MEDAVIE HealthEd ÉduSanté

HEMODYNAMIC MONITORING

Advanced Care Paramedicine

Module: 12

Section: 02c

Introduction

- Hemodynamic monitoring important aspect of critical care medicine
- Subtle changes in hemodynamic parameters often earliest indications of patient deterioration
- Patients often transported with monitors and in-dwelling catheters

Value of Hemodynamic Monitoring

- Understand common critical care monitoring devices
- Interpret changes
  - Allows the critical care paramedic to:
    - Identify and appreciate trends
    - Determine treatment effectiveness

Commonly Monitored Parameters

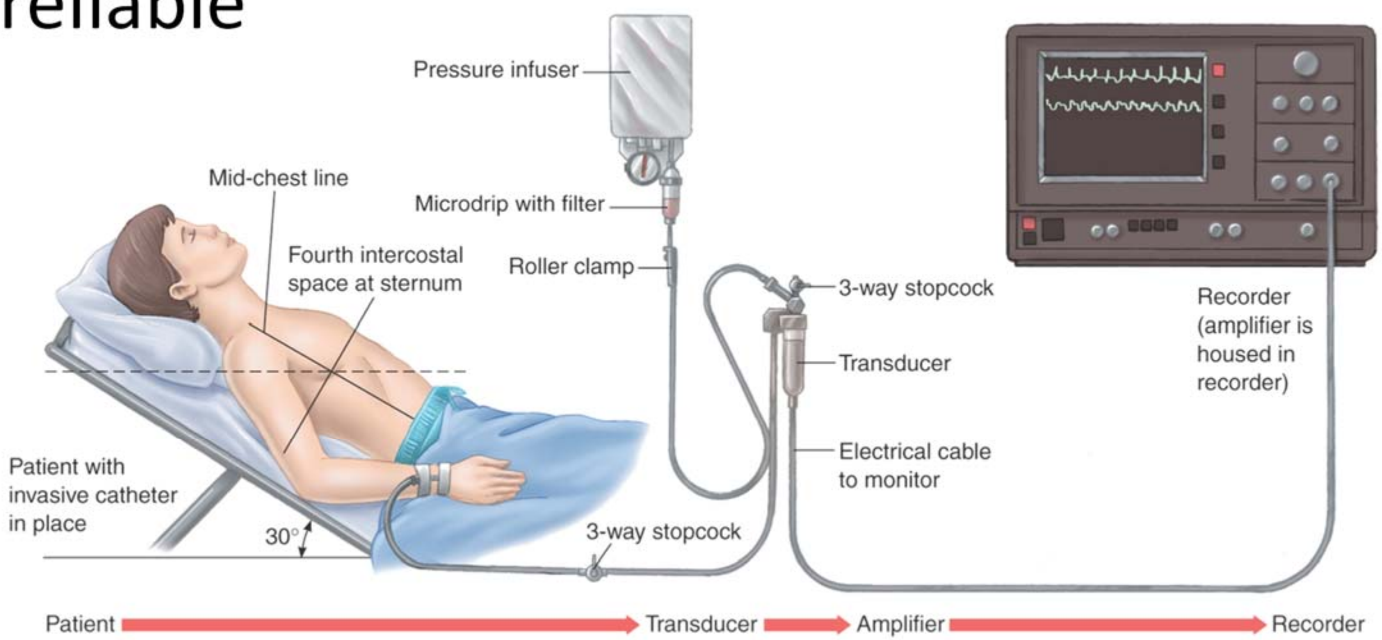
- Electrocardiogram
- Arterial blood pressure
- Central venous pressure
- Cardiac output
- Pulmonary capillary wedge pressure
- Stroke volume
- Oxygen delivery

Electrocardiographic Monitoring

- 12-Lead ECG monitoring and interpretation now common in prehospital environment
- Principles of 12-lead monitoring similar to routine cardiac monitoring
- 12-Lead ECG designed to detect most common cardiac insults

Arterial Blood Pressure

- One of the most important physiologic measurements in medicine
  - Also one of the most unreliable
  - Measurement with sphygmomanometer unreliable



Indirect (Noninvasive) Pressure Monitoring

- Sphygmomanometer
  - Multiple sources of error
    - Inappropriate size cuff
    - User error
    - Environmental distractions
  - Usually adequate for most situations
  - Critical care patient requires more accurate arterial blood pressure determination

Direct (Invasive) Pressure Monitoring

- More involved than noninvasive pressure monitoring
  - Invasive procedure
  - Requires sophisticated equipment
    - Catheter
    - Transducer
    - Oscilloscope or graph

Arterial Catheter

- Filled with heparinized saline
- Serves as a fluid column between blood and transducer
- Transmits pressure from pulse

Transducer

- Receives pressure from pulse and produces weak electrical signal
- Amplifier commonly used to strengthen signal

Oscilloscope or Graph

- Displays signal from transducer
- Electric monitor commonly used

Electronic Monitor Displays

- Pressure waveform
- Numerical values for:
  - Systolic pressure
  - Diastolic pressure
  - Mean arterial pressure (MAP)
    - Frequent calibration and maintenance required

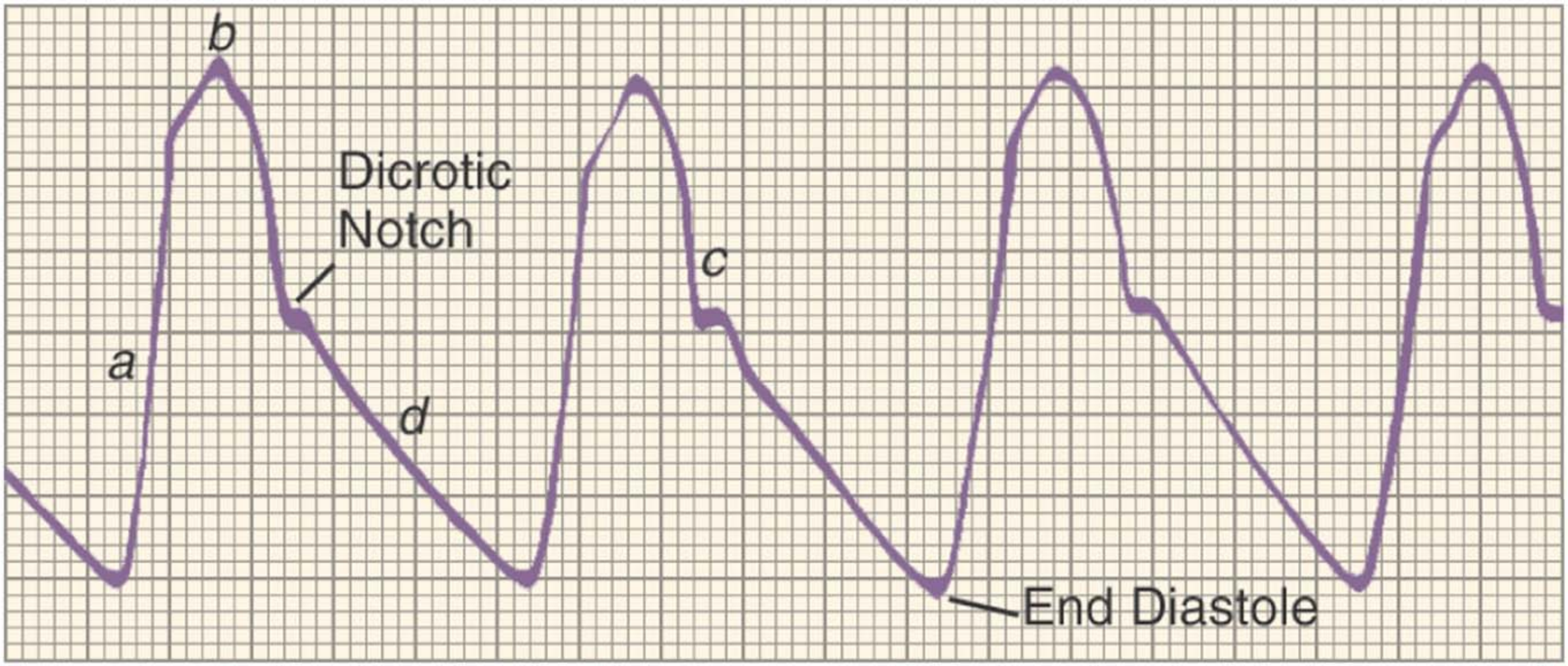
Leveling and Zeroing of Transducer

- Zero reference point at phlebostatic axis
  - Level of right and left atrium when patient supine
- Transducer is zeroed by exposing the pressure transducer to atmospheric air
  - Open three-way stopcock so it is closed to patient and the transducer is open to atmospheric air
  - Zeroing function on monitor activated
  - System left untouched until flat line appears on monitor
  - Three-way stopcock opened to patient and blood pressure measured
- System should be zeroed any time patient position changes

Arterial Waveform

- Rapid upstroke
  - Rapid ejection of blood from left ventricle into aorta
  - Follows QRS complex on ECG
- Dicrotic notch
  - Slight backflow of blood in aorta after closure of aortic valve
    - End of ventricular systole
  - Corresponds with end of ventricular repolarization
    - T wave on ECG
- Value measured at peak of waveform is systolic pressure
- Value measured at trough is diastolic pressure

Arterial Waveform



Mean Arterial Pressure (MAP)

- Electronic determination preferred to calculated determination
- MAP preferred over systolic pressure
  - Represents true peripheral blood flow driving pressure

Art Line Indications

- Need for continuous monitoring if intra-arteria pressure
- Need for frequent arterial access
  - Blood gas sampling
- Titration of vasoactive medications during transport

Insertion of Arterial Catheter

- Critical care paramedics not often responsible for placement
  - Familiarity of placement sites and insertion technique helpful in management
- Common placement sites
  - Radial artery
  - Ulnar artery
    - Rarely used
  - Brachial artery
  - Femoral artery

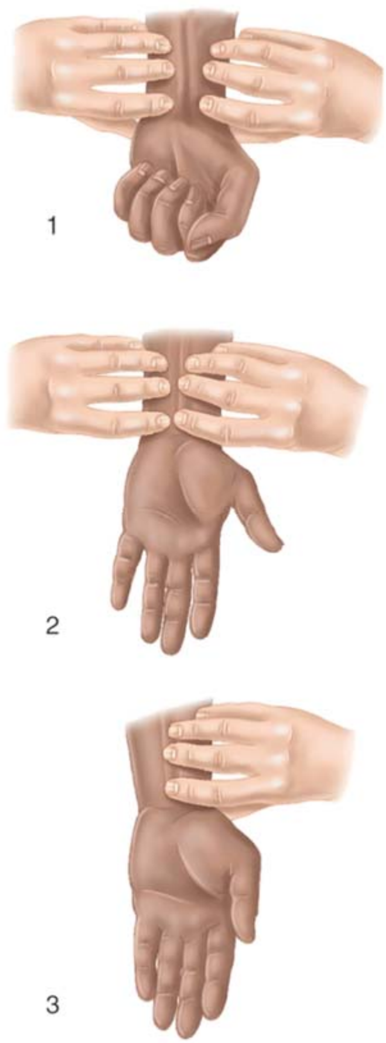
Insertion of Arterial Catheter

- Factors determining placement site
  - Experience of practitioner
  - Patient history of vascular disease
  - Relative hemodynamic status of patient
  - Evaluation of risks and benefits of each site

