Chapter 06
Cardiovascular Interventions

Objectives

- State the proper ventilation and compression rates for infants and children when performing CPR.
- Describe the indications for vascular access.
- Discuss age-appropriate vascular access sites for infants and children.
- List local and systemic complications of intravascular access.

Objectives

- State the indications for intraosseous infusion.
- Identify the landmarks for intraosseous infusion.
- Describe the advantages and disadvantages of peripheral venous, central venous, and intraosseous vascular access.
- Define defibrillation and synchronized cardioversion.
Objectives

- Describe factors affecting transthoracic resistance.
- Describe proper placement of hand-held defibrillator paddles or self-adhesive monitoring/defibrillation pads.
- Identify indications for defibrillation and synchronized cardioversion.
- Describe the procedure for defibrillation and synchronized cardioversion.

Objectives

- Describe the differences in the delivery of energy relative to the cardiac cycle with synchronized cardioversion and defibrillation.
- For each of the following dysrhythmias, identify the energy levels currently recommended and indicate if the shock should be delivered using synchronized cardioversion or defibrillation.
  - Pulseless VT/VF
  - Supraventricular tachycardia
- Discuss the indications and procedure for transcutaneous pacing.
- List examples of vagal maneuvers that may be used in the pediatric patient.

Basic Life Support

- Infant
  - Less than 1 year of age
- Child
  - One year of age until puberty
  - Puberty
    - Breast development in females
    - Presence of axillary hair in males
Basic Life Support

- Assess the scene for safety
  - Is it safe to approach the victim?
  - If the scene is not safe, alert EMS for help
  - Make sure other bystanders are aware of existing danger
- Assess the victim for life-threatening conditions
  - Shout for help if necessary
- Assess the nature of the emergency and approximate age of the victim

Assess Responsiveness

- Simultaneously establish the patient's mental status and his ability to maintain an open airway
- Determine level of responsiveness using AVPU:
  - A = Alert
  - V = Responds to verbal stimuli
  - P = Responds to painful stimuli
  - U = Unresponsive

Assess Responsiveness

- Permit the child with respiratory distress to remain in a position of comfort
- If the child is unresponsive, quickly check to see if he or she is breathing
Basic Life Support

- Positioning or moving a victim may be necessary if:
  - You find an unresponsive victim lying face down
  - You must momentarily leave a breathing victim unattended
  - The victim is breathing but unresponsive
  - The victim is vomiting or has debris in his or her mouth
  - The victim’s life is in immediate danger in his or her current location

Assess Breathing

- If normal breathing is present, CPR is not needed
- If the child is unresponsive but has normal breathing, place the child in the recovery position
  - If trauma to the head or neck is not suspected

Assess Circulation

- If the child is unresponsive and is not breathing (or only gasping):
  - Send someone to activate the emergency response system
  - Check for a pulse for up to 10 seconds
Assess Circulation

- Check for a pulse for up to 10 seconds
- In infants, assess brachial pulse
- Assess carotid or femoral pulse in a child

Basic Life Support

- If a pulse is present and the rate is 60 beats per minute or faster but breathing is inadequate:
  - Begin rescue breathing
    - Rate of 1 breath every 3 to 5 seconds (12 to 20 breaths per minute)
  - Recheck the pulse about every 2 minutes

Basic Life Support

- Begin chest compressions if:
  - There is no pulse (or you are unsure if there is a pulse) or
  - A pulse is present but the rate is slower than 60 beats per minute with signs of poor perfusion (e.g., pallor, mottling, cyanosis)
**Infant CPR**

<table>
<thead>
<tr>
<th>Age</th>
<th>Under 1 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess pulse</td>
<td>Brachial</td>
</tr>
<tr>
<td>Compress with</td>
<td>2 fingers (1 rescuer)</td>
</tr>
<tr>
<td></td>
<td>2 thumbs encircling chest (2 rescuers)</td>
</tr>
<tr>
<td>Compression depth</td>
<td>1.5 inches (4 cm)</td>
</tr>
<tr>
<td>Compression rate</td>
<td>At least 100/min</td>
</tr>
<tr>
<td>Ventilation rate</td>
<td>1 breath every 3 to 5 seconds (12 to 20 ventilations/min)</td>
</tr>
<tr>
<td>Compression to ventilation ratio</td>
<td>30:2 (1 rescuer) 15:2 (2 rescuers)</td>
</tr>
</tbody>
</table>

