Changed pages are highlighted and details of changes follow.

UNIT 1. BASIC SCIENCE

Deleted: 9. Serine-Protease Inhibitors .....38¶

UNIT 2. CARDIOPULMONARY BYPASS

UNIT I: BASIC SCIENCE

B. PATHOLOGY AND SURGICAL REPAIR
3. PERFUSION TECHNIQUES FOR AORTIC ANEURYSM DISSECTIONS: THORACIC AND THORACOABDOMINAL

UNIT OBJECTIVE:
This unit introduces adjunctive techniques of extracorporeal circulation for temporary compensation of loss or compromised hemodynamic and oxygenation to a localized area of patient's body required by corrective surgery of thoracic and thoracoabdominal aneurysms.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Identify the various types of thoracic and thoracoabdominal aneurysms;
(2) Understand the concepts of partial hemodynamic support/oxygenation, hypothermia, circulatory arrest and flow distribution to vital organs;
(3) Understand and identify available current technologies for adjunctive extracorporeal techniques after surgical correction of thoracic and thoracoabdominal aneurysm; and
(4) Make technical applications of learned concepts to various clinical situations and pathologies.

OUTLINE:

I. Type of Pathologies
   A. DeBakey's classification of thoracic aneurysm
      1. Stanford Type AB
      2. DeBakey Type I II III
   B. Crawford's classification of thoracoabdominal aortic aneurysm
      1. Type I
      2. Type II
      3. Type III
      4. Type IV

II. Extracorporeal Circulatory Concepts
   A. Hypothermia (review hypothermia section)
      1. Q10
      2. Threshold/gradient
      3. Thermodynamics of oxygen consumption/demand
      4. Hypothermic response – shivering – anesthesia
      5. Alpha-stat/pH stat strategy
   B. Circulatory Arrest – DHCA
      1. Coagulopathy – DIC
      2. Hemostasis
      3. Pathology
      4. Rheology – sludging
      5. Fluid shift – oncotic pressure – capillary leakage
   C. Current Available Technologies
      1. Coated Circuits
      2. Hemostatic monitors
      3. Pharmacological agents
      4. Spinal Drainage

Deleted: Type A
Deleted: Type B
Deleted: 3. Type C
Deleted: 6. SIRS
Deleted: Transcranial Doppler

5. Ice helmet
6. Cerebral Oximetry
7. In-line blood gas monitors
8. Special cannulaes

D. Applications of Techniques and Extracorporeal Techniques
1. Retrograde cerebral perfusion
2. Antegrade cerebral perfusion
3. Circulatory arrest
4. Hemostasis management
5. Coated circuitry
6. Technical circuitry relative to operable lesions: heat exchanger; oxygenator; and reservoir
7. Cannulation sites relative to operable lesions
8. Distal aortic operation techniques
9. Proximal aortic operation techniques
10. Left-sided heart bypass and selective visceral perfusion
11. Hemodynamic monitoring techniques – including renal artery interpretations and flow adjustments

UNIT I: BASIC SCIENCE

B. PATHOLOGY AND SURGICAL REPAIR
4. CONGESTIVE HEART FAILURE

UNIT OBJECTIVE:
This unit introduces the etiology and presentation of congestive heart failure.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the pathophysiology of congestive heart failure
(2) Describes the history, clinical signs, surgical techniques, and complications associated with congestive heart failure.

Deleted: types and locations of the atrial septal defect, partial anomalous pulmonary venous drainage, and atrio-ventricular septal defect; and

Deleted: each of the above mentioned defects

OUTLINE:

I. Determinants of myocardial performance
   A. Preload
   B. Ejection fraction
   C. Oxygen consumption
II. Clinical causes of CHF
   A. Viral
   B. Ischemic
   C. Idiopathic
   D. Antibody

UNIT I: BASIC SCIENCE

B. PATHOLOGY AND SURGICAL REPAIR
8. CONGENITAL HEART DEFECTS: MISCELLANEOUS ANOMALIES

UNIT OBJECTIVE:
This unit introduces the anatomy, pathological presentation and surgical correction of miscellaneous congenital anomalies.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the anatomy of the unusual congenital anomaly;
(2) Describe the pathological presentation of the unusual congenital anomaly;
(3) Describe the standard surgical corrections for the unusual congenital anomaly; and
(4) Discuss extracorporeal circuitry and techniques and they relate to the unusual congenital anomaly.

