Functions and Cellular Processes

1) Ventilation - Perfusion

a) Measurement of Ventilation/Perfusion (V/Q) Ratio, Implications of Alveolar-Arterial O₂ Gradient (A-aDO₂), Arterial-Alveolar CO₂ Gradient (A-aDCO₂), Dead Space to Tidal Volume Ratio (V_d/V_t), Shunt Fraction (Q_s/Q_t), Lung Scan

b. Anatomy

1) Lungs

a) Divisions and Bronchoscopic Anatomy

b) Bronchial and Pulmonary Circulations

c) Microscopic Anatomy

c. Biochemistry

1) Normal Acid-Base Regulation: Buffer Systems; Compensatory Mechanisms;

2) Effects of Imbalance on Electrolytes and Organ Perfusion;

3) Strong Ionic Difference (SID);

4) ABG Interpretation;

a) Anion Gap;

b) Temperature Effect on Blood Gases: Alpha-Stat vs. pH-Stat

d. Clinical Science

1) Respiratory System

a) Obstructive Disease

(1) Upper Airway: Congenital, Infectious, Neoplastic, Traumatic, Foreign Body, Obstructive Sleep Apnea

(2) Tracheobronchial: Congenital, Infectious, Neoplastic, Traumatic, Foreign Body

(3) Parenchymal: Asthma, Bronchitis, Emphysema, COPD, Lung Abscess, Bronchiectasis, Cystic Fibrosis, Mediastinal Masses

b) Restrictive Disease

(1) Neurologic: CNS Depression, Spinal Cord Dysfunction, Peripheral Nervous System

(2) Musculoskeletal: Muscular, Skeletal, Obesity, Chest Trauma

- (3) Parenchymal: Atelectasis, Pneumonia, Interstitial Pneumonitis, Pulmonary Fibrosis, Respiratory Distress Syndrome (ARDS), Bronchopulmonary Dysplasia
- (4) Pleural and Mediastinal: Pneumo-, Hemo-, and Chylothorax, Pleural Effusion, Empyema, Bronchopleural Fistula
- (5) Other: Pain, Abdominal Distention

c) Management of the Patient with Respiratory Disease

- (1) Evaluation: History and Physical Examination, Chest X-Ray, Arterial Blood Gases (ABGs), Pulmonary Function Tests (PFTs); Assessment of Perioperative Risk
- (2) Anesthetic Management
 - (a) Preoperative Preparation: Respiratory Therapy, Drug Therapy (Antibiotics, Bronchodilators, Mucolytics, Steroids), Tobacco Smoking Cessation (Techniques to Assist Patients, Benefits)
 - (b) Intraoperative Management
 - (1) Monitoring
 - (2) Choice of Anesthesia
 - (3) Anesthetic Techniques: Nonpulmonary Surgery, Thoracic and Pulmonary Surgery, One-Lung Ventilation, Thoracoscopic Techniques, Lung Transplantation, Mediastinoscopy
 - (c) Postoperative Care: Pain Management, Respiratory Therapy, Ventilator Support, Extubation Criteria
- (3) Management of Respiratory Failure
 - (a) Nonventilatory Respiratory Management: O₂ Therapy and Toxicity, Tracheobronchial Toilet, Positive Airway Pressure, Respiratory Drugs
 - (b) Ventilatory Management
 - (1) Criteria for Ventilatory Commitment and Weaning
 - (2) Mode of Ventilation: Conventional Mechanical Ventilation, Peep, CPAP, IMV, SIMV, Pressure Support, Pressure Control, High Frequency Ventilation (Positive Pressure, Jet, Oscillation), Prone Ventilation, BIPAP, Airway Pressure-Release Ventilation
 - (3) Complications and Side Effects of Mechanical Ventilation: Volutrauma, Barotrauma, Biotrauma
 - (4) Management of Bronchospasm: Bronchodilator Drugs, Anti-Inflammatory Drugs, Acute and Chronic Management, Perioperative Management
 - (c) Other Management Adjuncts: Nitric Oxide, Steroids
 - (d) Lung Transplantation: Anesthetic Implications