Allen's Test

- Assures adequate collateral blood flow to palm
- Technique
  - Have patient clench fist on arm to be used for catheterization
    - Aids with venous flow from palm
  - Digitally occlude radial and ulnar arteries
    - Palmer region will blanch due to lack of arterial blood supply

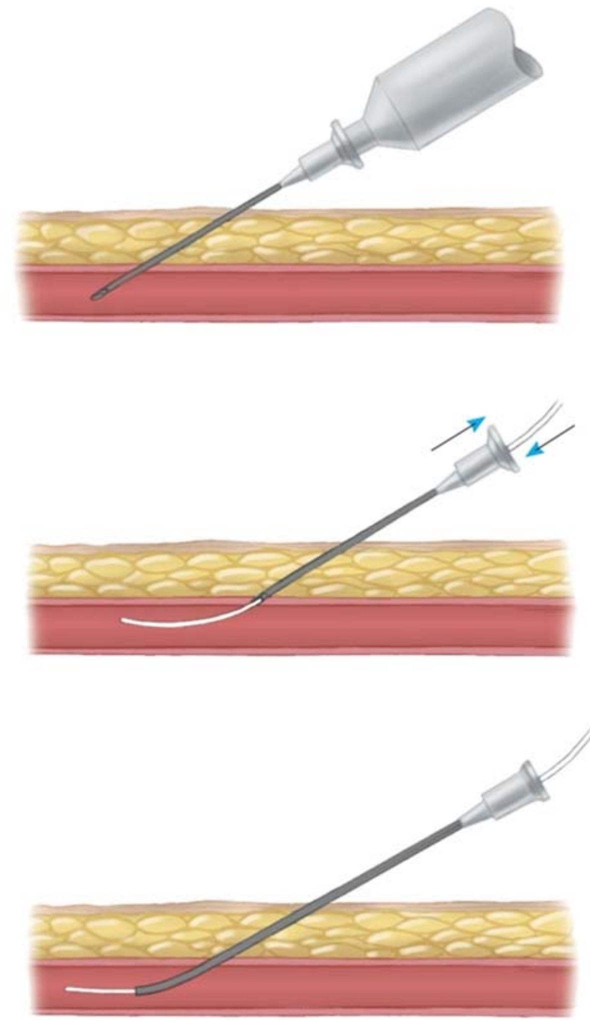
Allen's Test



- While occluding arteries, have patient open hand
- Release occlusion of ulnar artery that will not be cannulated
- If adequate perfusion supplied by unoccluded ulnar artery, blanching will subside in <3 seconds
- Positive Allen's Test occurs when blushing of the palm indicates ulnar patency

Art Line Placement

- Sterile technique
  - Catheter-over-needle
  - Modified Seldinger technique
- Local anesthesia
  - 1% Lidocaine at insertion site
- Any over-the-needle catheter may be used if anatomy allows
  - For deeper vessels requiring longer catheters, commercial kits are available
    - Guidewire used to increase success rate



Art Line Complications

- Pain
  - Nerve fibers alongside arterial vessels
- Hemorrhage
  - Higher pressure in arterial system compared to venous
  - Significant hemorrhage can occur rapidly
    - Direct pressure for at least 10 minutes
    - Application of pressure dressing
    - Monitor peripheral perfusion
      - Assess for distal ischemia
        - » Use of blood thinners, fibrinolytics, 2b3a inhibitors

Art Line Complications

- Vasospasm
  - Arteries more vasoactive than veins
- Waveform distortion
  - Arterial line must be flushed often and rezeroed
    - Ensures accurate readings
  - Damping
    - Suspected when reading does not improve with flushing and rezeroing
    - Results from interaction of arterial pressure wave and arterial line setup

Art Line Complications

- Overdamping
  - Causes
    - Blood clots
    - Air bubbles in tubing
    - Kink in tubing
  - Results in:
    - Slurred upstroke
    - Loss of dicrotic notch
    - Loss of fine detail of tracing
    - Erroneously low blood pressure readings

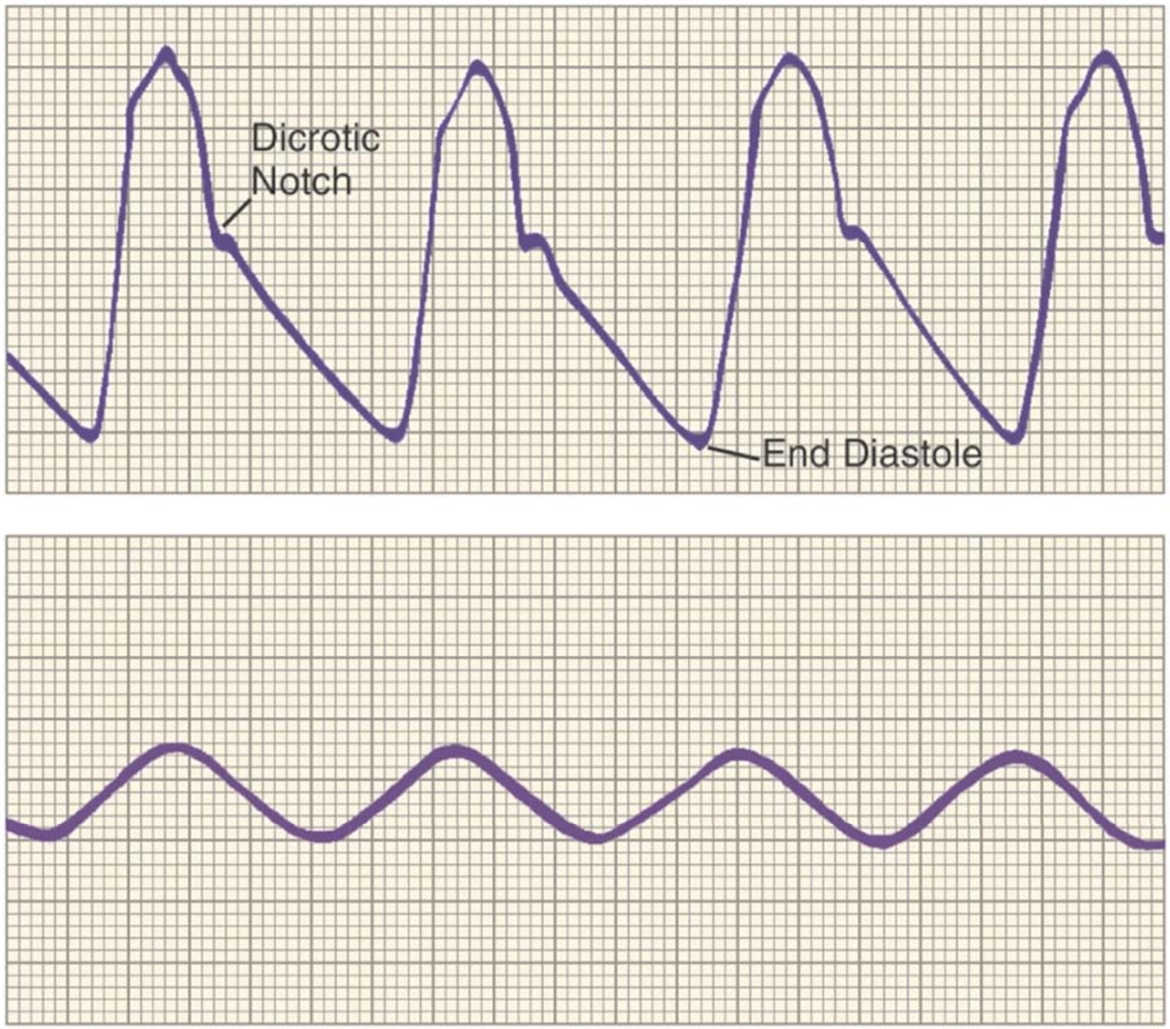
Art Line Complications

- Underdamping
  - Causes
    - Long connecting tubing
    - Small tubing
    - Catheter too large for vessel
      - Occludes vessel lumen
  - Results in:
    - Exaggerations in peaks and troughs of waveform
    - Erroneously high systolic pressures
    - Erroneously low diastolic pressures

Troubleshooting Arterial Dampening

- Damping corrected by addressing underlying problem
  - Ensure that all connections are tight
  - Continuously reassess catheter insertion site
- Kinking of catheter can result in poor distal perfusion
  - Distal ischemia
- Immobilization of extremity may help prevent catheter displacement, disconnection, and kinking

Troubleshooting Arterial Dampening



Arterial Catheter Waveform

- After placement, arterial catheter attached to monitoring system
  - Includes monitor
- Systolic blood pressure
  - Indicated by systolic peak of waveform
  - Peak begins to fall just after completion of QRS on ECG
  - Normal range: 90–140 mmHg

Arterial Catheter Waveform

- Diastolic blood pressure
  - Indicated by trough in waveform
  - Normal range: 60–90 mmHg
- Dicrotic notch
  - Indicates closure of aortic valve
  - Pressure measurement at dicrotic notch = MAP
    - Normal values: 65–100 mmHg
      - $>$ 60 mmHg = Hypoperfusion state
      - $>$ 55 mmHg = Significant hypoperfusion state

Central Circulation Monitors

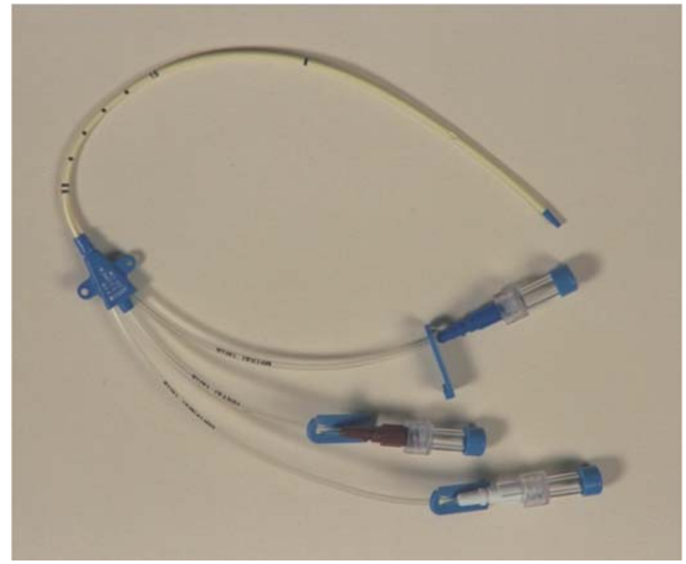
- Provides important hemodynamic information
- Two frequently used methods
  - Central venous pressure (CVP) monitor
  - Pulmonary artery catheter monitor

