ALLIANCE OF CARDIOVASCULAR PROFESSIONALS

ACVP Educational Guidelines for Invasive Cardiovascular Technology Personnel in the Cardiovascular Catheterization Laboratory

I. Invasive Cardiovascular History and Procedure Descriptions

- A. Pioneers and Historical Overview of the Profession
- B. Cardiovascular Terminology
- C. Right Heart Catheterization
    1. Indications & Contraindications
    2. Risks & Complications
- D. Left Heart Catheterization
    1. Indications & Contraindications
    2. Risks & Complications
- E. The Evolving Role of Registered Cardiovascular Invasive Specialists (RCIS)

II. Patient Ethics

- A. Patients' Rights and Safety
    1. Informed Consent
    2. Patient Identification
    3. Confidentiality/HIPAA
    4. Patient Bill of Rights
    5. Patient Safety Methods
- B. Professionalism
- C. Communication & Hand-offs

III. Anatomy and Physiology

- A. Normal Cardiovascular Anatomy and Physiology
- B. Flow Dynamics – Cardiac Cycle
- C. Wigger's Diagram
- D. Coronary Artery Physiology
    1. Coronary Perfusion Pressure
    2. Determinates of Coronary Flow
    3. Microcirculation and Autoregulation
- E. Sympathetic/Parasympathetic Nervous System
- F. Coronary Artery Anatomy and Physiology
    1. Left Coronary Artery System
    2. Right Coronary Artery System
- G. Cardiac Action Potential
- H. Kidney Regulation of Blood Pressure

ALLIANCE OF CARDIOVASCULAR PROFESSIONALS

IV. Patient Care

A. Patient Prep/Pre-Cardiovascular Catheterization Lab Teaching/Assessment/Time-Out
   1. Patient Medical Record
   2. Physician Orders

B. Procedure Preparation and Premedication

C. Basic Assessment Techniques
   1. History & Physical Examination
   2. Vital Signs
   3. Central Nervous System Assessment
   4. Respiratory System Assessment
      a. Whole Blood Oximetry Sampling
      b. PaO2, SaO2, SvO2, CaO2, CvO2
      c. Interpretation of Arterial Blood Gases
   5. Cardiovascular Assessment
      a. Auscultation, Murmurs, Pulses, Arrhythmias, 12-Lead Analysis, etc.
      b. Pain Assessment
   6. EKG
      a. EKG Monitoring
      b. EKG Paper/Caliper Measurements Heart Rate Calculations
      c. Rhythm Interpretation
      d. Electrical Dynamics
      e. 12-Lead Interpretation/Hypertrophy, Axis, Bundle Branch, and Infarct Patterns
      f. Pacemakers Temporary
      g. Defibrillation and Cardioversion
   7. Peripheral Vascular Assessment
      a. Pulses
      b. Use of Doppler
      c. Allen's Test (Radial Cases)
      d. Skin Mottling
      e. Barbeau testing

D. Interpretation of Laboratory Studies
   1. Chemistries, Cardiac Enzymes, Troponin
   2. Electrolytes
   3. Hematology & Coagulation Studies
   4. Lipid Panel/Profile

E. IV Therapy
   1. IV Insertion
   2. IV Assessment and Maintenance
   3. Troubleshooting

F. Foley Insertion
G. Patient Transport and Transfer
H. Post-Cardiovascular Cath Patient Care, Hemostasis and Teaching
I. High-Risk Patient Management
J. Patient Management During Procedure
    1. Point of Care Testing (POCT)
        a. ACT
        b. Whole Blood Oximetry
        c. PT/INR
        d. hCG
        e. Rapid Platelet Function Assays
K. Complication & Emergencies
    1. Acute MI (STEMI, UA/NSTEMI)
    2. Chest Pain
    3. Shortness of Breath
    4. Shock – All Types
    5. Dysrhythmias
    6. Tamponade
    7. Dissections – Coronary/Aortic/Iliac/Femoral/Radial…
    8. Cerebrovascular Accident – CVA/TIA
    9. Pulmonary Edema
    10. Pulmonary Embolism
    11. Acute Pulmonary Hemorrhage
    12. Hypertension/Hypotension
    13. Anaphylaxis and Allergic Reactions
    14. Bronchospasm
    15. Air Embolism
    16. Airway Management/Oxygen Delivery Devices
L. ACLS and BCLS Protocols