OUTLINE:

I. Hypoplastic left heart syndrome
   A. Anatomy
   B. Pathophysiology
      1. natural history
      2. clinical presentation
      3. diagnosis
   C. Surgical correction
   D. Extracorporeal circuitry and techniques
II. Single ventricle
   A. Anatomy
   B. Pathophysiology
      1. natural history
      2. clinical presentation
      3. diagnosis
   C. Surgical correction including hybrid procedures
   D. Extracorporeal circuitry and techniques
III. Pulmonary atresia
   A. Anatomy
   B. Pathophysiology
      1. natural history
      2. clinical presentation
      3. diagnosis
   C. Surgical correction
   D. Extracorporeal circuitry and techniques
IV. Corrected transportation
   A. Anatomy
   B. Pathophysiology
      1. natural history
      2. clinical presentation
      3. diagnosis
   C. Surgical correction
   D. Extracorporeal circuitry and techniques

V. Cor triatriatum
   A. Anatomy
   B. Pathophysiology
      1. natural history
      2. clinical presentation
      3. diagnosis
   C. Surgical correction
   D. Extracorporeal circuitry and techniques
VI. Coronary anomalies
   A. Anatomy
   B. Pathophysiology
      1. natural history
      2. clinical presentation
      3. diagnosis
   C. Surgical correction
   D. Extracorporeal circuitry and techniques

UNIT I: BASIC SCIENCE

C. PHYSIOLOGY
7. COAGULATION MANAGEMENT

UNIT OBJECTIVE:
This unit describes the process of and management of hemostasis as applicable to the practice of perfusion care.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the physiology of coagulation and the process of hemostasis;
(2) Describe the various components of hemostasis;
(3) Discuss various coagulopathic states and treatments thereof; and
(4) Discuss measurement of laboratory values regarding normal and abnormal hemostatic states.

OUTLINE:

I. Physiology of coagulation and hemostasis
   A. Elements, proteins, and cellular and other anatomic structures associated with hemostasis
   B. Initiation of hemostasis
   C. Amplification phase of clot formation
   D. Development of primary hemostatic mass
   E. Contraction of smooth muscle
   F. Healing and restoration of endothelial continuity
II. The platelet and formation of the primary hemostatic plug
   A. Platelet production and destruction
   B. Platelets activation
      1. stimulators
      2. secretors
      3. platelet receptor sites
III. Coagulation cascade and formation of the fibrin clot
IV. The fibrinolytic system
V. Assessment of coagulation
VI. Coagulation Disorders, etiology and treatment
   A. Heparin resistance
   B. HIT
   C. DIC
   D. platelet dysfunction
   E. Factor deficiency

Deleted: Coagulopathy

Deleted: 1. complex disorders

UNIT I: BASIC SCIENCE

D. PHARMACOLOGY

9.HEPARIN INDUCED THROMBOCYTOPENIA (HIT)

UNIT OBJECTIVE:

This unit describes the immunological basis and the clinical approach to HIT.

LEARNER OBJECTIVES:

Upon completion of this unit the student will be able to:

(1) Discuss patient risk associated with receiving chronic heparin therapy;
(2) Explain the immunological basis for HIT; and
(3) Identify clinical management approaches that a perfusionist should use for HIT positive patients.

OUTLINE:

I. Background
   A. Heparin
   B. Thrombocytopenia
II. Consequence of HIT
   A. Arterial thrombosis
   B. DIC
III. Mechanism
   A. LgG antibody
   B. Antiheparin antibody
   C. Heparin–PF 4 on platelet membranes
IV. Management
   A. Stopping the heparin
   B. Warfarin
   C. Ticlopidine
V. Alternate anticoagulation
   A. The low-molecular-weight heparins
   B. The low-molecular-weight heparinoids
   C. Hirudin, bivalirudin (Hirulog), and argatroban
   D. Platelet aggregarion inhibitors
VI. Assays
   A. Factor xa assays
   B. Activated clotting time (ACT)
   C. Reversal of anticoagulation at the end of CPB
   D. Protamine
   E. Ancrod

Deleted: *9. SERINE-PROTEASE INHIBITORS*¶
¶
UNIT OBJECTIVE:¶
This unit describes the use of aprotinin, the dosage required- ACT considerations, thromboembolic considerations and treatment of reactions.¶
¶
LEARNER OBJECTIVES: ¶
Upon completion of this unit the student will be able to:¶
(1) Identify the indications for aprotinin use;¶
(2) Describe the technique for administration of aprotinin;¶
(3) Describe the modification of ACT measurement and heparin administration; and¶
(4) Describe appropriate treatment for hypersensitivity reaction.¶
¶
OUTLINE:¶
I. Indications¶
A. Patient evaluation¶
B. Age¶
C. Patients undergoing repeat medial sternotomy¶
II. Dosage¶
A. Loading dose/test dose¶
B. CPB pump prime loading dose¶
C. Continuous infusion during CPB¶
III. Heparin management ¶
A. Celite activated tests ¶
B. Kaolin activated tests¶
C. Heparin level monitoring¶
D. Timed heparin administration¶
IV. Thromboembolic complications¶
A. Reported complications¶
B. Heparin administration¶
C. The heparin bonded circuit¶
D. Frequency of ACT¶
V. Treatment for infusion reaction¶
A. Emergency drugs¶
B. Hypersensitivity¶
C. Test dose considerations¶
D. Time lapse between test and administration¶
Page Break

UNIT 2: CARDIOPULMONARY BYPASS

A. EXTRACORPOREAL CIRCUIT COMPONENTS FOR CARDIOPULMONARY BYPASS
1. PERFUSION CIRCUITS

UNIT OBJECTIVE:
This unit describes the individual circuit components for cardiopulmonary bypass.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:
(1) Describe the characteristics of the components of a perfusion circuit;
(2) Describe all of the safety devices for the perfusion circuit; and
(3) Discuss how all of the above fit together for a safe and controllable system.