3. Cardiovascular System

a. Normal Anatomy of Heart and Major Vessels

- 1) Echocardiographic Heart Anatomy: Chambers, Valves, Great Vessels, Pericardium, Basic Transesophageal Echocardiography (TEE) Views
- 2) Radiographic: Roentgenograms, CT, MRI
- 3) Other

b. Clinical Sciences

1) Ischemic Heart Disease

- a) Risk Factors; Predictors of Perioperative Risk, Modification of Perioperative Risk (e.g., Prophylactic Beta-Blockers)
- b) Manifestations
- c) Diagnosis of Myocardial Infarction and Acute Coronary Syndrome; Clinical, ECG, Enzymes, Echocardiography, Nuclear Techniques,
- d) Classification of types of MI (STEMI vs. demand)
- e) Pharmacological Treatment of Angina, Thoracic Epidural for Angina, Interventional Cardiology Techniques
- f) Determinants of Myocardial Oxygen Requirements and Delivery, Silent Ischemia, Postoperative Ischemia
- g) Perioperative Diagnosis and Treatment of Ischemia; ECG, TEE
- h) Coronary Artery Bypass Procedures; Cardiopulmonary Bypass; of F-Pump Techniques

2) Valvular Heart Disease

- a) Classification
- b) Diagnosis (Including Echocardiography), Natural History, Surgical Management
- c) Anesthetic Considerations
- d) Subacute Bacterial Endocarditis Prophylaxis

3) Rhythm Disorders and Conduction Defects

- a) Chronic Abnormalities: Etiology, Diagnosis, Therapy
 - (1) Automated Implantable Cardioverter/Defibrillator (AICD) Implantation
 - (2) Pacemakers: Permanent, Temporary, Transvenous, Transcutaneous; Ventricular Synchronization
 - (3) Ablations, Cryotherapy, Maze Procedure
- b) Perioperative Dysrhythmia: Etiology, Diagnosis, Therapy
- c) Perioperative Implications of Pacemaker and AICD

4) Heart Failure and Cardiomyopathy (Ischemic, Viral, Hypertrophic)

- a) Definition and Functional Classification, Perioperative Diagnosis and Treatment
- b) Compensatory Responses
- c) Right or Left Ventricular Dysfunction

- (1) Etiology
- (2) Signs and Symptoms
- (3) Diagnostic Tests
- (4) Systolic vs. Diastolic Dysfunction
- d) Treatment
 - (1) Pulmonary Edema
 - (2) Pulmonary Hypertension
 - (3) Cardiogenic Shock
- e) Cardiac Transplantation
- 5) Cardiac Tamponade and Constrictive Pericarditis
 - a) Etiology
 - b) Diagnosis; TEE, PA Catheter
 - c) Anesthetic Management
- 6) Circulatory Assist
 - a) Cardiopulmonary Bypass
 - (1) Components (Pump, Oxygenator, Heat Exchanger, Filters)
 - (2) Cardiopulmonary Bypass Techniques
 - (3) Mechanisms of Gas Exchange
 - (4) Priming Solutions, Hemodilution
 - (5) Anticoagulation and Antagonism; Activated Clotting Time (ACT) and Other Clotting Times, Heparin Assays, Antithrombin III, Protamine Reactions, Heparin and Protamine Alternatives
 - (6) Prophylaxis with Aminocaproic Acid, Tranexamic Acid
 - (7) Anesthetic Considerations During Bypass
 - (8) Extracorporeal Membrane Oxygenation (ECMO)
 - (9) Cooling and Warming, Deep Hypothermic Circulatory Arrest
 - (10) Monitoring, Blood Pressure Management
 - (11) Minimally Invasive Bypass Techniques
 - (12) Myocardial Preservation: Physiology, Techniques, Complications
 - (13) Preconditioning
 - b) Minimal Invasive Cardiac Surgery
 - (1) Off-pump coronary artery bypass (OPCAB)
 - (2) Minimally invasive direct coronary artery bypass (MIDCAB)
 - (3) Percutaneous valve repair/replacement
 - c) Intraaortic Balloon: Rationale, Indications, Limitations