Central Venous Pressure (CVP) Monitor

- Central venous pressure
  - Blood pressure in vena cava/right atrium
  - Pressures equal as no valves exist between locations
- Provides information about right ventricular preload
  - Helpful as a guide for fluid therapy
- Tip of catheter in vena cava near right atrium

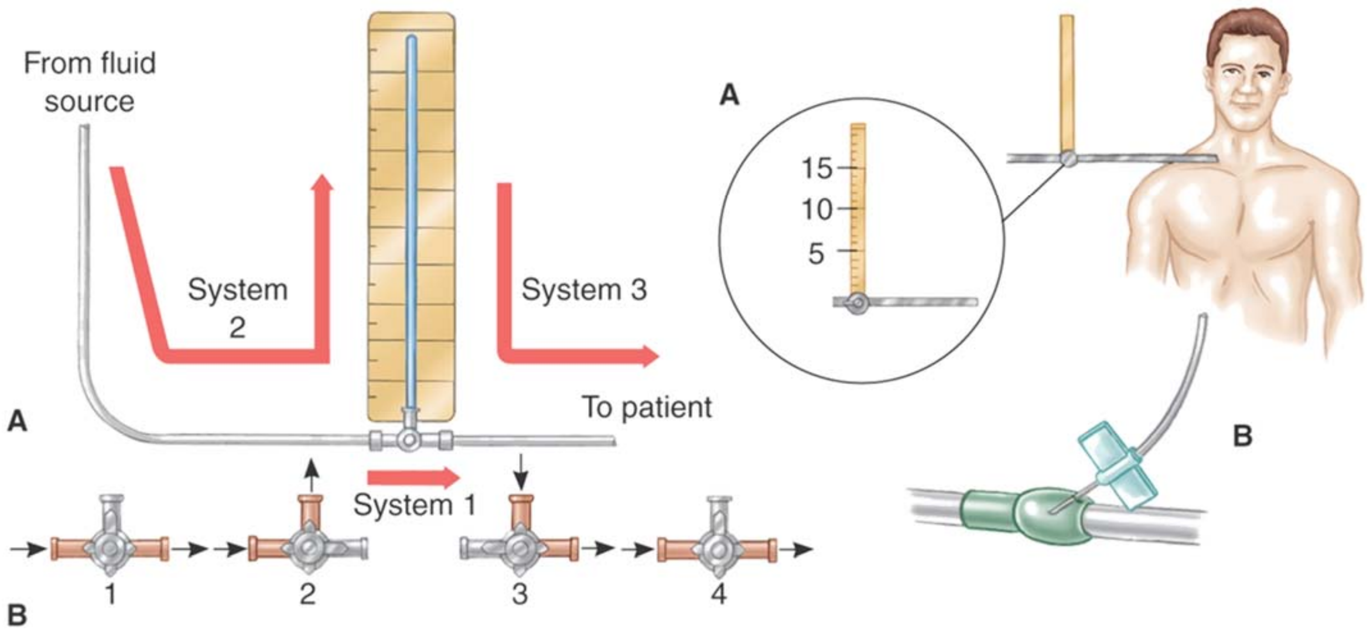
CVP Pressure Monitoring

- Water manometer
  - Placed in line between IV fluid and CVP catheter
  - Three-way stopcock
    - To measure, open stopcock between manometer and patient
    - Column of water in manometer equilibrates with pressure in vena cava
    - Level fluctuates with respiration
  - cm H_20
  - Divide by 1.36 to convert to mmHg



CVP Pressure Monitoring

- Electronic pressure transducer
  - More common than manometry
  - mmHg
  - Must be leveled, calibrated, and zeroed



CVP Pressure

- Normal CVP
  - 5–8 cmH_20
  - 0–6 mmHg
  - Trends important
    - Isolated fluctuations of little importance

Abnormal CVP

- Low CVP secondary to:
  - Hypovolemia
    - Relative
      - Venodilation
    - Absolute
      - Hypovolemia

Increased CVP

- Secondary to:
  - Right ventricular failure
  - Vasoconstriction
  - Fluid volume overload
  - Cardiac tamponade
  - Chronic pulmonary disease
  - Chronic left ventricular failure
  - Tricuspid insufficiency
  - Mechanical ventilation

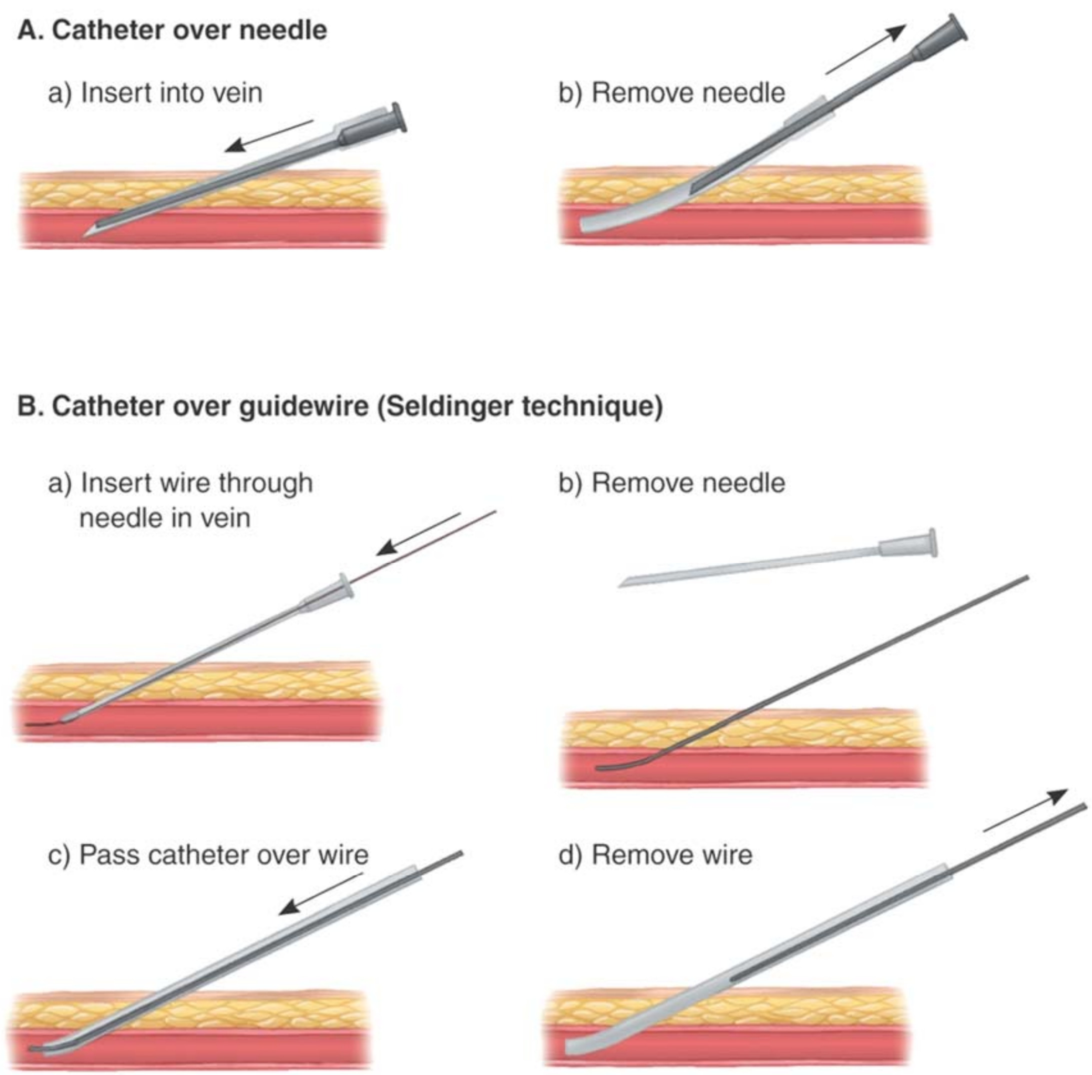
Indications

- Need for CVP monitoring
- Emergency venous access
  - Large volume fluid administration
  - Medication administration
- Routine venous access
  - Peripheral sites unavailable
  - Need for long-term venous access

Central Venous Catheter Insertion

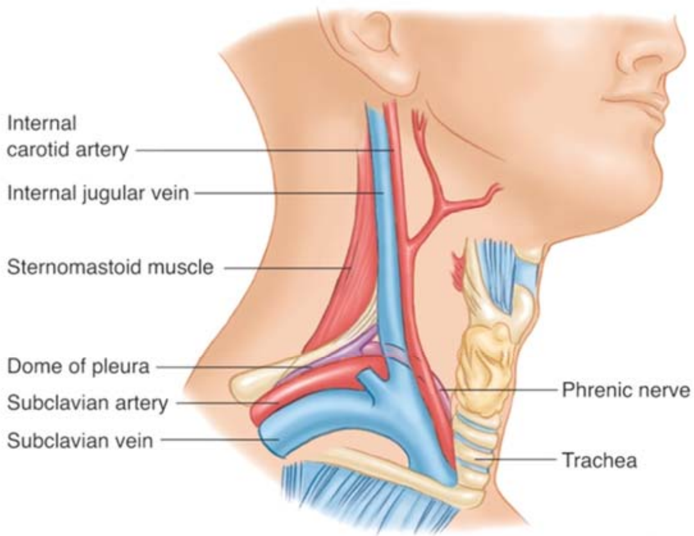
- Sterile conditions
- Seldinger technique
  - Needle puncture site anesthetized with 1% lidocaine
  - Needle placed in vein
  - Guidewire passed through needle into vein
  - Needle removed
  - Small skin incision made at guidewire to facilitate catheter passage
  - Catheter passed over guidewire into vein
  - Guidewire removed
  - Tubing attached to central line

