

ADULT CARDIAC ANESTHESIOLOGY EXAMINATION

Content Outline April 2022

The Adult Cardiac Anesthesiology (ACA) Content Outline identifies the key topic areas that are assessed on the Adult Cardiac Anesthesiology Subspecialty Certification Examination. While individual practices may vary with respect to patient populations and management roles, this examination reflects core concepts in adult cardiac anesthesiology that each candidate is expected to understand.

The Content Outline is divided into 9 sections, including Foundations (e.g. anatomy and physiology), Cardiothoracic diseases, Pharmacodynamics, and additional specialized areas. The examination includes items from each of the 9 content areas, though is more heavily weighted to clinical diseases and management. Specialized areas include devices and their management (e.g. cardiopulmonary bypass), specific pathophysiological states (e.g. valvular heart disease), and other topics related to patient populations cared for by adult cardiac anesthesiologists.

The Content Outline is designed to serve as a resource for individuals preparing for the ACA subspecialty certification examination.



ADULT CARDIAC ANESTHESIOLOGY CONTENT OUTLINE

- A. Foundations of Adult Cardiac Anesthesiology
 - 1. Anatomy
 - a. Embryological Development
 - a. Echocardiographic Anatomy: Chambers, Valves, Great Vessels, Pericardium
 - b. Coronary circulation
 - c. Heart conduction
 - d. Anatomical landmarks for regional anesthesia (e.g. PECS or ESP blocks)
 - 2. Physiology
 - a. Electrophysiology: Ion channels and currents
 - b. Synchronicity of Pressure, flow, ECG, Valvular function
 - c. Ventricular Function
 - i. Myocardial Contractility
 - i. Cardiac Output
 - 1. Measurements (e.g. PA, TEE, Fick Principle)
 - ii. Myocardial Oxygen utilization
 - d. Regulation of Circulation and Blood volume
 - i. Venous Return
 - 1. Vascular compliance/venous capacitance
 - 2. Blood volume and distribution
 - ii. Central
 - 1. Vasomotor Center/Hypothalamic-Pituitary-Adrenal Axis
 - 2. Peripheral: Receptors and Reflexes
 - e. Blood Pressure
 - i. Systolic, Diastolic, Mean and Perfusion pressures
 - ii. Systemic and Pulmonary Vascular Resistance
 - iii. Baroreceptor Function
- B. Cardiothoracic Diseases (Pathophysiology, Pharmacology, and Clinical Management)
 - 1. Cardiac disease
 - a. Cardiomyopathy
 - i. Types
 - 1. Dilated
 - 2. Ischemic v. non-ischemic
 - 3. Hypertrophic
 - 4. Restrictive
 - 5. Arrhythmogenic Right Ventricular Dysplasia
 - 6. Viral
 - 7. Others (e.g. idiopathic, peripartum)
 - ii. Diagnosis
 - 1. TEE
 - 2. Stress tests
 - 3. Cardiac Catheterization
 - 4. Cardiac MRI/CT
 - iii. Medical/Interventional management
 - 1. Pharmacological interventions
 - 2. Cardiac resynchronization therapy/Pacer support
 - iv. Surgical interventions
 - 1. Septal ablation/myomectomy
 - 2. Mechanical Circulatory Support

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3. Transplant
- b. Heart Failure
 - i. Systolic (Heart Failure with Reduced Ejection Fraction)
 1. Etiology
 2. Diagnostic Tests
 - ii. Diastolic (Heart Failure with Preserved Ejection Fraction)
 1. Etiology
 2. Diagnostic Tests
 - iii. Acute vs. Chronic
 - iv. Medical/Interventional Management
 1. Pharmacological Interventions
 - a. Acute
 - b. Chronic
 2. Cardiac Resynchronization Therapy (e.g., indications)
 3. Implantable cardioverter defibrillators
 - v. Surgical interventions
 1. Indications for:
 - a. Revascularization/valvular surgery
 - b. Mechanical Circulatory Support (e.g. IABP, VAD, etc)
 - c. Heart transplant
- c. Cardiac Tamponade
 - i. Etiology
 - ii. Diagnosis: POCUS, TEE, CVP, PAC, CXR
 - iii. Anesthetic Management and Goals
 - iv. Management
 1. Pericardiocentesis
 2. Pericardial window
- d. Ischemic heart disease
 - i. Risk Factors
 - ii. Determinants of Myocardial Oxygen Requirements and Delivery, Silent Ischemia, Postoperative Ischemia
 - iii. Diagnosis of Severity of Myocardial Infarction and Acute Coronary Syndrome:
 1. Clinical presentation
 2. ECG, Enzymes
 3. Echocardiography
 4. Nuclear Techniques
 5. Cardiac catheterization
 6. Cardiac CT
 - iv. Treatment
 1. Pharmacological
 2. Interventional Cardiology Procedures
 3. Surgical
 - a. Revascularization
 - b. Mechanical Circulatory support (e.g. IABP, VAD)
 - c. Transplant
- e. Valvular heart disease
 - i. Congenital (e.g. bicuspid aortic valve, Ebstein abnormality)
 - ii. Acquired (e.g. aortic sclerosis)