d) Ventricular Assist Devices and Artificial Heart: Internal and External

7) Pulmonary Embolism

a) Etiology: Blood, Air, Fat, Amniotic Fluid

b) Diagnosis, TEE Findings

c) Treatment; Acute, Preventive

8) Hypertension

a) Etiology, Pathophysiology, Course of Disease

b) Drug Treatment, Interactions with Anesthetics, Risk of Anesthesia

c) Intra or Postoperative Hypertension; Differential Diagnosis and Treatment

9) Shock States: Anesthetic Management of Patient in Shock

10) Vascular Diseases

a) Cerebral Circulation; Luxury Perfusion, Steals, Infarcts, Intracranial Hemorrhage

b) Carotid Endarterectomy: Anesthetic Management, Monitoring of Cerebral Perfusion, Complications

c) Abdominal Aneurysm Resection: Anesthetic Management

d) Peripheral Arteriosclerotic Disease

e) Aneurysms of Ascending, Descending and Arch of Aorta, Thoracoabdominal Aneurysms, Including Endovascular Repair Techniques

11) Cardiopulmonary Resuscitation

a) Recognition

b) Management - Drugs, Defibrillators, Monitors, Advanced Cardiac Life Support (ACLS) Algorithms

c) Complications and Outcomes of Therapy

d) Pediatric/Adult Differences

4. Gastrointestinal / Hepatic Systems

a. Biochemistry: Nutrition

1) Parenteral: Peripheral Or Central Vein, Hyperalimentation, Solutions Used and Complications, Anesthetic Implications

2) Enteral: GI Elemental Diets, Routes of Delivery, Complications, Anesthetic Implications

b. Clinical Science

1) Morbid Obesity/Anesthesia for Bariatric Surgery

a) Pre-Anesthetic Evaluation and Management

b) Pharmacologic Considerations

c) Anesthetic Management (Airway, Ventilation, Monitoring, Venous Access)

d) Postoperative Management (Ventilation, Analgesia)

2) Hepatic Disease

- a) Preoperative Laboratory Assessment
 - b) Anesthesia Choice (Hepatocellular Disease, Ascites, Portal Hypertension)
 - c) Postoperative Hepatic Dysfunction, Hepatic Failure, Hepatorenal Syndrome
 - d) Hepatic Transplantation
- 3) Intestinal Obstruction
- a) Causes; Paralytic Ileus; Mechanical; Vascular
 - b) Physiological Changes; Fluid and Electrolyte; Respiratory
 - c) Anesthesia Management: Full Stomach; Fluid Therapy; Nitrous Oxide
5. Renal and Urinary Systems/ Electrolyte Balance: Clinical Science
- a. Renal Disease
 - 1) Pathophysiology of Renal Disease; Risk Factors for Acute Renal Failure
 - 2) Anesthetic Choice in Reduced Renal Function
 - 3) Anesthetic Management in Renal Failure, Arteriovenous (A-V) Shunts
 - 4) Anesthetic Management in Renal Transplantation
 - 5) Perioperative Oliguria and Anuria
 - 6) Dialysis and Hemofiltration: Hemodialysis, Peritoneal Dialysis, Continuous Hemofiltration (Arteriovenous, Venovenous)
 - 7) Pharmacologic Prevention and Treatment of Renal Failure
 - b. Urologic Surgery - Lithotripsy, Transurethral Resection of Prostate (TURP)/Irrigating Fluids/Hyponatremia
 - c. Perioperative Electrolyte Abnormalities
6. Hematologic System
- a. Clinical Science
 - 1) Hematologic Disorders
 - a) Diseases of Blood
 - (1) Anemias; Compensatory Mechanisms
 - (2) Polycythemias; Primary vs. Secondary
 - (3) Clotting Disorders
 - (a) Thrombocytopenia and Thrombocytopeny
 - (b) Congenital and Acquired Factor Deficiencies
 - (c) Disseminated Intravascular Coagulation
 - (d) Fibrinolysis
 - (e) Pharmacologic: Anticoagulants and Antagonists
 - (f) Coagulopathy in Trauma Patients
 - (4) Hemoglobinopathies, Porphyrrias
 - b) Massive Transfusion Protocol