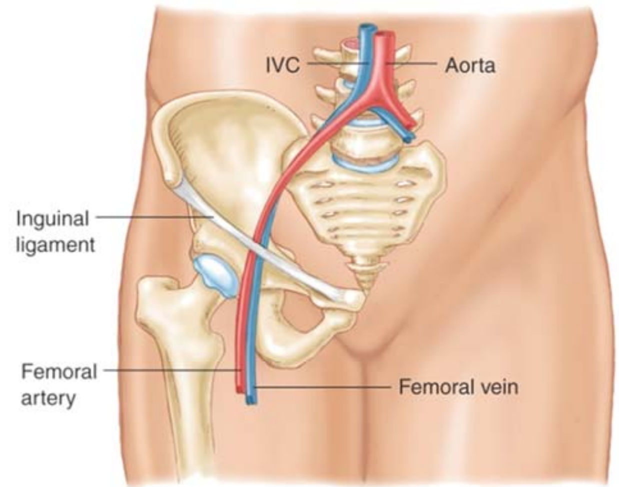
Seldinger Technique

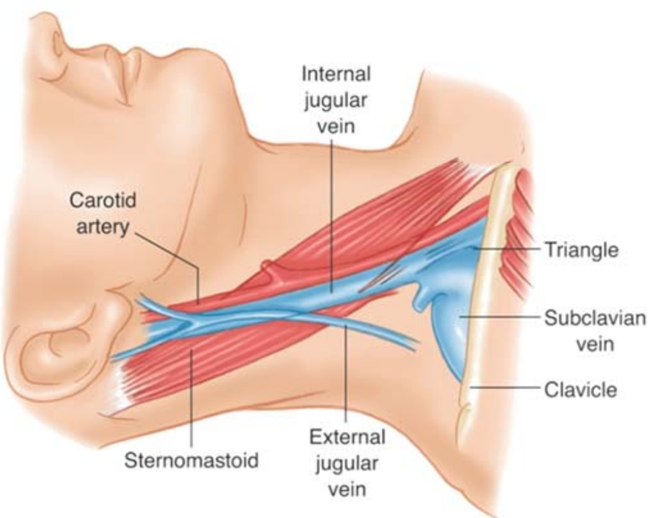


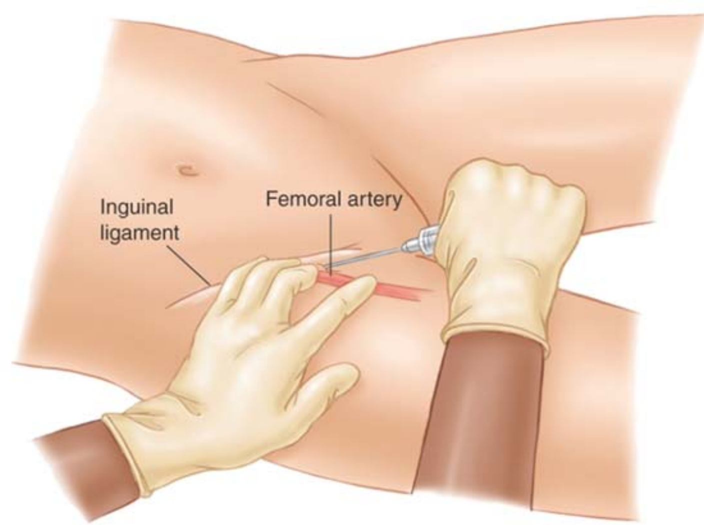
Different methods of insertion

Central Venous Catheter Insertion









Central Venous Catheter Insertion

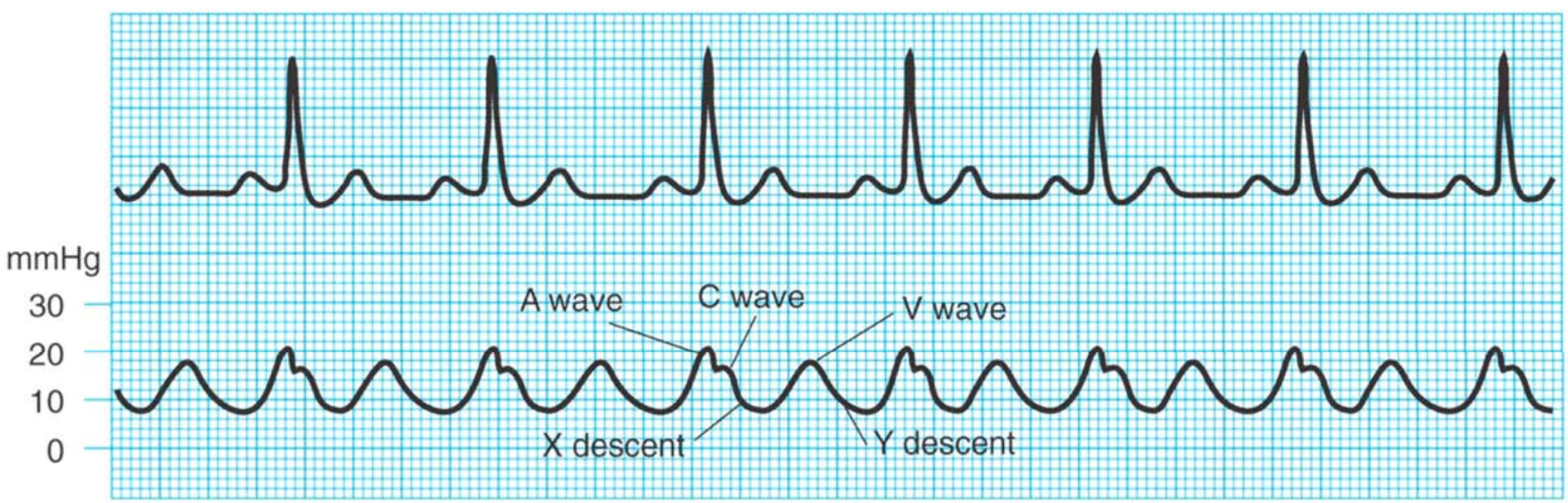
- Access routes
  - Most frequently used
    - Subclavian vein
    - Internal jugular vein
  - Infrequently used
    - Femoral vein
    - External jugular vein
    - Antecubital vein
      - If central route unobtainable
- Type of catheter used dictated by patient need
  - Single lumen
  - Double lumen
  - Triple lumen

Complications

- Hemorrhage
  - Venous perforation
  - Arterial puncture
  - Cannula dislodgment
- Pulmonary complications
  - Pneumothorax
  - Hydrothorax
  - Hemothorax
  - Pneumomediastinum
  - Hydromediastinum
- Dysrhythmias
- Infection
- Extravasation of administered fluids, medications

Central Venous Catheter Waveform

- When electronic monitor is used, waveform and numerical display are produced
- Systolic and diastolic pressures are indistinguishable
  - Low-pressure, venous system
- Mean pressure monitored



Pulmonary Artery Pressure Monitoring

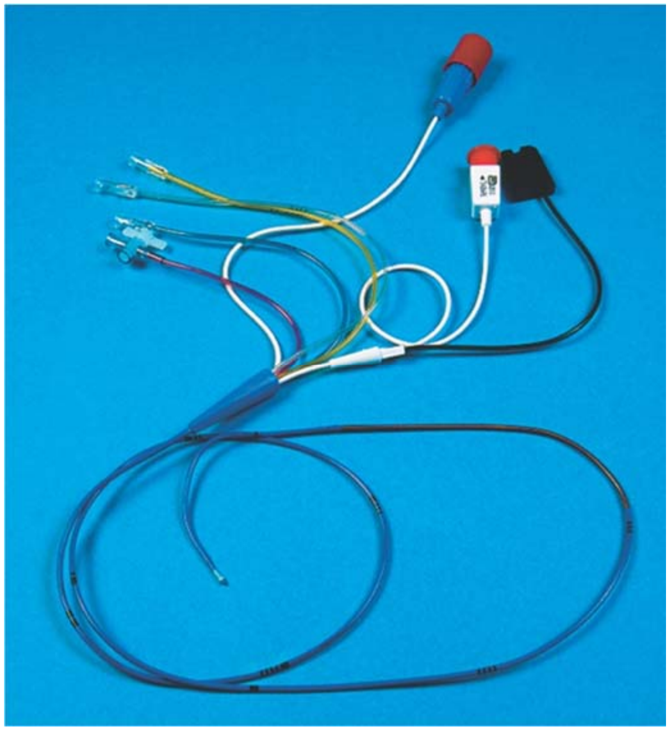
- Central venous catheter passed through right atrium, right ventricle, past tricuspid valve, and into pulmonary artery
- Allows monitoring of:
  - Right ventricular function
  - Pulmonary vascular status
  - Left ventricular function (indirectly)

Pulmonary Artery Pressure Monitoring

- Specific parameters measured
  - CO
  - Right arterial pressure
  - Right ventricular pressure
  - Pulmonary artery pressure
  - Pulmonary artery wedge pressure (PAWP)

Pulmonary Artery Pressure Monitoring

- Catheter
  - Flow-directed, balloon-tipped pulmonary artery catheter
    - Swan-Ganz catheter
    - Dual lumen
      - Distal port
      - Proximal port
    - Balloon inflated to:
      - "Float" catheter into position
      - Measure pulmonary wedge pressures



Waveform Interpretation

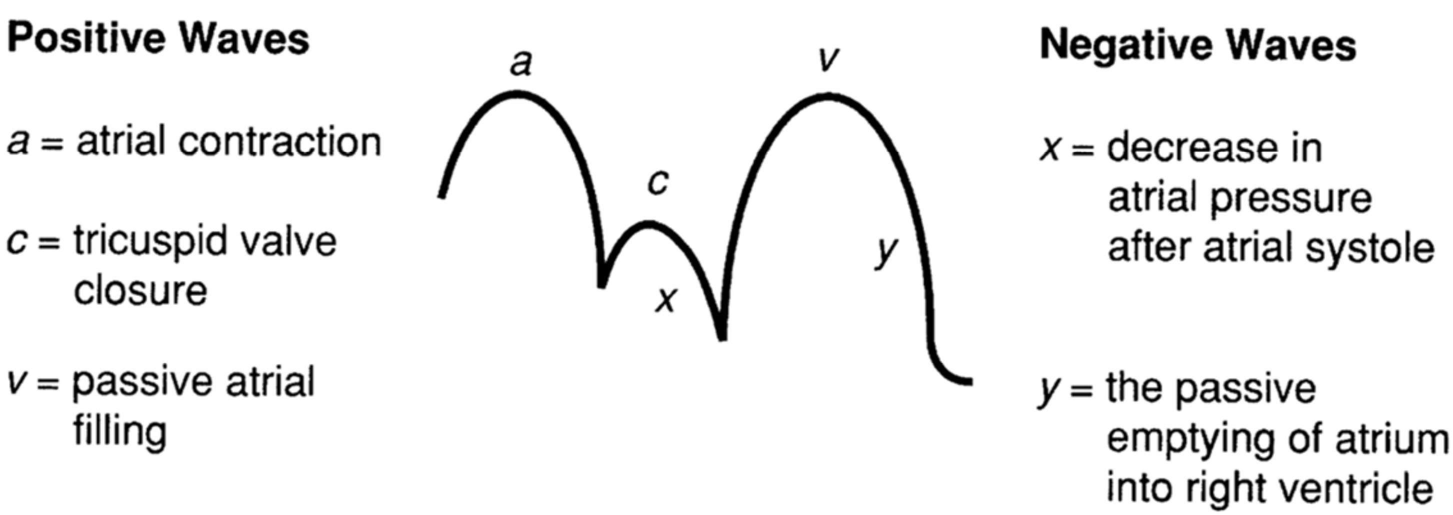
- Pressure changes during systole and diastole
- Waveforms classified as:
  - Right atrial
  - Right ventricular
  - Pulmonary artery pressure
  - Pulmonary artery wedge pressure
- Relationship between ECG and waveforms