OUTLINE:
I. Perfusion circuits
  A. Open
  B. Closed
  C. Adult
  D. Pediatric
  E. Infant
  F. Mini bypass circuit with and without venous reservoir
II. Safety
  A. Response time
  B. Alarms
  C. Servoregulation
III. Design considerations
IV. Designing the circuit
  A . Venous line
    1. pre-bypass filter
    2. diameter
  B. Arterial pump line
    1. occlusion
    2. flow monitoring
  C. Arterial outlet line
  D. Arterial filter
  E. Arterial line
  F. Suckers and vent lines
  G. Cardiotomy line
  H. Quick prime line
  I. Gas line
    1. gas filter
    2. gas mixer
    3. oxygen analyzer
  J. Manifold system
  K. Cardioplegia delivery system
    1. pressure monitoring
    2. temperature monitoring
    3. flow monitoring
  L. Oxygenator

UNIT 2: CARDIOPULMONARY BYPASS

A. EXTRACORPOREAL CIRCUIT COMPONENTS FOR CARDIOPULMONARY BYPASS
4. EXTRACORPOREAL FILTERS

UNIT OBJECTIVE:
This unit introduces the various types of filters used during cardiopulmonary bypass.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:
(1) Describe the different types of filtering technology used during CPB; and
(2) Discuss the characteristics of individual filter types used during CPB.

OUTLINE:
I. Description of filter technology
   A. Depth
   B. Screen
   C. Affinity
   D. Defoaming agent
   E. Air handling characteristics
   F. Bubble point pressure
II. Specific CPB filters
   A. Arterial line filter
   B. Cardiotomy/reservoir filters
   C. Cardioplegia filters
   D. Pre-bypass filters
   E. Transfusion filters
   F. Gas filters
   G. Leukodepletion
   H. Lipid removal
   I. Hydophobic filters for air removal

UNIT 2: CARDIOPULMONARY BYPASS

A. EXTRACORPOREAL CIRCUIT COMPONENTS FOR CARDIOPULMONARY BYPASS
5. OXYGENATORS

UNIT OBJECTIVE:
This unit introduces the variety of oxygenators used in cardiopulmonary bypass circuits.

LEARNING OBJECTIVES:
Upon completion of this unit the student will be able to:
(1) Describe the characteristics of an ideal oxygenator;
(2) Discuss the historical development of oxygenator techniques;
(3) Describe different types of membrane oxygenators; and
(4) Discuss the oxygen characteristics of different membrane oxygenators.

OUTLINE:
I. Characteristics of an ideal oxygenator
II. Historical oxygenation technologies
  A. Screen
  B. Disk
  C. Bubble
III. Membrane oxygenator
  A. Materials
    1. silicone
    2. microporous polypropylene
      a. flat sheet
      b. hollow fiber
    3. polymenthylpentene (PMP)
  B. Design characteristics
    1. pressure drop
    2. prime volume
    3. maximum rating
    4. air handling
    5. integrated arterial filtration
  C. Evaluating oxygenator performance
  D. Special considerations (eg. PMP)

Deleted: ing
Deleted: polypropyhene

UNIT 2: CARDIOPULMONARY BYPASS

A. EXTRACORPOREAL CIRCUIT COMPONENTS FOR CARDIOPULMONARY BYPASS
7. RESERVOIRS

UNIT OBJECTIVE:
This unit introduces the various types of reservoirs used during cardiopulmonary bypass.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the difference between a reservoir and a cardiotomy;
(2) Describe different reservoir technologies and configurations;
(3) Describe internal filtering systems found in cardiotomy systems; and
(4) Discuss safety issues as they relate to reservoir.

OUTLINE:

I. Reservoirs versus cardiotomy
II. Reservoir systems
    A. Open vs closed systems
    B. Hard shell
    C. Bag reservoirs
III. Internal filtering systems
IV. Safety issues
    A. Servoregulation
    B. Air handling pressure relief valve

UNIT 2: CARDIOPULMONARY BYPASS

A. EXTRACORPOREAL CIRCUIT COMPONENTS FOR CARDIOPULMONARY BYPASS

8. HEMOCONCENTRATOR/ULTRAFILTERS/DIALYSIS

LEARNER OBJECTIVES:

Upon completion of this unit the student will be able to:

(1) Describe the different types of ultrafiltrators;
(2) Describe the operational characteristics of ultrafilters;
(3) Discuss the impact of hemoconcentration of circulating concentrations of drugs and ions; and
(4) Describe the use of the hemoconcentration before, during and after CPB.