7. Endocrine and Metabolic Systems: Clinical Science

a. Pituitary Disease

1) Hypopituitarism, Pituitary Removal - Substitution Therapy

- a) Panhypopituitarism
- b) Diabetes Insipidus

2) Hyperpituitarism

- a) Acromegaly, Including Airway Management
- b) Inappropriate ADH Secretion

b. Thyroid Disease

1) Hyperthyroidism

- a) Metabolic and Circulatory Effects
- b) Anesthetic Management
- c) Thyroid Storm

2) Hypothyroidism

- a) Metabolic and Circulatory Effects, Myxedema Coma
- b) Substitution Therapy
- c) Anesthetic Implications

3) Complications of Surgery: Hypocalcemia, Recurrent Laryngeal Nerve Injury, Diagnosis and Treatment

c. Parathyroid Disease

1) Hyperparathyroidism; Physiological Effects

2) Hypoparathyroidism; Postoperative Manifestations and Treatment

d. Adrenal Disease

1) Cushing's Syndrome

2) Primary Aldosteronism

3) Addison's Disease

4) Pheochromocytoma

- a) Circulatory and Metabolic Manifestations
- b) Diagnosis
- c) Anesthetic Management

e. Carcinoid Syndrome

f. Diabetes Mellitus

1) Pathophysiology

2) Control of Blood Glucose - Hypoglycemia; Hyperglycemia and Ketoacidosis

3) Elective Anesthesia - Perioperative Management

- 4) Emergency Anesthesia
- 5) Hyperosmolar Coma
- 6) Pancreas Transplantation

8. Neuromuscular Diseases and Disorders: Clinical Science

a. Demyelinating Diseases

- 1) Multiple Sclerosis
- 2) Motor Neuron Diseases: Amyotrophic Lateral Sclerosis, Spinobulbar Muscular Atrophy, Hereditary Spastic Paraplegia
- 3) Guillain-Barre Syndrome
- 4) Charcot-Marie-Tooth Disease

b. Primary Muscle Diseases

- 1) Muscular Dystrophies: Duchenne's, Becker's, Limb-Girdle, Congenital, Myotonic
- 2) Mitochondrial Myopathies

c. Channelopathies

d. Myasthenic Syndromes

- 1) Myasthenia Gravis
- 2) Lambert-Eaton Myasthenic Syndrome
- 3) Congenital Myasthenic Syndromes

e. Ion Channel Myotonias

- 1) Acquired Neuromyotonia
- 2) Myotonia Congenita
- 3) Hyperkalemic Periodic Paralysis, Paramyotonia Congenita, Postassium-Aggravated Myotonia
- 4) Hypokalemic Periodic Paralysis

D. Clinical Subspecialties

1. Painful Disease States

a. Pathophysiology

- 1) Acute Pain
- 2) Cancer-Related Pain
- 3) Chronic Pain States
 - a) Acute and Chronic Neck and Low Back Pain
 - b) Neuropathic Pain States
 - (1) Complex Regional Pain Syndrome, Types I and II
 - (2) Postherpetic Neuralgia
 - (3) Phantom Limb, Post-Stroke
 - (4) Peripheral Neuropathies (e.g., Diabetic Neuropathy)

c) Somatic Pain Conditions: Myofascial Pain, Facet Arthropathy, etc.

b. Treatment

1) Acute Postoperative and Posttraumatic Pain

a) Postoperative Epidural Analgesia

b) Neuraxial Opioids

c) Peripheral Nerve Blockade and Catheters

d) Patient-Controlled Analgesia

e) Other Modalities, Multimodal Analgesia (Nonsteroidal Analgesics, Electrical Stimulation, Acupuncture, Ketamine, etc.)