Right Atrial Pressure

- Mean right atrial pressure
  - 8 mmHg

Right Atrial Pressure Waveform

- A wave
  - First positive deflection
  - Rise in pressure due to atrial contraction
  - Follows P wave of ECG



Right Atrial Pressure Waveform

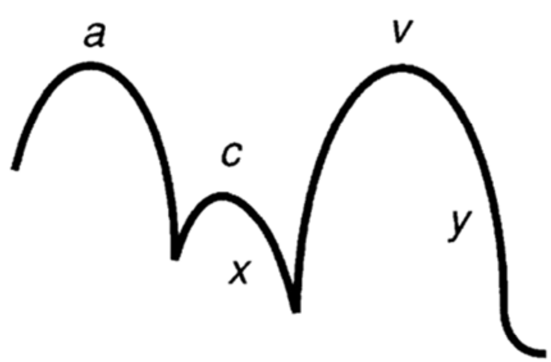
- X descent
  - Downslope following A wave
  - Fall in pressure due to relaxation of atria

Positive Waves

a = atrial contraction

c = tricuspid valve closure

v = passive atrial filling



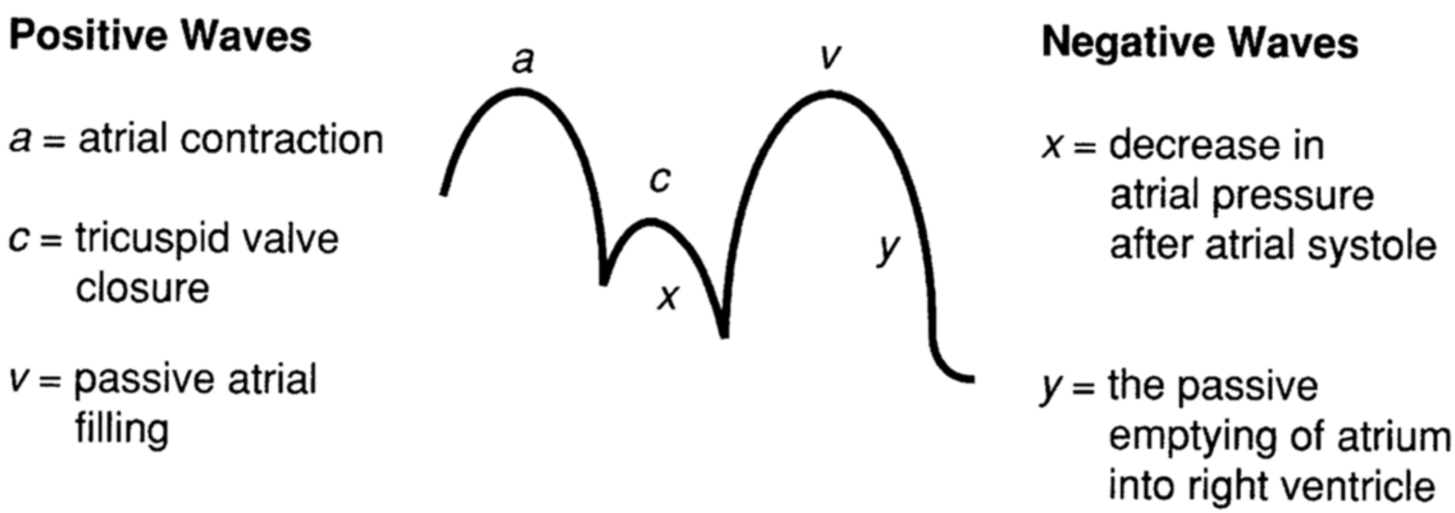
Negative Waves

x = decrease in atrial pressure after atrial systole

y = the passive emptying of atrium into right ventricle

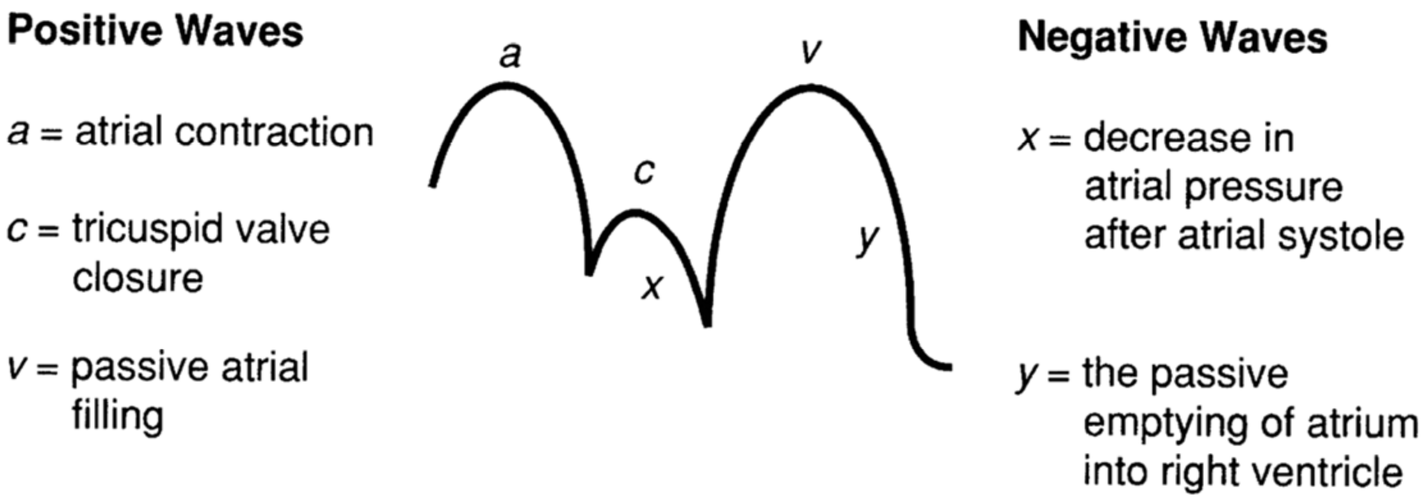
Right Atrial Pressure Waveform

- C wave
  - Small positive deflection on downslope of A wave (X descent)
  - Bulging of tricuspid valve early in ventricular systole



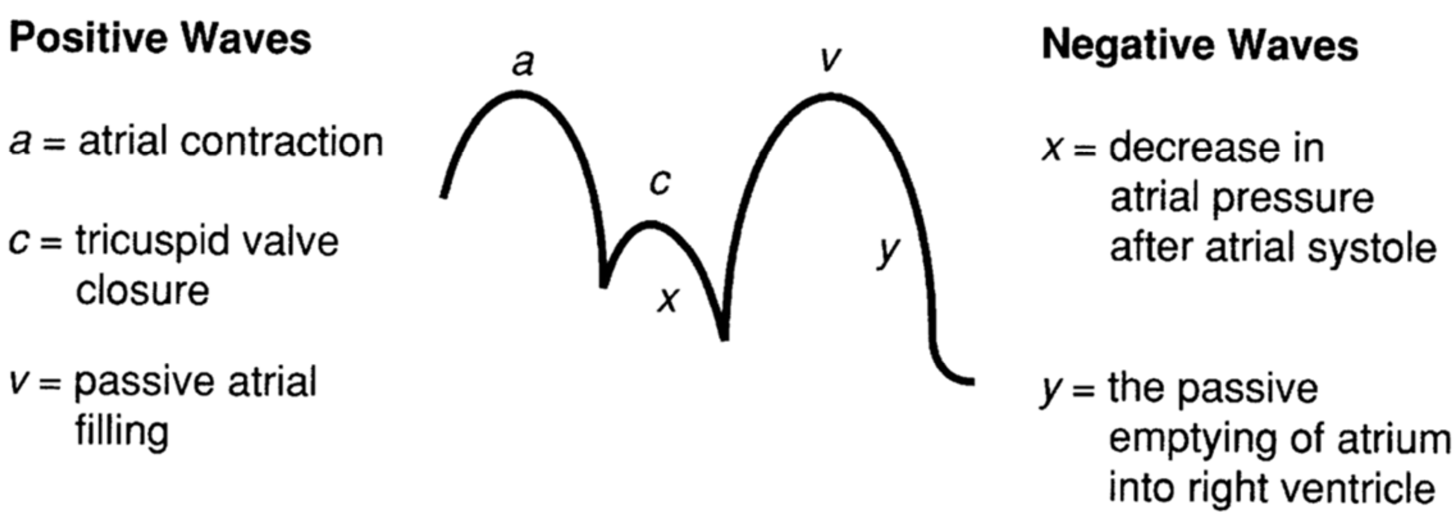
Right Atrial Pressure Waveform

- V wave
  - First positive deflection following C wave
  - Caused by atrial filling during ventricular systole



Right Atrial Pressure Waveform

- Y descent
  - Follows V wave
    - Fall in pressure due to opening of tricuspid valve
      - Ventricular filling



Right Ventricular Pressure

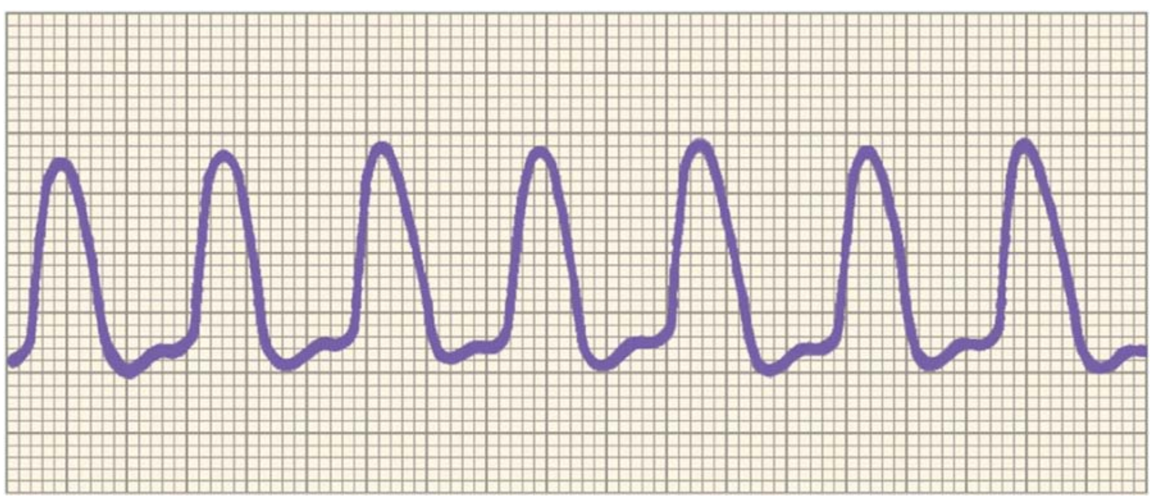
- Right-atrial end-diastolic pressure
  - 0–8 mmHg
  - Equal to right atrial pressure when tricuspid valve opens