V. X-Ray Generation and Radiation Physics/Safety

A. X-ray Tube Components and Imaging Chain
    1. Radiation Production, Radiation Units, Characteristics and Physics
    2. Imaging System (X-ray Tube and Image Intensifier/Intensifying Screen)
    3. Principles, Positioning and Operation of the Fluoroscopic X-ray Machine
    4. Digital Imaging Systems and Flat Panels
B. Radiation Biology & Protection
    1. Cellular Biology Overview
    2. Biological Effects of Radiation
    3. Radiation Safety/Radiation Protection (Patients and Personnel)

4. Dose Reduction Techniques
5. Radiation Exposure Monitoring
6. Limits for Exposure to Ionizing Radiation
    a. ALARA
    b. Sentinel Event
7. Quality Assurance
8. Image Analysis and Digital Imaging

VI. Diagnostic and Intervention Procedures

A. Hospital/ Cardiovascular Catheterization Lab Environment and Safety
    1. Regulatory Compliance
    2. Procedure Room Preparation
    3. Body Mechanics
        a. Safely Moving Patients
        b. Safety Strategies for Staff
    4. Electronics
        a. Biomedical Instrumentation
        b. Ohms Law, Resistance

B. Aseptic Technique
    1. Pathogens
        a. Blood-borne, Air-borne, Bacteria, HIV, TB, Hepatitis, MRSA, C-Diff
    2. OSHA Regulations
    3. Universal Precautions
    4. Hand Washing
    5. PPE (Personal Protective Equipment)
        a. Accident Exposure
            1. Engineering Controls
            2. Workplace Controls
    6. Gowning and Gloving
        a. Open & Closed Techniques
    7. Sterile Field/Tray Setup
    8. Maintaining the Sterile Field
    9. Methods of Sterilization and Disinfection
    10. Tear Down – Biohazard Handling and Disposal
    11. Latex Allergy
    12. Isolation
        a. Contact
        b. Airborne
        c. Droplet

C. Prepare Patient and Sterile Table Setup
    1. Patient Positioning, Instruction/Education, and Setup

2. Sterile Table Setup
3. Percutaneous Access
    a. Femoral
    b. Radial

D. Equipment
    1. Disposable and Non-disposable Equipment
        a. Needles, Sheaths, Guide Wires, Catheters, Stents, Manifolds, Transducers, Automatic Power Injector, Imaging Equipment, Defibrillator, etc.

E. Diagnostic Procedure Protocols/Steps
    1. Left Heart Catheterization
    2. Right Heart Catheterization
    3. Combined Heart Catheterization

F. Manipulation and Positioning of the Patient and X-ray Equipment

G. Contrast Media
    1. Ionic, Non-ionic
    2. Osmolarity
    3. Contrast Reactions – Risk Factors, Side Effects, Precautions, Premedication
    4. Contrast Induced Nephropathy (CIN)
    5. CIN Scores

H. Angiography – Standard Techniques and Projections
    1. Native Coronaries
    2. Grafts, RIMAS and LIMAs
    3. Coronary Vasospasm
    4. Collateral Circulation
    5. TIMI Flow

I. Injection Techniques
    1. Damped and Ventriculized Waveforms
    2. Hand Injection
    3. Automatic Pressure Injectors

J. Left Ventriculography

K. Aortography

L. Peripheral Arteriography

M. Pulmonary Angiography

N. Venography

O. QCA – Vessel Measurement

P. Arterial, Venous, Pulmonary Artery Lines/Catheters

Q. Hemostasis (Femoral & Radial)
    1. Manual Technique
    2. Topical Accelerators
    3. Compression Products (C-Clamps, FemoStop)

4. Mechanical Closure devices (Hemoband, etc.)
5. Biosealants
6. Collagen Plugs
7. Sutures/Staples
8. Pressure Dressings
9. Complications
    a. Hematoma
    b. Vasovagal Reactions
    c. Pseudoaneurysm
    d. Retroperitoneal Bleed
    e. AV Fistula
    f. Limb ischemia

R. Diagnostic Specialty Procedures
1. Fractional Flow Reserve (FFR)
2. Intravascular Ultrasound (IVUS)
3. Intra-Cardiac Echo (ICE)
4. Optical Coherence Tomography (OCT)
5. Near Infrared Spectroscopy (NIRS)
6. Endomyocardial Biopsy