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- iii. Aortic stenosis/insufficiency
 1. Risk factors
 2. Pathophysiology
 3. Pharmacological management
 4. Interventional management
 5. Surgical management
- iv. Mitral stenosis/insufficiency
 1. Risk factors
 2. Pathophysiology
 3. Pharmacological management
 4. Interventional management
 5. Surgical management
- v. Tricuspid stenosis/insufficiency
 1. Risk factors
 2. Pathophysiology
 3. Pharmacological management
 4. Interventional management
 5. Surgical management
- vi. Pulmonic stenosis/insufficiency
 1. Risk factors
 2. Pathophysiology
 3. Pharmacological management
 4. Interventional management
 5. Surgical management
- f. Congenital heart disease
 - i. Normal embryological development
 - ii. Common congenital lesions (e.g. Tetralogy of Fallot, bicuspid aortic valve)
 - iii. Management of the adult with congenital heart disease
 1. Corrected
 2. Uncorrected
- g. Electrophysiologic disturbances
 - i. Anatomy of the cardiac conduction system
 1. Sinus node
 2. AV junction
 3. Intraventricular conduction
 - a. Left bundle branch (anterior/posterior fascicles)
 - b. Right bundle branch
 - ii. Mechanisms of arrhythmias
 - iii. Diagnosis
 1. History
 2. ECG, Holter, Echocardiogram, implantable loop recorder
 3. Electrophysiological (EP) study
 - iv. Arrhythmia classification
 1. Atrioventricular nodal reentrant tachycardia, focal atrial tachycardia
 2. Atrial fibrillation, atrial flutter
 3. Supraventricular tachycardia
 4. Ventricular tachycardia
 5. Ventricular fibrillation
 - v. Treatment

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1. Pharmacological
 2. Cardioversions
 3. EP ablations
 - a. Anesthetic management
 4. Implantable cardioverter-defibrillators
 - a. Guidelines for insertion
 - h. Neoplastic diseases
 - i. Risk factors
 - ii. Types (myxoma, lipoma)
 1. Benign vs. malignant
 - iii. Diagnosis (TEE, cardiac MRI)
 - iv. Anesthetic considerations
 - i. Rare cardiac diseases (e.g. Infiltrative, storage, endomyocardial disease)
 - i. Classification
 1. Infiltrative
 - a. Amyloidosis
 - b. Sarcoidosis
 - c. Fatty infiltration
 2. Storage disease
 - a. Hemochromatosis
 - b. Glycogen storage disease
 - c. Fabry disease
 3. Endomyocardial causes
 - a. Carcinoid
 - b. Radiation
 - c. Hypereosinophilic disease
 - d. Toxicity
 - i. Drug related (e.g. anthracycline, serotonin, ergotamine)
 - ii. Risk factors
 - iii. Diagnosis (e.g., TEE, Cardiac MRI, laboratory markers)
 - iv. Anesthetic considerations
2. Thoracic vascular disease
 - a. Pathophysiology/classification
 - i. Aneurysmal disease
 - ii. Dissection/disruption
 - iii. Atherosclerotic disease
 - iv. Arterial insufficiency/thoracic outlet obstruction
 - v. Others
 - b. Specific anesthetic considerations
 - i. Cerebrospinal fluid drains
 - ii. Lung isolation
 - iii. SSEP monitoring
 - iv. Postoperative complications (e.g. spinal cord ischemia, renal failure, recurrent laryngeal nerve injury)
3. Esophageal disease
 - a. Impact for echocardiography
- C. Patient Evaluation