OUTLINE:

I. Types of ultrafilters
   A. Semipermeable membrane
      1. hollow fiber
      2. flat plate
      3. coil

II. Operational characteristics
   A. Trans membrane pressure
   B. Serving coefficient
      1. pore size
      2. molecular weight
      3. drug removal
      4. protein binding
      5. ion removal

III. Ultrafiltration circuits/techniques
   A. Pre bypass
      1. pre-buff
   B. During bypass
      1. conventional ultrafiltration (cuf)
      2. zero-balance ultrafiltration (z-buf)
      3. dilutional ultrafiltration (duf)
   C. After bypass
      1. modified ultrafiltration (muf)
      2. residual circuit volume hemoconcentration

IV. Dialysis
   A. Circuit design
   B. Solutions
   C. CVVH/D

UNIT 2: CARDIOPULMONARY BYPASS

B. CARDIOPULMONARY BYPASS TECHNIQUES
2. CPB CANNULATION AND MONITORING

UNIT OBJECTIVE:
This unit describes methods of cannulating for CPB and presents the physiologic monitoring of the cardiac surgery patient.

LEARNING OBJECTIVES:
Upon completion of this unit the student will be able to:
(1) Describe cannulation as it relates to the CPB patient; and
(2) Describe the methods of physiologic monitoring for the CPB patient.

OUTLINE:
I. Cannulation
  A. Arterial
    1. ascending aortic
    2. femoral artery
    3. other
  B. Venous
    1. right atrium
    2. vena cava
    3. femoral vein
  C. Venting
    1. ascending aorta
    2. left ventricle
    3. other
II. Monitoring
  A. Electrocardiogram (EKG)
  B. Blood pressure (BP)
  C. Cardiac filling pressures Swan-Ganz catheter
  D. Cardiac output
  E. Temperature
    1. bladder
    2. tympanic membrane
    3. nasopharyngeal
    4. blood temperature
  F. Renal function
  G. Flows
  H. Blood gases and electrolytes
  I. Coagulation and anticoagulation measurements
  J. TEE
  K. Cerebral monitoring
    1. EEG/BIS
    3. oximetry
III. Troubleshooting

UNIT 2: CARDIOPULMONARY BYPASS

C. ADEQUACY OF PERFUSION

UNIT OBJECTIVE:
This unit identifies the parameters monitored to determine adequacy of perfusion.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Identify the important monitoring variables that would assure that CPB delivery of nutrients meets the tissue demands;
(2) Define homeostasis and physiological mechanisms that assure adequate uptake and removal of metabolic products; and
(3) Describe the physiological variables used to assess cellular energy balance during CPB.

OUTLINE:

I. Definition of term adequacy
II. Factors influencing the adequacy of extracorporeal circulation
    A. Mechanical
    B. Biological
    C. Hemodynamic
    D. Thermal
III. Oxygen and nutrient delivery
    A. Content of oxygen in blood
    B. Hemoglobin
    C. Oxygen dissociation curve
    D. Delivery of oxygen
    E. Miscellaneous factors affecting oxygen delivery
IV. Determinants of total oxygen consumption
    A. Temperature
    B. Anesthesia
    C. BMR
    D. Other pathological considerations
V. Assess of adequacy of perfusion
    A. Oxygen consumption
    B. Regional oxygen consumption
    C. Perfusion pressure
    D. Arterial / venous blood gasses pO2/oxygen saturation
    E. Acid-base status
    F. Lactate concentrations
    G. Temperature
    H. Anesthesia
    I. Cerebral oxygen saturation
    J. Miscellaneous factors

UNIT 2: CARDIOPULMONARY BYPASS

D. MYOCARDIAL PRESERVATION
1. CARDIOPLEGIA ADMINISTRATION TECHNIQUES

UNIT OBJECTIVE:
This unit presents the physiological and technical considerations associated with caridoplegia administration.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the physiology of myocardial preservation;
(2) Discuss the determinants of appropriate myocardial preservation techniques; and
(3) Discuss the technical details related to cardioplegia administration.

CONTENTS:

I. Cardiac anatomy
II. Cell (patho-) physiology
    A. Respiration and aerobic metabolism
    B. Anaerobic metabolism
    C. Myocardial 0_2 supply and consumption
    D. Myocardial stunning
    E. Reperfusion injury
    F. Stone heart
    G. Ischemic preconditioning
III. Cardioplegia
    A. Components and their function
    B. Delivery pressure
    C. Temperature/myocardial temperature
    D. Delivery intervals
    E. Delivery methods
    F. Routes of delivery
IV. Considerations of patient variables

UNIT 2: CARDIOPULMONARY BYPASS

E. SYSTEMIC HYPOTHERMIA

UNIT OBJECTIVE:
This unit describes the physiologic basis of and the technical considerations associated with systemic hypothermia.

LEARNER OBJECTIVES:
At the completion of this unit the student will be able to:

(1) Describe the physiology of systemic hypothermia; and
(2) Discuss application of systemic hypothermia to specific surgical procedures.