**Child CPR**

<table>
<thead>
<tr>
<th>Age</th>
<th>1 year to puberty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess pulse</td>
<td>Carotid or femoral</td>
</tr>
<tr>
<td>Compress with</td>
<td>Heel of 1 hand or heel of 1 hand, other hand on top (as for adult)</td>
</tr>
<tr>
<td>Compression depth</td>
<td>2 inches (5 cm)</td>
</tr>
<tr>
<td>Compression rate</td>
<td>At least 100/min</td>
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**Two-rescuer Infant CPR**
Airway and Breathing

- Open the airway using a head tilt-chin lift maneuver
  - If trauma suspected, use the jaw thrust without head tilt maneuver
- Give 2 breaths
  - 30:2 (1 rescuer)
  - 15:2 (2 rescuers)
- Resume compressions

Defibrillation

- Upon arrival of an AED:
  - Apply the adhesive pads to the patient’s chest
  - Turn the AED on
  - Follow the machine’s prompts
  - About every 2 minutes, the AED will prompt rescuers to re-analyze the rhythm

Vascular Access
Vascular Access—Indications

- Maintain hydration
- Restore fluid and electrolyte balance
- Provide fluids for resuscitation
- Administration of medications, volume expanders, blood and blood components, maintenance solutions
- Obtain venous blood specimens for laboratory analysis

Vascular Access

- If no IV is in place at the onset of a cardiac arrest, the intraosseous route is useful as the initial means of vascular access

Peripheral Venous Access

- Advantages
  - Effective route for fluid and medication administration
  - Does not require interruption of resuscitation efforts
  - Easier to learn than central venous access techniques
  - If IV attempt unsuccessful, site easily compressible to reduce bleeding
  - Fewer complications than central venous access
Peripheral Venous Access

- Disadvantages
  - In circulatory collapse, peripheral veins may be absent or difficult to access
  - Small vessel diameter
  - Greater distance from the central circulation
  - Should be used only for administration of isotonic solutions

Over-the-needle Catheters

- Widely used
- Soft catheter made of plastic or plastic-like material
- Rigid, plastic hub is color-coded
- Hollow metal needle preinserted into catheter
- Length of catheter limited by length of needle
- Puncture site in vein exactly size of catheter
  - Reduces possibility of bleeding around venipuncture site

Over-the-needle Catheters

- Advantages
  - Comfortable for patient because catheter is pliable
  - Low incidence of infiltration

- Disadvantages
  - Possibility of catheter-fragment embolism exists if proper insertion technique is not used
Through-the-needle Catheter

- Steel needle used to perform venipuncture
  - Plastic catheter slides through needle into vein
  - After venipuncture, needle is pulled out of the skin and left attached to the apparatus
- Risk of sharp tip of needle shearing off end of catheter
  - Catheter-fragment embolus

Hollow Needle—Butterfly Type

- Steel needle with flexible plastic wings
- May be easier to insert than other types of IV devices
- Steel needle tip may puncture vasculature after placement

Factors to Consider When Selecting an IV Site

- Purpose of the infusion
- Amount/type of IV fluid or medications to be infused
- Expected duration of IV therapy
- Accessibility of the vein
- Size and condition of the vein
- Patient's age, size, general condition, and preference
- Your experience and skill at venipuncture
Preferred Sites for Venous Access in Infants

Scalp Veins

- Very small veins found close to the surface and more easily seen than extremity veins
- May be useful for fluid and medication administration after stabilization

Upper Extremity Veins
Central Venous Access

- Advantages
  - Rapid volume expansion
  - Delivery of medications closer to their sites of action
  - More reliable route of venous access than peripheral venous cannulation
  - Central venous pressure measurement
Central Venous Access

- Disadvantages
  - Special equipment required
  - Excessive time may be required for placement
  - Higher complication rate than peripheral venipuncture
  - Skill deterioration
  - Inability to initiate procedure while other patient care activities in progress

External Jugular Vein

- Advantages
  - Usually easy to cannulate because the vein is superficial and easy to visualize
  - Provides rapid access to the central circulation

- Disadvantages
  - May not be readily accessible during an arrest due to rescuers working to manage the airway
  - May be easily dislodged
  - May be positional with head movement
  - May be difficult to thread a guidewire or catheter into the central circulation because of angle of entry into subclavian vein
Complications of Vascular Access

Local Complications
- Pain and irritation
- Cellulitis
- Phlebitis
- Thrombosis
- Bleeding
- Hematoma formation
- Inadvertent arterial puncture
- Nerve, tendon, ligament, and/or limb damage
- Infiltration and extravasation
Systemic Complications

- Sepsis
- Fluid overload/electrolyte imbalance
- Hypersensitivity reactions
- Air embolism
- Catheter-fragment embolism
- Pulmonary thromboembolism

Peds Pearl

- Infusion pumps should be used for all IV infusions in infants and children to avoid inadvertent circulatory overload unless large volumes of fluid are deliberately administered as part of the resuscitation effort.