2) Cancer-Related Pain

a) Systemic Medications, Tolerance and Addiction

b) Continuous Spinal and Epidural Analgesia

c) Neurolytic and Non-Neurolytic Blocks

d) World Health Organization Analgesic Ladder

3) Chronic Pain (Non-Cancer-Related)

a) Systemic Medications: Nonsteroidal Anti-Inflammatory Drugs (NSAIDs), Opioid Analgesics, Anticonvulsants, Antidepressants

b) Spinal and Epidural Analgesia

c) Peripheral Nerve Blocks

d) Sympathetic Nerve Blocks

e) Other Techniques: TENS, Spinal Cord Stimulation, Neuroablation (Surgical and Chemical Neurolysis)

2. Pediatric Anesthesia

a. Apparatus: Breathing Circuits (Advantages/Disadvantages, Dead Space, Etc.), Humidity, Thermal Control

1) Endotracheal Tube Selection (Cuffed vs. Uncuffed) and Sizing

2) Warming Devices: Types, Efficacy, Complications

b. Premedication: Drugs; Dosage; Routes; Vehicles, Including Topical Anesthetics; Parental Presence

c. Agents and Techniques

1) Induction Techniques

2) Anesthetics: Actions Different From Adults

a) Drug Toxicities Preferentially Occurring in Children: e.g., Propofol

b) Opioid Dosing and Sensitivity

c) Neuromuscular Blockers (Sensitivity, Congenital Diseases, Complications of Succinylcholine, Age-Related and Drug-Related Pharmacodynamics and Pharmacokinetics)

- d) Regional Anesthesia
- d. Fluid Therapy and Blood Replacement, Physiologic Anemia, Glucose Requirements
- e. Problems in Intubation and Extubation (Full Stomach, Diaphragmatic Hernia, Tracheo Esophageal (T-E) Fistula, Pierre-Robin, Treacher-Collins, Crouzon's, Goldenhar's, Hurler's, Awake/Fiberoptic Intubation, Dentition, Laryngospasm, Stridor)
- f. Neonatal Physiology
 - 1) Respiratory
 - a) Development, Anatomy, Surfactant
 - b) Pulmonary Oxygen Toxicity
 - c) Pulmonary Function
 - d) Lung Volumes vs. Adult
 - e) Airway Differences, Infant vs. Adult
 - 2) Cardiovascular
 - a) Transition, Fetal to Adult
 - b) Persistent Fetal Circulation
 - 3) Retinopathy of Prematurity: Anesthetic Implications
 - 4) Metabolism, Fluid Distribution and Renal Function
 - 5) Thermal Regulation (Neutral Temperature, Nonshivering Thermogenesis)
 - 6) Fetal Hemoglobin
 - 7) Prematurity, Apnea of Prematurity
 - 8) Bronchopulmonary Dysplasia
- g. Congenital Heart and Major Vascular Disease
 - 1) Cyanotic Defects
 - 2) Acyanotic Defects
 - 3) Primary Pulmonary Hypertension
 - 4) Major Vascular Malformations: Coarctation, Persistent Patent Ductus Arteriosus, Vascular Rings.
 - 5) Altered Uptake/Distribution of IV and Inhalation Anesthetics
 - 6) Anesthetic Considerations
 - a) Cardiac Surgery; Corrective and Palliative
 - b) Noncardiac Surgery
 - c) Chronic Congenital Heart Disease, Corrected, Uncorrected, and Palliated
 - (1) In Childhood Beyond the Newborn and Infant Periods
 - (2) In Adulthood
- h. Emergencies in the Newborn
 - 1) Diaphragmatic Hernia

- 2) Tracheoesophageal Fistula and Esophageal Atresia
- 3) Neonatal Lobar Emphysema
- 4) Pyloric Stenosis
- 5) Necrotizing Enterocolitis
- 6) Omphalocele/Gastroschisis
- 7) Respiratory Distress Syndrome: Etiology, Management, Ventilation Techniques
- 8) Myelomeningocele