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1. Non-invasive cardiovascular evaluation
 - a. Electrocardiography
 - b. Transthoracic echocardiography
 - c. Transesophageal echocardiography
 - d. Stress testing (e.g., exercise, dobutamine)
 - e. Cardiovascular imaging (e.g. MRI, CT)
 2. Cardiac catheterization procedures and diagnostic interpretation
 - a. Invasive cardiac catheterization procedures
 3. Pre-anesthetic evaluation and preparation of adult cardiothoracic patients
- D. Monitoring
1. Vascular pressures:
 - a. Arterial
 - i. Invasive/noninvasive differences
 - ii. Site specific indications/contraindications and limitations
 - b. Central venous (CVP)
 - c. Pulmonary arterial (PAP)
 - i. Pulmonary artery occlusion (PAOP), Left atrial (LAP), Left ventricular end-diastolic (LVEDP)
 - d. Pulse pressure variation
 2. Heart function
 - a. Electrocardiogram (ECG)
 - b. Echocardiography
 - i. Doppler
 - c. Cardiac Output
 - i. TEE
 - ii. PAC
 1. Other modalities (e.g. esophageal Doppler, thoracic impedance, etc.)
 - d. Cardiac catheterization, cardiac MRI
 3. Mixed venous oxygen saturation (SvO₂)
 4. Cerebral oximetry
 5. Peripheral oximetry
 6. Coagulation
 7. Temperature
 - a. Cardiopulmonary bypass considerations
 8. Urine output
 9. ABG interpretation
 - a. Anion gap
 - b. Temperature effect on blood gases: alpha-stat vs. pH-stat
 10. Cerebrospinal fluid pressure
- E. Pharmacodynamics and Pharmacokinetics
1. Preoperative medications
 2. Anesthetic induction agents in patients with cardiac disease
 3. Medications prescribed for management of hemodynamic instability
 - a. Inotropes
 - b. Vasopressors
 - c. Vasodilators
 - i. Intravenous (e.g. nitrates, phosphodiesterase inhibitors)
 - ii. Inhaled (e.g., nitric oxide, prostaglandin)
 - d. Diuretics

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- e. Beta-blockers
 - f. ACE-I/ARBs
 - g. Calcium channel blockers
 - h. Nitrates
- F. Devices
- 1. Cardiopulmonary Bypass (CPB)
 - a. Myocardial preservation
 - b. CPB on pharmacokinetics and pharmacodynamics
 - c. Cardiothoracic effects of CPB
 - d. Respiratory effects of CPB
 - e. Neurological effects of CPB
 - f. Metabolic effects of CPB
 - g. Endocrine effects of CPB
 - h. Hematological effects of CPB
 - i. Renal effects of CPB
 - j. Thermoregulatory effects of CPB
 - k. Coagulation/anticoagulation before, during, and after CPB
 - 2. Circulatory assist devices
 - a. Intra-aortic balloon counterpulsation
 - b. Left and right ventricular assist devices
 - i. Indications
 - ii. Contraindications
 - iii. Anesthetic management
 - 1. Preoperative evaluation (e.g. TEE exam findings to guide management)
 - iv. Percutaneous devices
 - c. Extracorporeal Membrane Oxygenation (ECMO)
 - i. Indications
 - ii. VA vs. VV ECMO
 - iii. Anticoagulation considerations
 - iv. Complications
 - v. Anesthetic management
 - 1. Initiation
 - 2. Weaning
 - 3. Pacemaker
 - a. Indications and insertion
 - b. Modes of operation
 - c. Headless pacemakers
 - d. Biventricular pacing
 - e. Implantable cardioverter defibrillators (ICD)
 - f. Subcutaneous implantable cardioverter defibrillators (S-ICD)
 - g. Perioperative management of ICD and S-ICD
- G. Surgical Procedures
- 1. Cardiac
 - a. Coronary revascularization
 - b. Valve repair and replacement
 - c. Pericardial
 - d. Neoplastic
 - e. Mechanical circulatory support
 - f. Heart transplant

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- g. Rhythm disturbances
- h. Structural heart disease interventions (e.g. TAVR, Mitral clip, Watchman)
- i. Myomectomy/cardiac remodeling
- j. Other surgical/interventional procedures
- 2. Thoracic aortic
 - a. Ascending/arch aortic surgery with circulatory arrest
 - b. Descending aortic surgery
 - c. CPB employing low flow and/or retrograde perfusion
 - d. Lumbar drain indications and management
 - e. Spinal cord protection
 - i. Cerebrospinal fluid drainage
 - ii. Pharmacologic
- H. Postoperative and Perioperative
 - 1. Peri-operative ventilator management
 - a. Intra-operative anesthetics
 - b. Critical care unit ventilators and techniques
 - c. Weaning and discontinuation of mechanical ventilation
 - d. Post-operative sedation considerations
 - 2. Peri-operative pain management
 - a. Regional anesthesia for cardiac surgical patients
 - b. Post-operative pain management
 - 3. Post-anesthetic critical care of adult cardiothoracic surgical patients
 - a. Diagnosis and management of postoperative complications
 - i. Hemorrhagic
 - ii. Vasoplegic
 - iii. LV, RV, or biventricular failure
 - iv. Delayed emergence/neurologic
 - b. Interpretation and management of mechanical support of circulation
- I. Other Topics
 - 1. Research methodology/statistical analysis
 - a. Fundamentals of research design and conduct
 - b. Interpretation and presentation of data
 - 2. Practice management
 - a. Costs of medical/anesthesia care
 - v. Understanding principles of healthcare funding and payment
 - vi. Cost-conscious practice
 - b. Efficient OR staffing and scheduling
 - i. Subspecialization issues: pediatrics, cardiac, regional, obstetric coverage
 - ii. Anesthesia care team and scope of practice
 - c. Population health: perioperative surgical home and enhanced recovery
 - i. Population based health determinants, resources to improve access
 - ii. Health care disparities between populations
 - d. Clinical informatics
 - i. Electronic medical record systems: costs and benefits
 - ii. Artificial intelligence and machine learning
 - e. Documentation, coding, and billing
 - i. Compliance with documentation requirements
 - ii. Accuracy, clarity, specificity of medical records
 - iii. Coding integrity, audits, and insurance denials