OUTLINE:

I. The physiology of hypothermia
   A. VO_2
   B. Thermal gradients
   C. Degrees of hypothermia
   D. Duration of safe circulatory arrest
   E. Glucose control
   F. Electrolyte control
   G. Blood gas control
II. Blood gas strategies
   A. Alpha stat
   B. pH stat
   C. Alkaline stat

Deleted: C. Alkaline stat

III. Alterations in organ function
   A. Arrhythmias
   B. Renal function
   C. Cerebral blood flow
   D. Edema
   E. Hormonal response
   F. Viscosity
IV. Procedures requiring hypothermia
V. Hematological considerations
   A. Coagulation
   B. DIC
   C. Emboli
VI. Cold agglutinins

UNIT 2: CARDIOPULMONARY BYPASS

F. BLOOD CONSERVATION TECHNIQUES
5. HEMOCONCENTRATION

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the different types of ultrafiltrators;
(2) Describe the operational characteristics of ultrafilters;
(3) Discuss the impact of hemoconcentration of circulating concentrations of drugs and ions; and
(4) Describe the use of the hemoconcentration during CPB to control hematocrit.

OUTLINE:

I. Types of ultrafilters
   A. Semipermeable membrane
      1. hollow fiber

Deleted: 2. flat plate¶ 3. coil

II. Operational characteristics
   A. Trans membrane pressure
   B. Serving coefficient
      1. pore size
      2. molecular weight
      3. drug removal
      4. protein binding
      5. ion removal

III. Conventional ultrafiltration during cardiopulmonary bypass
   A. Indications
   B. Limitations
   C. Circuitry

UNIT 2: CARDIOPULMONARY BYPASS

F. BLOOD CONSERVATION TECHNIQUES
6. PHARMACOLOGICAL INTERVENTIONS

UNIT OBJECTIVE:
This unit presents the pharmacological options available to reduce blood loss.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the actions of the various drugs available to reduce the amount of blood loss during and after cardiac surgery;
(2) Describe the indications and contraindications for each of the drugs; and
(3) Discuss dosing and CPB considerations for each drug.

OUTLINE:

I. EACA (amicar)
   A. Mechanism of action
   B. Indications
   C. Contraindications
   D. Dosing
   E. CPB considerations
II. Erythropoeitin
   A. Mechanism of action
   B. Indications
   C. Contraindications
   D. Dosing
III. Transexemic acid
   A. Mechanism of action
   B. Indications
   C. Contraindications
   D. Dosing
IV. Desmopressin acetate DDAVP
   A. Mechanism of action
   B. Indications
   C. Contraindications
   D. Dosing

Deleted: Aprotinin

UNIT 2: CARDIOPULMONARY BYPASS

G. SPECIAL CONSIDERATIONS IN PERFUSION
3. SICKLE CELL AND OTHER BLOOD DISORDERS

UNIT OBJECTIVE:
This unit provides a detailed description of blood disorders that may affect perfusion techniques.

LEARNER OBJECTIVES:
At the completion of this unit the student will be able to:
(1) List the inherited and acquired blood disorders that are important to CPB;
(2) Discuss the mechanism of action of each; and
(3) Describe the therapeutic approaches to each to be able to perform CPB.

OUTLINE:
I. Sickle cell
   A. Pathophysiology
   B.Considerations for CPB
   C.Other blood disorders
II. Methemoglobinemia
   A. Pathophysiology
   B. Considerations for CPB
III. Thalassemia
IV. Spherocytosis & elliptocytosis
V. Hemosiderosis & hemochromatosis
VI. Erythrobolastosis fetalis
VII. Hereditary coagulation disorders
   A. Von Willebrand's disease
      1. Type I
      2. Type II
      3. Type III
   B. Hemophilia A
   C. Hemophilia B
VIII. Acquired coagulation disorders
   A. Disseminated intravascular coagulation (DIC)
   B. Primary fibrinolysis
   C. Vitamin K dependent deficiency
   D. Protein C and Protein S deficiency
IX. Platelet disorders
   A. Thrombocytopenia
   B. Cold agglutinins

UNIT 2: CARDIOPULMONARY BYPASS

I. ADJUNCTIVE TECHNIQUES
1. ASSISTED VENOUS DRAINAGE

UNIT OBJECTIVE:
This unit details assisted venous drainage techniques.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:
(1) Discuss the rationale for using assisted venous return;
(2) Compare VAVD with KAVD; and
(3) Describe the equipment required for each system.

OUTLINE:
I. Vacuum-assisted venous drainage (VAVD)
  A. Concept is to apply a negative pressure in the venous reservoir to augment the rate of venous return.
  B. The advantages of this method are:
    1. increased venous return
    2. smaller venous cannulae for a given flow rate
    3. heart remains empty
  C. The disadvantages of VAVD are:
    1. additional cost
    2. blood trauma if vacuum is too high
    3. potential of pulling air into the arterial blood stream of hollow fiber oxygenators
  D. Hardware for VAVD
    1. hard shell venous reservoir – VAVD can not be applied to soft-shell reservoirs
    2. vacuum source –
    3. vacuum regulator
    4. positive and negative relief valves

Deleted: maximum (-90 mm Hg)