- Mini-drip infusion sets should be used and closely monitored if infusion pumps are not available.

Intraosseous (IO) Infusion
Indications
- Cardiopulmonary arrest or decompensated shock where vascular access is essential and venous access is not readily achieved
- Multi-system trauma with associated shock and/or severe hypovolemia
- Unresponsive patient in need of immediate medications or fluid resuscitation
- Presence of burns or a traumatic injury preventing access to the venous system at other sites

Advantages
- Skill is easily mastered, even if done infrequently
- Preferred access sites are distant from major sites of activity during resuscitation efforts
- Low incidence of complications
- Medications and fluids administered IV can be administered IO
- Absorption of medications administered via the IO route is more rapid than medications administered via the subcutaneous or rectal routes
- Blood sampling for laboratory studies is possible
- Venous access is often easier to obtain after initial fluid resuscitation via the intraosseous route

Disadvantages
- Short-term intervention until venous access can be obtained
- Causes extreme pain in responsive patient
Contraindications

- Femoral fracture on the ipsilateral side
- Osteopetrosis (high fracture potential)
- Osteogenesis imperfecta (high fracture potential)
- Fracture at or above the insertion site
- Severe burn overlying the insertion site (unless this is the only available site)
- Infection at insertion site (unless this is the only available site)
- Use of the extremity in which an unsuccessful IO attempt was made

Indicators of Correct IO Needle Position

- Aspiration of bone marrow
- The needle stands firmly without support
- A sudden loss of resistance occurred on entering the marrow cavity
  - Less obvious in infants than in older children because infants have soft bones
- Fluid flows freely through the needle without signs of significant swelling of the subcutaneous tissue
Anterior Superior Iliac Spine Approach

Possible Problems with IO Infusion

- Incomplete penetration of the bony cortex
- Penetration of the posterior cortex
- Fluid or medications escaping around the needle through the puncture site
- Fluid leaking through a nearby previous cortical puncture site
- Fracture of the tibia
- Local abscess or cellulitis
- Lower extremity compartment syndrome
- Osteomyelitis
- Loss of vascular access site may occur due to needle obstruction by marrow, bone fragments, or tissue

Possible Problems with IO Infusion

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<td>Incomplete penetration of the bony cortex</td>
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<tr>
<td>Penetration of posterior cortex</td>
</tr>
<tr>
<td>Radiograph of bilaterally misplaced IO needles with penetration through the posterior tibial cortices</td>
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</tbody>
</table>
Possible Problems with IO Infusion

| Fluid or medications escaping around the needle through the puncture site |
| Fluid leaking through a nearby previous cortical puncture site |

Electrical Therapy

Definition and purpose
- The therapeutic delivery of unsynchronized electrical current through the myocardium over a very brief period to terminate a cardiac dysrhythmia

Defibrillation
Defibrillation—Indications

- Pulseless ventricular tachycardia
- Ventricular fibrillation

Defibrillator

- Defibrillator
  - Used to administer an electrical shock at a preset voltage to terminate a cardiac dysrhythmia

Defibrillation Paddles/Pads
Paddle Size

- Use adult paddles/pads for patients weighing more than 10 kg (22 lbs) (older than 1 year)
- Use infant size paddles/pads for infants weighing less than 10 kg (22 lbs)

Paddle Size

- Generally, use the largest paddles or pads that will fit the patient’s chest without overlapping with at least 1 in (3 cm) separating the pads

Conductive Media

- Hand-held paddles
  - Use defibrillation gel
  - Do not use the following:
    - Saline-soaked pads
    - Ultrasound gel
    - Bare paddles
    - Alcohol pads
Conductive Media

- Self-adhesive pads
  - Pregelled
  - Do not require application of additional gel

Selected Energy

- Pulseless VT/VF
  - Initial energy dose 2 to 4 J/kg
  - If dysrhythmia persists, reasonable to use 4 J/kg
  - If dysrhythmia persists:
    - Subsequent energy levels should be at least 4 J/kg
    - Higher energy levels may be considered but should not exceed 10 J/kg or the adult maximum dose