Right Ventricular Pressure

- Right-atrial systolic pressure
  - 15–30 mmHg
  - Opens pulmonic valve
    - Propels blood into pulmonary artery
  - Higher-pressure chamber

Right Ventricular Pressure Waveform

- Early, steep upstroke
  - Rapid, passive ventricular filling
- Middle, gradual upstroke
  - Slower filling period
- Late, steep upstroke
  - Ventricular filling during atrial systole

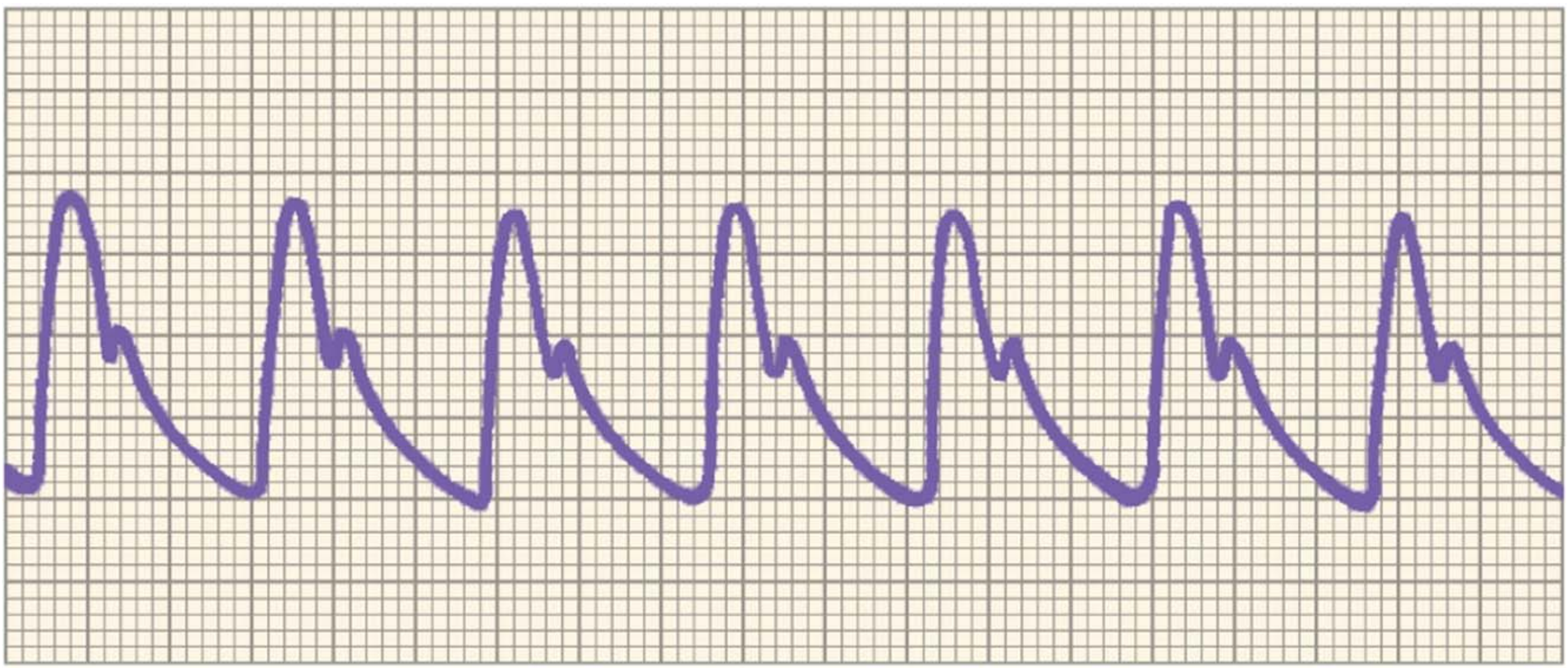


Right Ventricular Pressure

- Right atrial and ventricular pressures equal during diastole
  - Tricuspid valve open
- Pressures monitored
  - Right ventricular systolic peak
  - Right ventricular end-diastolic

Pulmonary Artery Pressure

- Low-pressure system
- Pulmonary artery pressure



Pulmonary Artery Pressure

- Systolic
  - 15–30 mmHg
  - Equal to right ventricular systolic pressure

Pulmonary Artery Pressure

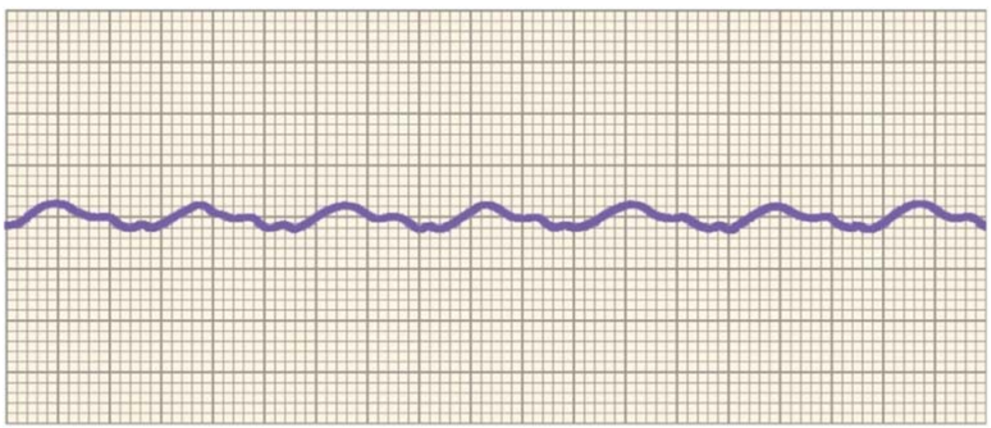
- Diastolic
  - 8–15 mmHg
  - Reflects resistance of pulmonary vascular bed
    - Left-ventricular end-diastolic pressure also
    - PA diastolic pressure is indirect measurement of left ventricular pressure

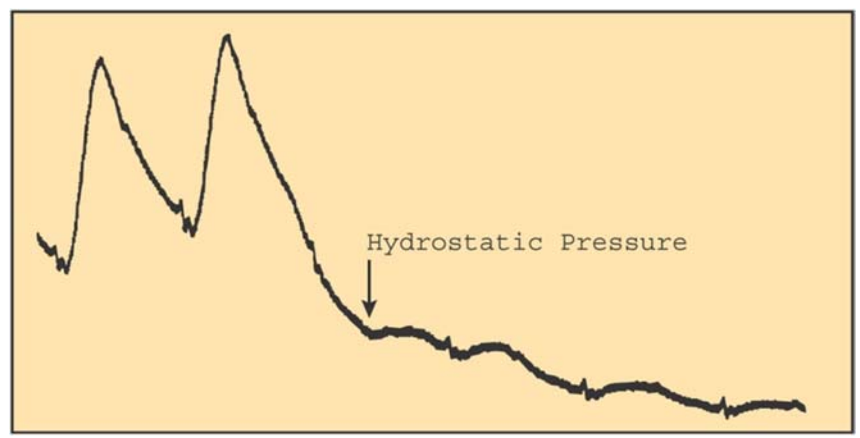
Pulmonary Artery Pressure

- Mean pulmonary artery pressure
  - 10–20 mmHg

Pulmonary Artery Wedge Pressure (PAWP)

- Measures left-atrial and ventricular end-diastolic pressure
  - More accurate than estimate from pulmonary artery diastolic pressure





PAWP

- 8–12 mmHg
- Catheter tip placed in pulmonary artery
  - In-place pulmonary artery catheter used
  - Balloon on distal tip inflated
- Balloon advanced until it lodges in branch of pulmonary artery
  - Forward blood flow stopped
  - Static column of blood created
    - Branch of artery
    - Pulmonary capillaries
    - Pulmonary vein
    - Left atrium
    - Open mitral valve
      - During diastole
    - Left ventricle
  - Balloon deflated after measurements completed

PAWP Waveform

- A wave
  - Atrial contraction
- V wave
  - Left ventricular contraction

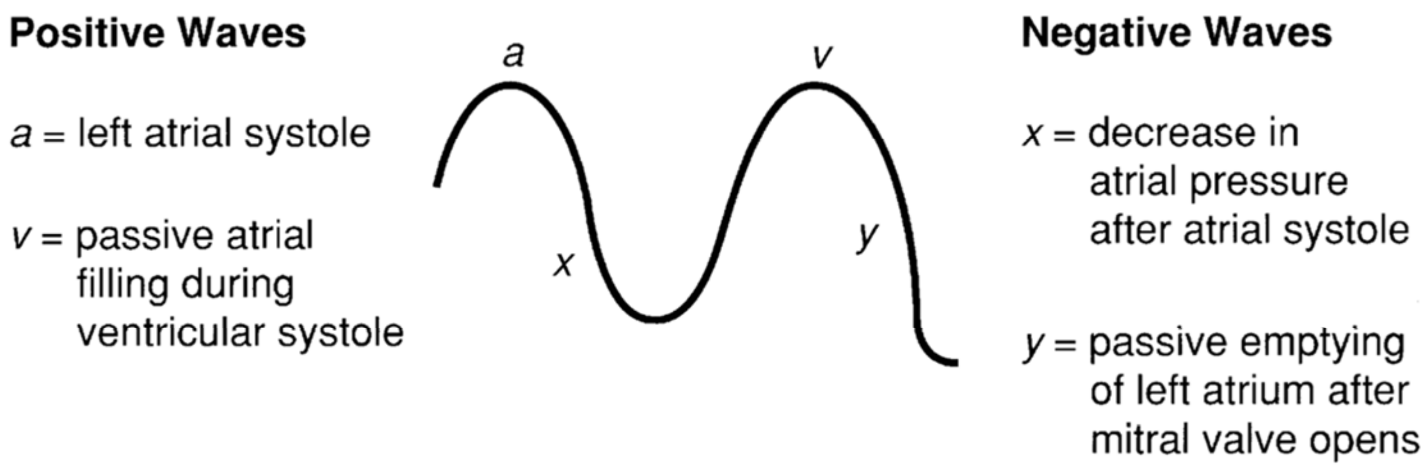
Complications of PA Catheterization

- Pulmonary injury
  - During needle puncture
- Dysrhythmias
- Infection
- Pulmonary artery rupture