i. Pediatric Medical Problems with Anesthetic Implications

- 1) Respiratory: Upper Respiratory Infections (Colds, Epiglottitis, Laryngotracheobronchitis), Bronchopulmonary Dysplasia, Cystic Fibrosis
- 2) Musculoskeletal: Muscular Dystrophies, Myotonias, Etc.
- 3) Developmental Delay, Cerebral Palsy, Autism
- 4) Childhood Obesity
- 5) Endocrine Diseases: Childhood Diabetes, Congenital Adrenal Hyperplasia, Etc.
- 6) Skeletal Abnormalities with Or without Systemic Implications: Klippel-Feil, Achondroplasia, Marfan's, Morquio's, Osteogenesis Imperfect
- 7) Trisomy 21 and Other Chromosomal Abnormalities
- 8) Juvenile Rheumatoid Arthritis
- 9) Anemias: Congenital and Acquired: Iron Deficiency, Physiologic Anemia, Sickle Cell, Thalassemia, Etc.
- 10) Malignant Hyperthermia in Children; Susceptibility, Associated Diseases, Anesthetic Management of MH Susceptibility, Intraoperative Diagnosis, Treatment

j. Anesthetic Implications for Common Non-Neonatal Pediatric Subspecialty Surgery

- 1) Otolaryngology: Cleft Lip and Palate, Tonsillectomy and Adenoidectomy, Common Ear Procedures, Peritonsillar Abscess, Flexible and Rigid Bronchoscopy, Diagnostic and Therapeutic Laryngoscopy Techniques (Jet Ventilation, Laser Implications), Airway Foreign Bodies
- 2) Neurosurgery: Craniotomies for Tumor Or Vascular Malformations, Hydrocephalus, Ventriculoperitoneal Shunts, Craniofacial Procedures, Tethered Spinal Cord, Halo Placement Implications
- 3) Thoracic Surgery: Anterior Mediastinal Mass, Lung Isolation Techniques, Pectus Excavatum and Carinatum
- 4) General and Urologic Surgery: Laparotomy vs Laparoscopy, Bowel Surgery, Urologic Surgery (Wilms Tumor, Ureteral Reimplantation, Bladder and Urethral Malformations, Neuroblastoma)
- 5) Orthopedic Surgery: Fractures and Dislocations, Congenital Hip Dysplasia, Foot and Hand Malformations; Scoliosis Implications and Repair
- 6) Ophthalmologic: Strabismus, Cataract, Glaucoma Procedures, Etc.

k. Outpatient Pediatric Anesthesia

- 1) Indications and Contraindications
- 2) Anesthetic Considerations: Premedication, Induction, Maintenance, Monitoring
- 3) Postoperative Considerations: Recovery Period, Discharge Criteria, Post-Discharge Monitoring/Follow-Up

l. Postoperative Analgesia

- 1) Systemic Medications and Routes of Administration, Multimodal Therapy
- 2) Regional Techniques: Caudal, Epidural, Nerve Blocks

m. Postoperative Nausea and Vomiting: Risk Factors, Prophylaxis, Treatment

n. Pediatric Sedation: Guidelines, Pharmacology, Credentialing, Indications, Monitoring, Complications

o. Pediatric Anesthesia Outside the Operating Rooms: Diagnostic and Interventional Radiologic Procedures, Gastroenterology Laboratory, MRIs, Radiation Therapy

3. Obstetric Anesthesia

a. Maternal Physiology

- 1) Effects of Pregnancy on Uptake and Distribution
- 2) Respiratory (Anatomy, Lung Volumes and Capacities, Oxygen Consumption, Ventilation, Blood Gases, Acid Base)
- 3) Cardiovascular (Aorto-Caval Compression, Regulation of Uterine Blood Flow)
- 4) Renal
- 5) Liver (Albumin/Globulin Ratio, Protein Binding of Drugs)
- 6) Gastrointestinal (Gastric Acid, Motility, Anatomic Position, Gastroesophageal Sphincter Function)
- 7) Hematology (Blood Volume, Plasma Proteins, Coagulation)
- 8) Placenta
 - a) Placental Exchange - O₂, CO₂
 - b) Placental Blood Flow
 - c) Barrier Function

b. Maternal-Fetal Considerations

- 1) Pharmacology
 - a) Anesthetic Drugs and Adjuvants
 - b) Oxytocic Drugs (Indications, Adverse Effects)
 - c) Tocolytic Drugs (Indications, Adverse Effects)
 - d) Antiseizure Drugs; Interactions (Magnesium Sulfate)
 - e) Mechanisms of Placental Transfer, Placental Transfer of Specific Drugs
 - f) Fetal Disposition of Drugs