II. Kinetically-assisted venous drainage (KAVD)
  A. Concept is to apply a centrifugal pump in the venous return line to augment the rate of venous return
  B. The advantages of this method are:
    1. increased venous return
    2. smaller venous cannulae for a given flow rate
    3. heart remains empty
    4. no need to apply a vacuum in the venous reservoir
    5. KAVD can be used for soft-shell reservoir as well as heard shell
  C. The disadvantages of KAVD are:
    1. additional cost for centrifugal pump head
    2. blood trauma if pump rate is too high
  D. Hardware for KAVD
    1. centrifugal pump
    2. centrifugal pump head

UNIT 2: CARDIOPULMONARY BYPASS

I. ADJUNCTIVE TECHNIQUES
2. SELECTIVE CEREBRAL PERFUSION

UNIT OBJECTIVE:
This unit details the concepts and techniques for cerebral perfusion.

Deleted: retrograde

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:
(1) Describe the indications for this technique;
(2) Discuss the perfusion circuit; temperatures; pressures; and flows used with the technique; and
(3) Discuss the outcomes of the technique compared to only profound hypothermic circulatory arrest.

OUTLINE:
I. Indications
A. Aortic aneurysm
1. ascending
2. ascending including aortic valve
3. transverse
II. Technique
A. EEG monitoring
B. Profound hypothermic circulatory arrest
C. Cardioplegia administration
D. Antegrade cerebral perfusion
1. hypothermia
2. blood flow rate
3. cannulation sites
D. Retrograde cerebral perfusion (RCP)

Deleted: oxygenated blood
Deleted: 10°C
Deleted: through superior vena cava

1. hypothermia
2. blood flow rate
3. cannulation sites
4. pressure of 25 mmHg
5. flows < 500 ml/min
6. when nasopharyngeal temperatures are < 12°C RCP is halted.
7. arch replacement
8. with head down, RCP restarted
9. at rewarming an arterial sidearm is inserted into transverse graft to deliver antegrade flow
10. air is removed from LV and proximal anastomosis
11. .patient weaned from CPB at appropriate temperature and protamine sulfate is given in the normal fashion

III. Outcomes
A. Mortality
B. Stroke rate

UNIT 2: CARDIOPULMONARY BYPASS

J. PATIENT MONITORING

UNIT OBJECTIVE:
This unit describes the systems used for patient monitoring during open-heart surgical procedures.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Interpret an ECG;
(2) Describe the technical aspects associated with hemodynamic monitoring;
(3) Discuss the relationship of ECG blood pressure, blood gas, chemistry, and temperature as they relate to patient status.

OUTLINE:

I. ECG
II. Pressure monitoring
    A. Noninvasive
    B. Intravascular
        1. radial arterial
        2. femoral Arterial
        3. pulmonary artery – Swan-Ganz
        4. strain gauges
III. Blood gas
    A. Blood gas measurements sampling
        1. sample handling
        2. temperature
        3. anaerobic
        4. anticoagulation
    B. Inline blood gas monitoring
IV. Pulse oximetry
V. Temperature monitoring
    A. Patient temperature
        1. bladder
        2. nasopharyngeal
        3. rectal
        4. skin versus internal
    B. CPB bypass temperature
        1. venous
        2. arterial
        3. cardioplegia
VI. Cerebral blood flow monitoring/Cerebral oximetry
VII. Renal function monitoring
    A. BIS

UNIT 2: CARDIOPULMONARY BYPASS

K. ORGAN TRANSPLANTATION
1. HEART TRANSPLANTATION: DONOR RECIPIENT CONSIDERATIONS

UNIT OBJECTIVE:
This unit introduces the donor and recipient selection considerations as they relate to heart transplantation.

LEARNER OBJECTIVE:
Upon completion of the unit the student will be able to:
(1) Discuss the history, criteria for recipient and donor selection, operative techniques, immunosuppression; and
(2) Discuss outcomes of heart, heart-lung, and lung transplantation.

OUTLINE:
I . History
II. Recipient selection
  A. Age: newborn to 65 years.
  B. Irremediable cardiac disease-class IV NYHA
III. Donor selection
  A. Age
  B. Normal EKG
IV. Operative techniques
  A. Orthotopic
  B. Heterotopic
V. Immunosuppression
VI. Postoperative surveillance
  A. Rejection
  B. Infection
    1. viral
    2. bacterial
    3. fungal
  C. Other
VII. Outcomes
VIII. Myocardial preservation for heart transplantation

Deleted: 60

UNIT 3: MECHANICAL ASSIST

A. EXTRACORPOREAL LIFE SUPPORT TECHNIQUES
1. ECMO

UNIT OBJECTIVES:
This unit presents the basic concepts of ECMO for neonatal and pediatric patients.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the indications for ECMO;
(2) Discuss the advantages of each cannulation technique;
(3) Discuss management of the ECMO patient – especially flows and anticoagulation; and
(4) Describe how to terminate ECMO.