S. Provocative Maneuvers
1. Hypertrophic Cardiomyopathy
2. Myocardial Viability
3. Coronary Spasm

T. Interventional Procedures
1. Percutaneous Coronary Interventions (PCI)
    a. Anticoagulation/Antiplatelet Agents/Glycoprotein IIb/IIIa Inhibitors
2. Stents (Bare Metal, Drug Eluting, Bio-absorbable)
3. Intra-Aortic Counter Pulsation/Balloon Pump
4. Embolic Filters
5. Laser
6. Atherectomy (Rotational, Directional, Laser)
7. Thrombectomy (Mechanical and Manual Aspiration)
8. Fibrinolytic Therapy
9. Aspiration and Distal Embolic Protection Devices
10. Valvuloplasty and Percutaneous Valve Replacement (TAVR) and Repair (TMVR)
11. Structural Heart Interventions (PFO/ASD/VSD/PDA/LAA Closure)
12. Pericardiocentesis
    a. Anterior Approach
    b. Subxyphoid Approach
    c. Echo Guidance

13. Percutaneous LVADs (Impella, Tandem Heart) and Cardiopulmonary Support – CPS
14. Transseptal Approach
15. Investigational Therapies
16. Clinical Research Trial

VII. Hemodynamics

A. Hemodynamic Pressure Recognition
   1. Normal Pressures and Hemodynamic Values
      a. Waveform Identification (Atrial/Venous – a, x, c, v, y, mean, ventricular-s, d, edp, arterial-s, d, m)
      b. Pressure Values (Intra-cardiac & Vascular)
      c. Cardiac Cycle/Wigger's Diagram
      d. Cardiac Output/Cardiac Index (Preload, Afterload, Contractility)
      e. Systemic and Pulmonary Vascular Resistance
      f. Poisieulle's Law
      g. Starling's Law
   2. Transducers & Fluid-Filled Pressure Monitoring Systems
   3. Time-Pressure Relationships
   4. Pullback Waveform Identification and Analysis
      a. LV to AO, PCWP to Pa to RV to RA
   5. Abnormal Pressure Recognition
      a. Valvular Stenosis
      b. Valvular Insufficiencies
      c. Other Gradients
      d. Constructive Pressures
      e. Restrictive Pressures
      f. Tamponade
      g. Heart Failure Pressures
      h. Cardiomyopathies
      i. Pericardial Disorders
   6. Provocative Maneuvers
   7. Pressure and Waveform Hemodynamic Identification and Analysis
   8. Analysis of Pulmonary Artery Monitoring (Swan Ganz) Data
   9. Quality Control – QC

B. Cardiac Output and Blood Flow Determinations
   1. Fick
   2. Angiographic
   3. Thermodilution
   4. Comparison of Various Cardiac Output Methods
   5. Shunts

6. Regurgitant Fraction

C. Hemodynamic Calculations
   1. Cardiac Output
   2. Cardiac Index
   3. Mean Atrial Pressure
   4. Systemic and Pulmonary Vascular Resistance
   5. Systemic and Pulmonary Blood Flow
   6. Shunts (Right to Left, Left to Right, Bi-directional)
   7. Regurgitant Fraction
   8. Ejection Fraction/LV Tracing
   9. Valve Areas – Gorlin and Haaki Formulas
   10. Evaluation of Calculated Values

VIII. Pharmacology

A. Medical & Legal Aspects, Documentation
B. Sympathetic/Adrenergic and Parasympathetic/Cholinergic Nervous Systems
C. Indications, Contraindications, Mechanism of Action, Normal Dosages, Side Effects, and Patient Care Consideration of the Medications Listed Below (E 1-27)
D. Routes of Administration
E. Pharmacokinetics and Pharmacodynamics of:
   1. Vasopressors and Vasodilators
   2. Diuretics
   3. Antihypertensives
   4. Local Anesthetics
   5. Anticoagulants (Heparins, Low Molecular Heparins)
   6. Direct Thrombin Inhibitors (Bivalirudin)
   7. Fibrinolytics
   8. Nitrates
   9. Antiarrythmics
   10. Antianginals
   11. Calcium Channel Blockers
   12. Contrast Media
   13. Cardiac Glycosides
   14. Analgesics and Reversal Agents
   15. Sedatives and Reversal Agents
   16. Insulin Therapy
   17. Steroids
   18. ACE Inhibitors, Angiotensin Receptor Blockers (ARB's), Aldosterone Antagonists
   19. Antiemetics