- g) Drug Effects on Newborn
- 2) Amniotic Fluid (Amniocentesis, Oligohydramnios, Polyhydramnios)
- 3) Antepartum Fetal Assessment and Therapy (Ultrasonography, FHR Monitoring, Nonstress Test, Stress Test, Biophysical Profile)
- 4) Anesthetic Techniques and Risks (Elective vs. Emergency, General vs. Regional)
 - a) Systemic Medications: Opioids, Sedatives, Inhalational Agents
 - b) Regional Techniques
 - (1) Epidural, Caudal, Spinal, Combined Spinal/Epidural
 - (2) Paracervical Block, Lumbar Sympathetic Block, Pudendal Block
 - c) Complications (Aspiration, Nerve Palsies)
- 5) Physiology of Labor (Metabolism, Respiration, Cardiovascular, Thermoregulation)
- 6) Influence of Anesthetic Technique on Labor
- 7) Cesarean Delivery: Indications, Urgent/Emergent, Anesthetic Techniques and Complications, Difficult Airway, Aspiration Prophylaxis
- c. Pathophysiology of Complicated Pregnancy
 - 1) Problems During Pregnancy and Delivery
 - a) Anesthesia for Cerclage or Non-Obstetric Surgery
 - b) Ectopic Pregnancy
 - c) Spontaneous Abortion
 - d) Gestational Trophoblastic Disease (Hydatid Mole)
 - e) Autoimmune Disorders (Lupus, Antiphospholipid Syndrome)
 - f) Endocrine (Thyroid, Diabetes, Pheochromocytoma)
 - g) Heart Disease (Valvular Disorders, Pulmonary Hypertension, Congenital Heart Disease, Arrhythmias, Cardiomyopathy)
 - h) Hematologic (Sickle Cell Anemia, Idiopathic Thrombocytopenic Purpura, Von Willebrand Disease, Disseminated Intravascular Coagulation (DIC), Anticoagulant Therapy, Rh and ABO Incompatibility)
 - i) Hypertension (Chronic, Pregnancy-Induced)
 - j) Neurologic (Seizures, Myasthenia, Spinal Cord Injury, Multiple Sclerosis, Subarachnoid Hemorrhage)
 - k) Respiratory (Asthma, Respiratory Failure)
 - l) Renal
 - m) Human Immunodeficiency Virus Infection
 - 2) Problems of Term and Delivery
 - a) Intrapartum Fetal Assessment (Fetal Heart Rate Monitoring, Fetal Scalp Blood Gases, Fetal Pulse Oximetry)
 - b) Preeclampsia and Eclampsia

- c) Supine Hypotensive Syndrome
 - d) Aspiration of Gastric Contents
 - e) Embolic Disorders (Amniotic Fluid Embolism, Pulmonary Thromboembolism)
 - f) Antepartum Hemorrhage (Placenta Previa, Abruptio Placenta, Uterine Rupture)
 - g) Postpartum Hemorrhage (Uterine Atony, Placenta Accreta)
 - h) Cord Prolapse
 - i) Retained Placenta
 - j) Dystocia, Malposition, and Malpresentation (Breech, Transverse Lie)
 - k) Maternal Cardiopulmonary Resuscitation
 - l) Fever and Infection
 - m) Preterm Labor
 - n) Vaginal Birth After Cesarean Section (VBAC)
 - o) Multiple Gestation
- 3) Resuscitation of Newborn
- a) Apgar Scoring
 - b) Umbilical Cord Blood Gas Measurements
 - c) Techniques and Pharmacology of Resuscitation
 - d) Intrauterine Surgery (Maternal and Fetal Considerations, Intrauterine Fetal Resuscitation)
4. Otorhinolaryngology (ENT) Anesthesia: Airway Endoscopy; Microlaryngeal Surgery; Laser Surgery, Hazards, Complications (Airway Fires, Etc.)
5. Anesthesia for Plastic Surgery, Liposuction
6. Anesthesia for Laparoscopic Surgery; Cholecystectomy; Gynecologic Surgery; Gastric Stapling; Hiatus Hernia Repair; Anesthetic Management; Complications
7. Ophthalmologic Anesthesia, Retrobulbar and Peribulbar Blocks; Open Eye Injuries
8. Orthopedic Anesthesia; Tourniquet Management, Complications, Regional Vs. General Anesthesia
9. Trauma Anesthesia
- a. Massive Trauma
 - 1) Evaluation of the Trauma Patient
 - 2) Hemorrhagic Shock
 - b. Burn Management
 - c. Mass Casualty
 - 1) Crisis Management and Teamwork
 - d. Biological Warfare