Abnormalities in PA Catheter Pressures

PA Waveform Abnormalities

- Increased size of A waves
  - Impaired arterial emptying
    - Tricuspid stenosis
    - Right ventricular failure
- Increased size of V wave
  - Tricuspid incompetence
    - Regurgitation



Elevated PA Pressure

- Left ventricular failure
- Mechanical ventilation
- Increased pulmonary vascular resistance
  - Pulmonary hypertension
  - Pulmonary embolism
  - ARDS

PAWP Waveform Abnormalities

- Increased size of V waves
  - Seen with any resistance to ventricular filling
    - Mitral regurgitation
- Increased size of A waves
  - Seen with any pathology that increases pressure during atrial contraction
    - Mitral stenosis

PAWP Elevation

- Left ventricular dysfunction
- Increased circulating blood volume
  - Increases in right and left ventricular diastolic pressures
    - Constrictive pericarditis
    - Pericardial tamponade

Cardiac Output Determination

- Outputs of left and right ventricles are identical
  - Methods of CO determination
    - Fick method
    - Standard technique
    - Cold thermodilution technique

$$CO = SV \times HR$$

Fick Method

$$Q\ (\text{L/minute}) = \frac{O_2\ \text{Consumption (ml/minute)}}{\text{Arteriovenous Oxygen Difference (ml/minute)}}$$

Standard Technique

- Most dependable when CO low
  - Arteriovenous oxygen difference large

Cold Thermodilution Technique

- Principle
  - When indicator is introduced to flow of blood, concentration of indicator at downstream site is inversely proportional to flow rate
    - Higher the flow rate, lower the concentration
- Technique
  - PA catheter proximal port used to introduce indicator fluid
    - 5% dextrose solution
    - Normal saline
    - Mixes with blood in right ventricle
  - Thermistor (temp probe) at distal tip of catheter measures temperature of fluid as it passes through pulmonary artery
  - Most dependable when CO high

Hemodynamic Parameters

Body Surface Area (BSA)

- Better indicator of body size than height and weight

$$BSA\ (m^2) = \sqrt{\frac{[\text{Height (cm)} \times \text{Weight (kg)}]}{3{,}600}}$$

Central Venous Pressure (CVP)

- Measured with pulmonary artery catheter

CVP = Right Atrial Pressure = Right-Ventricular End-Diastolic Pressure

Pulmonary Capillary Wedge Pressure (PCWP)

PCWP = Left Atrial Pressure = Left-Ventricular End-Diastolic Pressure

Stroke Volume Index (SVI)

- Amount of blood ejected by ventricles during one contraction

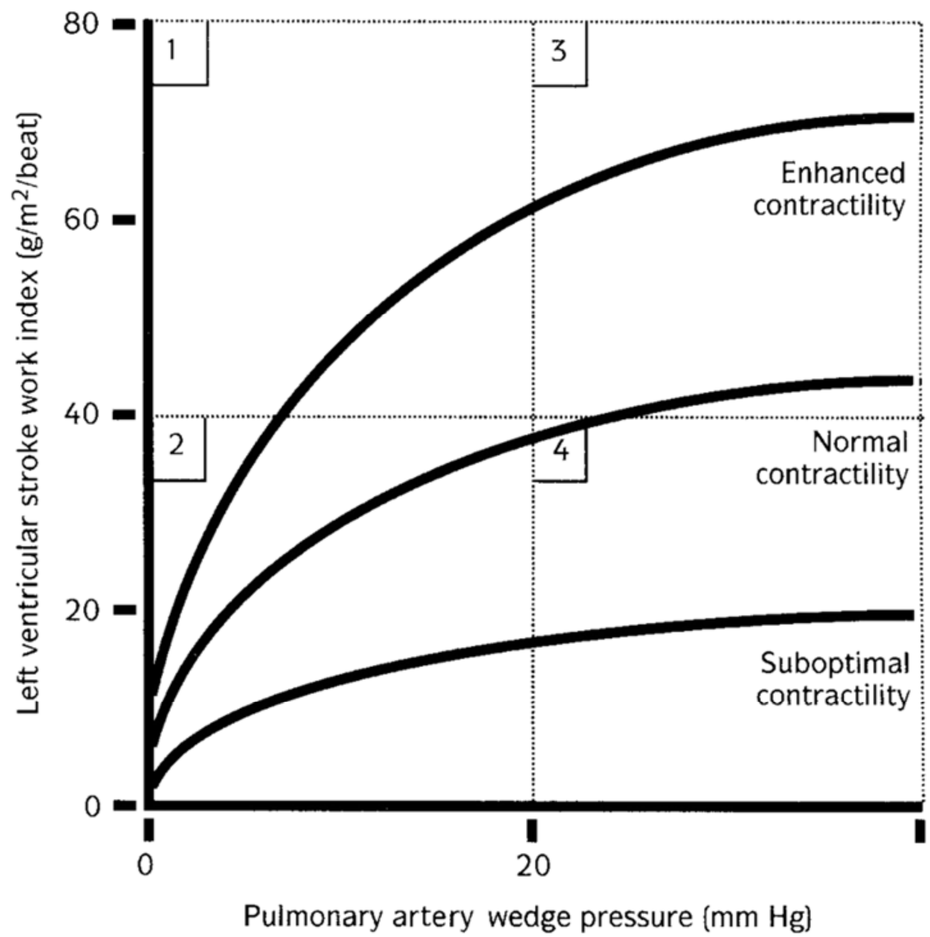
$$SVI = \frac{\text{Cardiac Index}}{\text{Heart Rate}}$$

Left Ventricular Stroke Work Index (LVSWI)

- Amount of work involved in moving blood in the left ventricle during one contraction
- Assesses contractility
- 35–80 g/m2/beat

$$LVSWI = (MAP - PAWP) \times SVI \times 0.0136 \text{ [constant]}$$

Left Ventricular Stroke Work Index (LVSWI)



Quadrant 1: Optimal function; Quadrant 2: Hypovolemia;
Quadrant 3: Hypervolemia; Quadrant 4: Cardiac failure

Systemic Vascular Resistance

- Resistance to blood flow created by systemic vasculature
  - Vasoconstriction increases SVR
    - Changes in blood viscosity can also affect SVR
  - Normal SVR = 900–1,200 dyne/sec/cm-5

SVR = (MAP – CV) Å CO

Systemic Vascular Resistance Index (SVRI)

- Measure of vascular resistance created by entire systemic circulation
  - Depends on:
    - Peripheral resistance
    - Preload
    - Cardiac output

$$SVRI = \frac{MAP - \text{Right Atrial Pressure}}{\text{Cardiac Index}} \times 80$$

Pulmonary Vascular Resistance (PVR)

- Calculation of right-side afterload
- Resistance to blood flow created by pulmonary vasculature
  - Pulmonary artery to left atrium
- Normal = 100–200 dyne/sec/cm-5

PVR (dyne/sec/cm -5) = (Mean Pulmonary Artery Pressure – PCWP) × 80

Pulmonary Vascular Resistance Index (PVRI)

$$PVRI = \frac{(PAP - PCWP) \times 80}{\text{Cardiac Index}}$$

Systemic Oxygen Transport

- Oxygen content
  - Amount of oxygen in blood available for offloading to cells
- Oxygen saturation
  - Amount of blood bound to hemoglobin
    - Oxyhemoglobin
    - 95 to 97 % of oxygen present as oxyhemoglobin
      - 3 to 5 Percent dissolved in plasma
  - Blood gas sample
    - Measures the oxygen dissolved in plasma

Systemic Oxygen Transport

- Oxygen delivery
  - Rate of oxygen transport
  - $DO_2 = \text{Cardiac Index} \times 13.4 \times \text{Hb} \times SaO_2$
- Mixed venous oxygen saturation
  - Oxygen saturation in pulmonary artery (SVO_2)
    - Measured with pulmonary artery catheter
  - SVO_2 varies inversely with amount of oxygen offloaded in microcirculation (oxygen uptake)
  - $SVO_2 = 1/O_2$ extraction

Systemic Oxygen Transport

- Oxygen uptake (VO_2)
  - Amount of oxygen offloading in microcirculation
  - $VO_2 = \text{Cardiac Index} \times 13.4 \text{ X Hb} \times (SaO_2 - SVO_2)$
- Oxygen extraction ratio (O_2ER)
- Ratio between O_2 delivery and O_2 uptake
  - $O_2ER = (VO_2/DO_2) \times 100$

Clinical Integration

Left Heart Failure

- Decreased CI
- Elevated PCWP
- Elevated SVRI

Cardiogenic Shock

- Decreased CI
- Elevated CVP
- Elevated SVRI
- Low DO_2
- Low VO_2

Hypovolemic Shock

- Decreased CI
- Decreased CVP
- Elevated SVRI
- Low VO_2

Distributive Shock

- Increased CI
- Decreased CVP
- Decreased SVRI
- Low VO_2

Pulmonary Catheter Placement

Indications of PA Catheter Placement

- Diagnosis of shock states and shock types
- Diagnosis of high-pressure versus low-pressure pulmonary edema
- Assessment of vascular tone
- Assessment of myocardial contractility, including determination of cardiac output
- Assessment of intravascular fluid balance