20. Antibiotics
21. Antihistamines
22. Oxygen
23. Beta Blockers
24. Antiplatelet Agents (IIb/IIIa's)
25. ACLS (1st and 2nd Line)
26. Cholesterol Lowering Agents
27. Conscious Sedation
    a. Monitoring, Aldrete Score, Malpatti Classification

F. Drug and IV Drip Calculations

IX. Cardiovascular Diseases, Assessment and Treatments

A. Identification of Pathologies and Complications
B. Evaluation of Statistical Data for Cardiovascular Diseases
C. Etiology, Pathophysiology, Clinical Manifestations, and Treatment of:
    1. Coronary Artery Disease – Atherosclerosis
    2. Angina
        a. Stable, Unstable Variants (Printzmetal's)
    3. Acute Coronary Syndromes – Myocardial Infarction (STEMI, UA/NSTEMI)
        a. No-Reflow, Microvascular Obstruction
    4. Heart Failure (Left Heart, Right Heart, Biventricular)
    5. Shock (Cardiogenic, Hypovolemic, Septic, Distributive)
    6. Valvular Heart Disease (Aortic, Mitral, Pulmonic, Tricuspid, Stenosis, Regurgitant/Insufficient)
    7. Heart Valves and Surgery
        a. Percutaneous repairs such as TAVR/TMVR
        b. Surgical Valve Repair and Replacement
    8. Cardiomyopathies (Dilated, Hypertrophic, Restrictive)
    9. Pericardial Diseases (Acute Pericarditis, Constrictive Pericarditis, Pericardial Effusion, Tamponade)
    10. Abdominal and Thoracic Aortic Aneurysms & Dissections
    11. Systemic and Pulmonary Hypertension
    12. Hereditary Diseases
    13. Pulmonary Diseases (COPD)
    14. Arterial Diseases
    15. Infectious Diseases
    16. Tumors
    17. Cerebrovascular Diseases
    18. Renal Disease
    19. Endocrine Disease
D. Athlete's Heart

1. Common Cardiovascular Cath Lab Findings

E. Surgical Procedures
   1. Coronary Bypass
   2. Minimally Invasive Coronary Bypass
   3. Surgical Valvular Repair/Replacement
   4. Transcatheter Valvular Repair/Replacement
   5. Heart Transplant
   6. Cardiac Implantable Electronic Devices (pacemaker, defibrillator, cardiac resynchronization therapy, implantable loop recorder)
   7. Investigational Clinical Procedures

F. Ventricular Assist Devices

X. Congenital/Pediatrics

A. Congenital Anomalies
   1. Fetal Embryology/Circulation/Transition at Birth
   2. Common Anomalies
      a. ASD, VSD, PFO, PDA, Coarctation, Transposition, Tetralogy, av Canal Defect, Hypoplastic Right and Left Ventricle, Truncus Arteriosus, Tricuspid Atresia, Total Anomalous Venous Return, Pulmonary & Aortic Stenosis
   3. Palliative and Corrective Surgical Interventions
      a. Prostaglandin E, Rashkind Atrial Septostomy, Pulmonary Artery Banding, Closure Devices, Arterial Switch, Blalock Taussig Shunt, Fontan Procedure, Norwood Procedure
   4. Catheter Interventions

B. Pediatric Catheterization Techniques

XI. Electrophysiology (Optional Content for RCIS Programs)

A. Implantable Devices
   1. Permanent Pacemaker Implantation
   2. ICD Implantation
   3. CRT devices, Loop recorders, subcutaneous ICD

B. Diagnostic/Mapping Procedures
C. Cardioversion
D. Tilt Table/Syncope
E. Radiofrequency Ablation – RFA
F. 3D Mapping Techniques (CARTO, Contact and non-contact electroanatomical mapping)
G. Pulmonary Vein Angioplasty
H. Drug infusion testing for the diagnosis of Brugada Syndrome and/or Inappropraite Sinus Tachycardia

ALLIANCE OF CARDIOVASCULAR PROFESSIONALS

XII. Clinical Competencies

A. Pre- and Post- Cardiovascular Cath Patient Care and Teaching
B. Monitoring – Recording
    1. Diagnostic – Left Heart, Right Heart, Vascular
    2. Interventional – Cardiac, Vascular
C. Manipulation of Imaging Equipment
D. Quality Control
E. Scrubbing
    1. Diagnostic – Left Heart, Right Heart, Vascular
    2. Interventional – Cardiac, Vascular
F. Circulating
    1. Diagnostic – Left Heart, Right Heart, Vascular
    2. Interventional – Cardiac, Vascular