II.D

- 10. Anesthesia for Ambulatory Surgery
 - a. Patient Selection and Preoperative Management
 - b. Anesthetic Management
 - c. Discharge Criteria and Postoperative Follow-Up, Including Continuous Nerve Blocks
 - d. Office-Based Anesthesia: Equipment, Safety, Organization, Patient Management

11. Geriatric Anesthesia / Aging

- a. Pharmacological Implications, MAC Changes
- b. Physiological Implications: CNS, Circulatory, Respiratory, Renal, Hepatic

12. Critical Care

a. Shock States

- 1) Etiology, Classification, Pathophysiology
- 2) Septic Shock and Life-Threatening Infection
- 3) Systemic Inflammatory Response Syndrome
- 4) Multiple Organ Dysfunction Syndrome

b. Poisoning and Drug Overdose

c. Near-Drowning

d. Infection Control

- 1) General and Universal Precautions
- 2) Needle Stick Injury
- 3) Catheter Sepsis
- 4) Nosocomial Infections
- 5) Antibiotics: Antibacterial, Antifungal, Antiviral, Antiparasitic; Antimicrobial Resistance

e. Ventilator Management

- 1) Volume Controlled; Pressure Controlled; PEEP, Inspired Oxygen Concentration; Tidal Volume
- 2) Pressure Support; Weaning

E. Special Problems or Issues in Anesthesiology

- 1. Electroconvulsive Therapy
- 2. Organ Donors: Pathophysiology and Clinical Management
- 3. Radiologic Procedures; CT Scan; MRI-Anesthetic Implications/Management, Anesthesia in Locations Outside the Operating Rooms
- 4. Ethics, Practice Management, and Medicolegal Issues
 - a. Professionalism and Credentialing, Licensure
 - b. Ethics, Advance Directives/Do Not Resuscitate (DNR) Orders; Patient Privacy Issues, e.g., Health Insurance Portability and Accountability Act (HIPAA)

- II.E.4
- c. Malpractice: Definition, Legal Actions and Consequences, National Practitioner Database, Closed Claims Findings, Anesthetic Accidents, Professional Liability Insurance
 - d. Practice Management; Medicare/Medicaid Requirements
 - e. Primary Certification, Recertification, Maintenance of Certification and Related Issues (Professional Standing, Lifelong Learning, Cognitive Knowledge, Clinical Practice Assessment, Systems-Based Practice)
 - f. Costs of Medical/Anesthesia Care, Operating Room Management
 - g. Patient Safety
 - 1) Definitions: Medical Error, Adverse Event, Sentinel Event
 - 2) Medication Errors: Assessment and Prevention
 - 3) Reporting: Mandatory and Voluntary Systems, Legal Requirements
 - 4) Disclosure of Errors to Patients
 - 5) Safety Practices: Process-Based, Evidence-Based
 - 6) Root Cause Analysis
 - h. Quality Improvement
 - 1) Quality Improvement Basics: Design, Analysis, Implementation of Quality Improvement Project
 - a) Anesthesia Quality Institute; Data Entry; Information
 - b) Lean Six Sigma; Assessing QI Methods; Approach
 - c) Physician Quality Reporting System: Significance and Role in Practice
 - d) Barriers to Quality Improvement