OUTLINE:

I. ECMO patient categories
   A. Neonatal respiratory failure
      1. indications
      2. exclusion
   B. Pediatric respiratory failure
      1. indications
      2. exclusion
   C. Adult respiratory failure
      1. indications
      2. exclusions
   D. Cardiac failure
      1. indications
      2. exclusions
II. Methods of ECMO
   A. Venoarterial ECMO
      1. cannulation
      2. device selection – oxygenators, pumps
      3. disadvantages
   B. Venovenous ECMO
      1. cannulation
      2. device selection – oxygenators, pumps
      3. disadvantages
III. Physiology of infants on ECMO
IV. ECMO management
   A. Setup and initiation of ECMO
   B. Management of surgical procedures on ECMO
V. Post-ECMO management
   A. Ventilator management
   B. Sedation
VI. Outcome studies

Deleted: advantages

Deleted: advantages

UNIT 3: MECHANICAL ASSIST

B. INTRA-AORTIC BALLOON PUMPING (IABP)

UNIT OBJECTIVE:
This unit introduces the theory and practice of intraaortic balloon pumping.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) List the indications and contraindications for the IABP;
(2) Identify the equipment required for the procedure;
(3) Describe the purpose for IABP; and
(4) Discuss proper timing.

OUTLINE:

I. Indications for IABP
   A. Unstable angina
   B. Cardiogenic shock
   C. Postcardiotomy support
   D. Augmentation of circulation
II. Contraindications for IABP
   A. Aortic insufficiency
III. Equipment
   A. Types of IABP
   B. Gas used for counterpulsation
   C. ECG monitoring devices
   D. Electrosurgical interference suppression devices
   E. Insertion devices
IV. Purpose
   A. Counterpulsation– increase coronary perfusion through increasing diastolic pressures
   B. Reduction of LV heart afterload
   C. Increasing cardiac output
V. Procedure
   A. Controls
   B. Function
   C. Manufacturers recommendations
   D. Leak test
   E. Acquiring EKG, 12 lead/slave
   F. Pressure tracing transducer/fiberoptic
   G. Selecting trigger-ECG or pressure
   H. Filling the gas chamber
   I. Identify proper selection of alarms and settings

UNIT 4: PRINCIPLES OF LABORATORY ANALYSIS

C. LABORATORY ANALYSIS-BLOOD CHEMISTRY

UNIT OBJECTIVE:
This unit describes the laboratory test used in diagnosing specific disease states.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Define laboratory test utilized in the determination of renal function;
(2) Define laboratory test utilized in the diagnosis of cardiac disease; and
(3) Define laboratory test utilized in the evaluation of liver function.

OUTLINE:

I. Renal function
   A. Urinalysis
   B. Clearance tests
   C. Blood urea nitrogen
   D. Serum creatine
   E. Osmolality

II. Cardiac disease
   A. Aspartate aminotransferase (AST)
   B. Lactic dehydrogenase / isoenzymes (LDH)
   C. Creatine kinase / isoenzymes (CK)
   D. Troponin-T

III. Liver disease
   A. Serum bilirubin
   B. Urine bilirubin and urobilinogen
   C. Alkaline phosphatase (ALP)
   D. Serum aspartate aminotransferase (AST/ SGOT)
   E. Serum alanine aminotransferase (ALT/SGPT)
   F. Lactic dehydrogenase (LDH)
   G.
   H. Prothrombin time (PT)
   I. Serum proteins and electrolytes
   J. Blood ammonia

Deleted: Gamma glutamyltransferase (GGT)

UNIT 5: BIOMEDICAL ENGINEERING

A. BIOMEDICAL INSTRUMENTATION

UNIT OBJECTIVE:
This unit presents the theory and application of biomedical instrumentation.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the basics of electrical theory including voltage, current, resistance, and capacitance;
(2) Describe various biopotentials emitted from the body and their source;
(3) Discuss how a physiological signal is transduced, processed, and displayed; and
(4) Identify potential sources of error in signal processing and display.

OUTLINE:

I. Electrical theory
   A. Ohm's law
   B. Capacitance
II. Bio-electric potentials
   A. Electrocardiogram
   B. Electroencephalogram
III. Electrodes, sensors, and transducers
   A. Transduction - definition
   B. Signal Acquisition
   C. Electrodes for biophysical sensing
      1. surface electrodes
      2. microelectrodes
   D. Mechanical transducers
      1. pressure
      2. flow
IV. Frequency content of physiologic signals
V. Amplifiers
VI. Digital signal processing
   A. Data acquisition
      1. analog to digital conversion
      2. sampling
   B. Data analysis
   C. Data display
      1. digital to analog conversion
      2. monitors

Deleted: E. Mass spectrometry¶
1. plethysmography¶
2. capnography

Deleted: 3. storage

UNIT 5: BIOMEDICAL ENGINEERING

D. MEDICAL AND DIAGNOSTIC IMAGING TECHNOLOGY

UNIT OBJECTIVE:
This unit introduces the various imaging technologies utilized in medicine with particular emphasis on those utilized in the diagnosis and treatment of cardiothoracic disorders.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the pre-operative, diagnostic tests falling under the category of Nuclear Medicine including cardiolyte stress tests, MUGA scans, and V/Q scans;
(2) Describe the various medical applications of ultrasound including echocardiography, doppler flow transduction, and ultrasonic blood pressure monitoring; and

Deleted: (3) Describe magnetic resonance spectroscopy and its uses as a diagnostic imaging modality for cardiothoracic disorders.