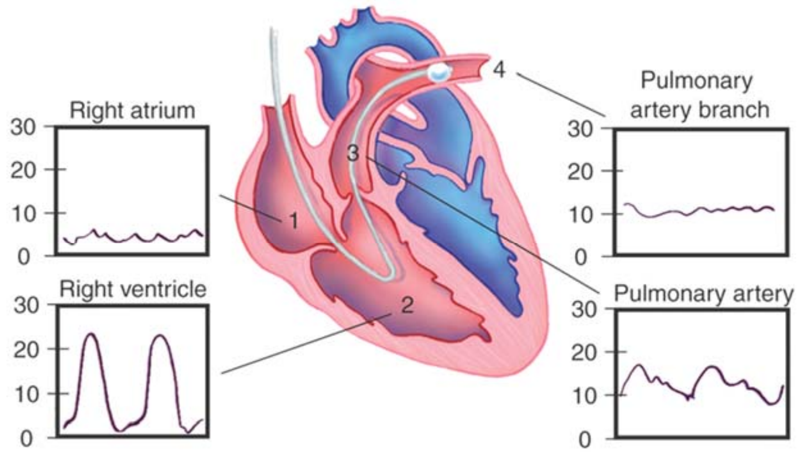
Indications of PA Catheter Placement

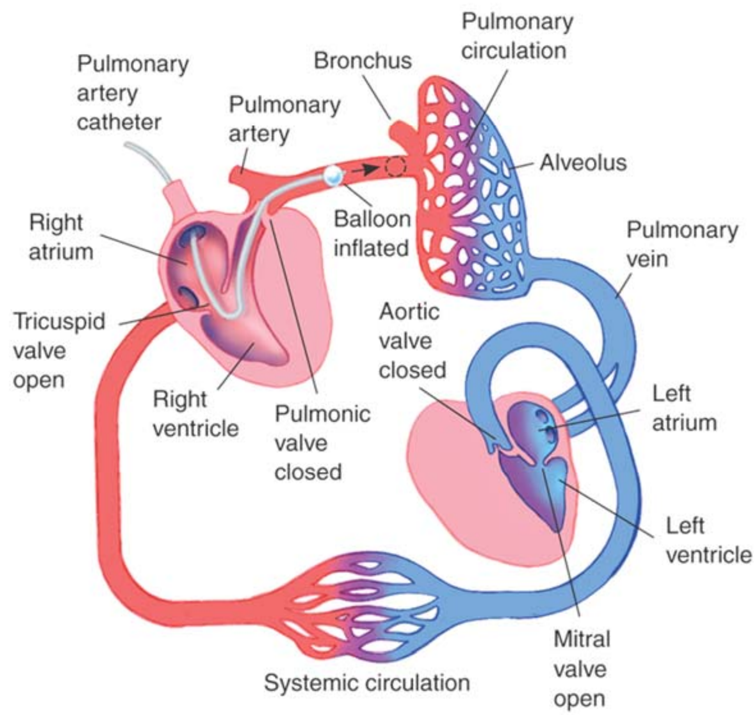
- Analysis of mixed venous oxygen saturation
- Monitoring and management of complicated AMI
- Assessment of hemodynamic response to therapies
- Management of MODS and/or severe burns
- Management of hemodynamic instability after cardiac surgery

Insertion of PA Catheter

- Catheter placed in vein
- Catheter fed into vein until distal tip in right atrium
- Distal balloon inflated with 1.5 cc of air
- Distal tip "floated" through tricuspid, into right ventricle, through pulmonic valve, and into pulmonary artery
- Balloon allowed to "wedge" itself in branch of pulmonary artery

Insertion of PA Catheter





Preparation for Hemodynamic Monitoring

- Prime the flush system
- Connect the transducer to the monitor
- Place the transducer
- Zero the pressure system to atmospheric pressure
- Calibrate the pressure system

Priming the Flush System

- Necessary equipment
  - 250–500 cc 0.9% normal saline or heparinized saline solution
  - Flush administration setup
- Tighten all connections in the flush administration set
- Expel all air from flush bag
  - 18g needle via medication administration port
- Spike flush bag, prime drip chamber, and administration set

Priming the Flush System

- Inspect the flush system for air bubbles
- Connect flush administration set to catheter being monitored
  – Flush administration set while connecting to catheter to eliminate air from the catheter
- Apply pressure infuser bag to flush solution
  – Inflate to 300 mm Hg

Connecting the Transducer to the Monitor

- Pressure transducer in administration set
- Connects to monitor cable via connector
  - Waveform visible
  - Leveling and zeroing of transducer needed for pressure measurement

Transducer Leveling and Zeroing

- Transducer placed at phlebostatic axis
  - Level of right atrium, fourth intercostal space
  - Patient supine
- Using three-way stopcock, close patient to transducer and open it to atmospheric air
- Activate zeroing function on monitor
- Close transducer to atmospheric air and open to patient

Transducer Waveform Calibration

- Transducer internally calibrated by monitor
- Most monitors today have default settings
  - Operator can rescale waveform

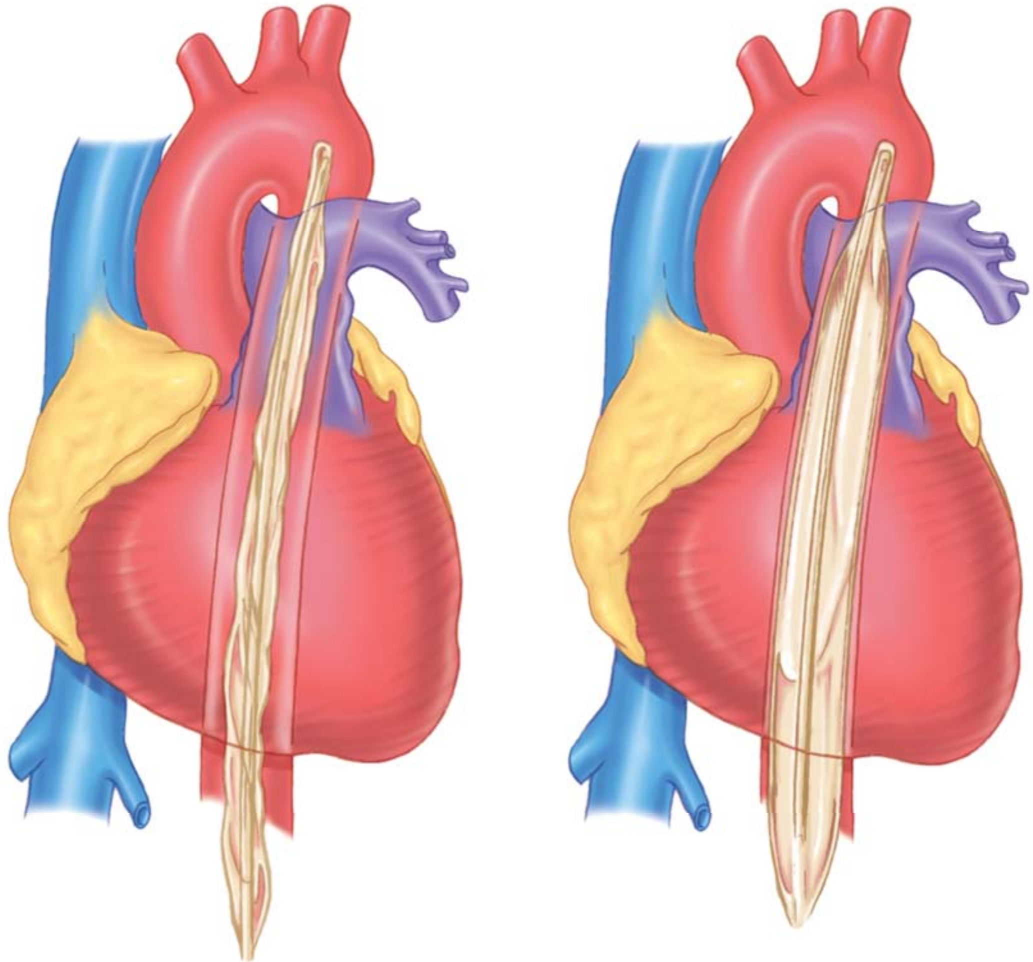
Complications of Invasive Catheters

- Hemorrhage
- Dysrhythmias
- Pulmonary injury
- Cardiac injury
- Dislodgement

Intra-Aortic Balloon Pump (IABP)

- Augments weakened heart's cardiac output
- Provides mechanical circulatory support for failing heart
- Catheter
  - 30-cm polyurethane balloon on distal end
    - Balloons sized according to height
  - Placed in aorta distal to left of subclavian artery
  - Inserted in femoral artery
  - During operation, rapidly inflated and deflated with 35–40 ml of helium

Intra-Aortic Balloon Pump (IABP)



A
Balloon deflated

B
Balloon inflated

Intra-Aortic Balloon Pump (IABP)

- IABP pump
  - Rate adjustable
    - 1:1, 1:2, 1:8
  - Inflation volume adjustable

Indications for IABP Therapy

- Cardiogenic shock
- Left ventricular failure
- Drug-induced cardiovascular failure
- Septic shock
- Stunned myocardium
- Cardiac surgery preparation

IABP Operation

- Balloon rapidly inflated at onset of ventricular diastolic period
  - Increases peak diastolic pressure
  - Displaces intravascular blood forward in circulation
  - Coronary artery perfusion increases
- Rapidly deflates at beginning of ventricular systole
  - Reduces end-diastolic pressure
    - Reduces impedance to forward blood flow
    - Decreases afterload
    - Increases SV

Datascope, Fairfield, NJ

IABP Contraindications

- Gross aortic insufficiency
- Peripheral vascular disease with poor femorals
- Irreversible brain damage
- Chronic end state heart disease
- Dissecting aortic or thoracic aneurysms
- Peripheral vascular disease

Side Effects and Complications

- Limb ischemia
- Bleeding at insertion site
- Thrombocytopenia
- Immobility of balloon catheter
- Balloon leak or rupture
  - Helium embolization
  - Thrombus formation
- Infection
- Aortic dissection
- Compartment syndrome

Intra-aortic Balloon Pump (IABP)

- Transport management of patient on IABP includes:
  - Evaluating patient response to treatment in terms of:
    - Hemodynamic status
    - Dysrhythmia control
    - Systemic perfusion
    - Relief of symptoms of cardiac ischemia

Intra-aortic Balloon Pump (IABP)

- Transport management of patient on IABP includes:
  - Observing such early signs of complications from IABP therapy as:
    - Limb ischemia
    - Bleeding
    - Infection
    - Thrombus formation
    - Displacement of balloon catheter
    - Arterial damage

Intra-aortic Balloon Pump (IABP)

- Ensure proper IABP functioning, including:
  - Correct timing
  - Consistent triggering
  - Appropriate troubleshooting of all alarm situations
  - Safe operation

Intra-aortic Balloon Pump (IABP)

- Air medical transport considerations
- Hypobaric environment can impeded IABP functioning
  - Volume decreases on ascent
  - Volume decreases on descent
- IABP must be reprimed
  - During ascent
  - At altitude
  - During descent

Mechanical Circulatory Support

- Ventricular assist device (VAD)
  - Used to increase CO in patients refractory to IABP therapy
  - Commonly used post–cardiac bypass surgery
  - Pumps placed in ventricle
    - Right (RVAD)
    - Left (LVAD)
    - Both (BiVAD)
  - External power source required
  - Short-term device
    - Bridge to cardiac transplantation

Left Ventricular Assist Device (LVAD)

- Allows rest of injured myocardium by diverting blood flow from injured left ventricle to mechanical pump
  - Pump maintains circulation
- Patients who can benefit from LVAD include those with:
  - Cardiogenic shock secondary to AMI
  - Postcardiotomy ventricular failure
  - Cardiac transplant candidacy

Summary

- Critical care paramedics will most likely not be required to establish/insert hemodynamic monitoring catheters
  - Must be familiar with insertion technique, however
- Must be prepared to:
  - Interpret data
  - Use data in differential diagnosis and treatment decisions
- Manage complications of devices