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3. Quality Improvement and patient safety
 - a. Definitions
 - i. Medical error, adverse events, sentinel events, misuse of medications and technology
 - ii. Human factors and mindfulness
 - iii. Systems thinking and technology design
 - b. Medication errors: assessment and prevention
 - i. Medication reconciliation
 - ii. Information technology to reduce medication errors
 - c. Crisis management and teamwork
 - i. Simulation training
 - ii. Crisis manuals and other cognitive aids
 - iii. Teamwork training
 - iv. Handoff communication
 - v. Preoperative and procedural checklists
 - d. Quality Improvement (QI) basics
 - i. Design, analysis, and implementation of QI projects
 - ii. Data collection
 - iii. QI metrics
 - iv. Patient satisfaction measurement
 - v. Value-based care incentives, pay-for-performance
 - e. Performance assessment
 - i. Individual benchmarking
 - ii. Group and facility scorecards
 - iii. Public reporting
 1. Federal Quality Payment Program
 2. Anesthesia registries
 - f. Change management methods
 - i. Peer review and morbidity and mortality Conferences
 - ii. Lean Six Sigma
 - iii. QI and the 5S process
 - iv. Value stream mapping
 - v. Failure mode and effects analysis
 - vi. Root cause analysis
 - g. Barriers to QI
4. Diversity, Equity and Inclusion (DEI) in health care
 - a. Surgical outcomes
 - b. Barriers
 - i. Systematic racism, colorism/shadeism, sexism, discrimination against orientation, gender identity, language, national origin, ethnicity, religion, immigration/citizenship status, age, familial status, and disability
 - ii. Bias; Implicit bias, microaggression, stereotype threat
 - c. Approaches to improvement; interventions at individual, inter-personal, community, organizational and policy levels; cultural and gender competency, upstander vs. bystander, allyship vs. performative action, tokenism vs representation, assortativity vs. homophily
 - d. DEI in the workplace
 - e. DEI in academia
 - i. Leadership

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- ii. Scholarship; Representation of diversity and race related topics in research, Importance of language in reports discussing racial inequities
- 5. Healthcare disparities
 - a. Social determinants of health considerations in assessment and management of patients – race, language, education status, religion, housing, nutrition, geographic location, rural vs. urban, access to and quality of care, health coverage
 - b. Maternal healthcare disparities; Maternal mortality and morbidity, Pain management
 - c. ICU disparities and outcomes
- 6. Ethics and medico-legal issues
 - a. Professionalism: definitions and teaching
 - i. Disclosure of errors or adverse events
 - ii. Professional behavior: honesty, integrity, compassion, respect, altruism, conflicts of interest, response to marketing
 - iii. Recognizing limitations in expertise and need to seek guidance
 - iv. Personal role in reporting unsafe conditions and fitness for work
 - v. Recognizing and responding to unprofessional behavior
 - vi. Evidence-based practice
 - b. Patient autonomy and decision making
 - i. Principles of informed consent and shared decision making
 - ii. Advance directives, Do Not Resuscitate (DNR) orders, medical orders for life-sustaining treatment
 - iii. Health care proxy laws and limitations
 - iv. Patients refusing transfusion or other treatments
 - c. Legal and regulatory issues
 - i. Elements of medical malpractice: duty, breach of duty, causation, damages
 - ii. Legal actions and consequences, National Practitioner Data Bank, Closed Claims findings, professional liability insurance
 - iii. Understanding laws related to controlled substances, including opioids and cannabinoids
 - iv. Patient privacy issues: principles of confidentiality, access to records, protected health information
 - v. The Health Insurance Portability and Accountability Act (HIPAA)
 - d. Primary certification, recertification, maintenance of certification and related issues (Professional Standing, Lifelong Learning, Cognitive Knowledge, Clinical Practice Assessment, Systems-Based Practice)
 - e. Research ethics
 - i. Principles of justice, autonomy, beneficence, nonmaleficence
 - ii. Ethical standards in research design: scientific validity, fair subject selection, favorable risk-benefit profile
 - iii. Review and implementation of trials, the institutional review board
 - iv. Informed consent in research
 - v. Conflicts of interest and financial disclosure
 - f. Clinician wellness and self-care
 - i. Diagnosis and treatment of burnout
 - ii. Sleep deprivation
 - iii. Adaptations for clinical disability
 - iv. Substance abuse