Paddle Position

- Follow the manufacturer’s instructions regarding proper placement of self-adhesive pads, hand-held paddles, and pregelled defibrillation pads
Paddle Position

- Sternum-apex position
  - Sternum paddle over the right side of the patient's upper chest below the clavicle
  - Apex paddle to the left of the patient's left nipple over the left lower ribs

Paddle Position

- Anterior-posterior position
  - Place one paddle (or monitoring/defibrillation pad) immediately to left of sternum
  - Place the other on back behind heart

Automated External Defibrillation

- Always follow the AED manufacturer's guidelines for the application, use, and maintenance of the AED
Automated External Defibrillation

- Use a standard AED for the patient that is:
  - Unresponsive
  - Apneic
  - Pulseless
  - And 8 years of age or older (about 55 pounds or more than 25 kg)

Automated External Defibrillation

- Use an AED equipped with a pediatric attenuator, if available, for an unresponsive, apneic, pulseless child who weighs less than 55 pounds (25 kg)

- If unavailable, use a standard AED

Automated External Defibrillation

- For infants:
  - Use of a manual defibrillator is preferred
  - If a manual defibrillator is not available, an AED equipped with a pediatric attenuator is desirable
  - If neither is available, use a standard AED
Automated External Defibrillation

- Advantages
  - Voice prompts the user
  - Easy to learn; memorizing treatment protocol is easier than recalling the steps of CPR
  - Less training required to operate and maintain skills than conventional defibrillators
  - Promotes rescuer safety by permitting remote, “hands-free” defibrillation

- If the patient has a pacemaker or implantable cardioverter-defibrillator (ICD):
  - Place the AED pads at least 1 inch from the implanted device
  - If an ICD is in the process of delivering shocks to the patient, allow it about 30 to 60 seconds to complete its cycle

- If the patient’s chest is dirty or covered with water, quickly wipe the chest before applying the AED pads.
Synchronized Cardioversion

- Delivery of an electrical shock to the heart timed to occur during ventricular depolarization (QRS)
  - Reduces potential for delivery of energy during vulnerable period of T wave

Synchronized Cardioversion

- Indications
  - SVT due to reentry
  - Atrial fibrillation
  - Atrial flutter
  - Atrial tachycardia
  - Monomorphic VT with a pulse

Synchronized Cardioversion

- Energy settings:
  - Initial: 0.5 to 1 J/kg
  - Second and subsequent shocks: 2 J/kg

- Ensure everyone is clear of the patient, bed, and any equipment connected to the patient

- Ensure oxygen is not flowing over the patient’s torso
Synchronized Cardioversion

- Select a lead with optimum QRS complex amplitude
- Press synchronizer control
- Ensure machine “flagging” of QRS complexes

Transcutaneous Pacing (TCP)

- Indications
  - Profound symptomatic bradycardia refractory to basic and advanced life support therapy

Transcutaneous Pacing (TCP)

- Follow the manufacturer’s recommendations for proper pacer pad placement
- Anterior-posterior placement
Transcutaneous Pacing (TCP)

- Anterolateral placement

Transcutaneous Pacing (TCP)

- Obtain rhythm strip
- Turn power on to pacemaker
- Set pacing rate
- Start pacemaker, increasing current slowly but steadily until pacer spikes visible before each QRS complex
- Verify electrical and mechanical capture

Vagal Maneuvers
Vagal Maneuvers

- May be tried in the stable but symptomatic child in SVT or during preparation for cardioversion or drug therapy for this dysrhythmia

- Success rates vary and depend on:
  - Patient age
  - Level of cooperation
  - Presence of underlying conditions

Vagal Maneuvers

- Application of a cold stimulus to the face for up to 10 seconds
  - Often effective in infants and young children
  - Do not obstruct patient’s mouth or nose
  - Do not apply pressure to the eyes

- Valsalva’s maneuver
  - Blow through a straw or take a deep breath and bear down for 10 seconds

Vagal Maneuvers

- Gagging
  - Use a tongue depressor or culturette swab to briefly touch the posterior oropharynx

- Carotid sinus massage
  - May be used in older children
  - Apply firm pressure just underneath the angle of the jaw for up to 5 seconds
  - Simultaneous, bilateral carotid pressure should never be performed
Vagal Maneuvers

- Ensure oxygen, suction, a defibrillator, and crash cart are available before attempting the procedure
- Obtain a 12-lead ECG before and after the vagal maneuver
- Continuous monitoring of the patient’s ECG essential
  - Note the onset and end of the vagal maneuver on the ECG rhythm strip

Questions?