OUTLINE:

I. Radiology
   A. X-ray
   B. Fluoroscopy
   C. Digital subtraction angiography (DSA)
   D. Computed tomography (CT)
II. Nuclear medicine
   A. Cardiolyte stress test
   B. MUGA scans
   C. V/Q scans
III. Ultrasound
   A. Echocardiography
   B. Doppler flow transducers
   C. Blood pressure monitors
IV. Magnetic resonance
   A. MRA
   B. MRI

UNIT 6: SAFETY

B. PATIENT SAFETY

UNIT OBJECTIVE:
This unit describes standard practice with regard to conducting safe perfusion.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Discuss rationale for using safety devices within the extracorporeal circuit;
(2) Describe what is involved in performing CP safely; and
(3) Describe the principles of risk management.

OUTLINE:

I. Safety devices
   A. Level sensors
   B. Bubble detectors
   C. High pressure alarms
   D. Arterial line filters / bubble traps
   E. One way valves
   F. Automatic clamp

II. Safe conduct
   A. Prebypass checklist
   B. Conduct on bypass

III. Risk management
   A. Establishing policies and protocols
   B. Establishing national standards
   C. Adhering to policies, protocols, and standards

UNIT 7: CONTINUOUS QUALITY ASSURANCE

A. CQI FOR THE PERFUSIONIST

UNIT OBJECTIVE:
This unit provides the definition and implementation of CQI in health care.

LEARNERS OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) Describe the basis of CQI;
(2) Describe what CQI can accomplish; and
(3) Discuss how CQI is implemented in perfusion health care.

OUTLINE:

I. Definition of continuous quality improvement
II. Core concepts of CQI
III. Core steps in continuous improvement
IV. Model for improvement
    A. Commonly used CQI tools and methods
    B. Brainstorming
    C. Nominal group technique (NGT)
    D. Multivoting
    E. Cause & effect/fishbone diagram
    F. Control charts
    G. Flowchart
    H. Histogram
    I. Pareto chart
    J. Run (trend) chart
    K. Scatter diagram
    L. Storyboard
    M. Conducting effective meetings
    N. Quality indicators
    O. Evidence based practice

UNIT 11: BUSINESS PRACTICES

A. BUSINESS PRACTICES REGULATORY AGENCIES

UNIT OBJECTIVE:
This unit introduces the various regulatory agencies with oversight responsibilities within the domain of the perfusionist and describes the responsibilities of the perfusionist in complying with his/her employing institution's policies and procedures.

LEARNER OBJECTIVES:
Upon completion of this unit the student will be able to:

(1) List the agencies with regulatory oversight over the domain of the perfusionist; and
(2) Discuss the necessity to comply with employing institution's policies and procedures.

OUTLINE:

I. Regulatory and standards setting agencies
   A. Joint Commission on the Accreditation of Healthcare Organizations (JCAHO)
   B. Occupational and Safety Association (OSHA)
   C. Healthcare Finance Administration (HCFA)
   D. College of American Pathologists and Clinical Laboratories Improvement Amendment I (CAP/CLIA)
   E. American Association of Blood Banks (AABB)
   F. American Association for the Advancement of Medical Instrumentation (AAMI)
II. Regulatory mandates regarding policies and procedures including HIPPA
III. Perfusion policies and procedures

UNIT 12: EMERGENCY PREPAREDNESS

UNIT OBJECTIVE:
This unit describes the various types of disasters and the need for emergency preparedness. The various options for management of patients and the role of the perfusionist during the treatment of patients in these situations will be discussed.

LEARNER OBJECTIVES:

(1) To describe the various types of emergencies that can occur and the response of the health care system to manage these events.
(2) To plan for managing patients using perfusion technology under the various conditions expected in a disaster situation.

OUTLINE:

I. Types of disaster
   A. Internal
   B. External
II. Threats in Health Care
   A. Natural - Hurricane, flooding, ice storms
   B. Mass causalities
   C. Cyber crimes / Sabotage
   D. Terrorism
   E. Weapons of mass destruction
   F. Nuclear
   G. Radiological
   H. Incendiary
   I. Biological
III. Disaster Planning
   A. Law Enforcement
   B. Fire Service
   C. Emergency Medical Service
   D. Public Works / Utility Companies
   E. State and National Resources
   F. Disaster Response Team
   G. County, State and National Planning
   H. Disaster Medical Assistance Teams
IV. Healthcare Emergency Management
   A. Hospital / Healthcare Emergency Management Structure
   B. Hospital Emergency Preparedness
V. Interventions
   A. Massive Transfusion/Autotransfusion
   B. Emergency ECMO Support
   C. Transportation of Patients on Life Support Devices