



ICU Competencies- PREVIEW

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Hospital

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Module 2:

Understanding ICU Equipment

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Objectives

Upon completion of this module, the learner will be able to:

- Identify common ICU equipment and be able to state the indications and precautions of each
- Discuss the ability to mobilize patients with various pieces of ICU equipment and any considerations that need to be undertaken
- Make clinical decisions regarding hemodynamic parameters

The Bedside Monitor

- **Monitoring Screen**
 - Heart rate
 - Arterial blood pressure
 - Central Venous Pressure
 - Pulse oximetry



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EKG

Let's Start with the Basics

- 2 Types of EKG monitoring
 - Hardwire
 - Telemetry

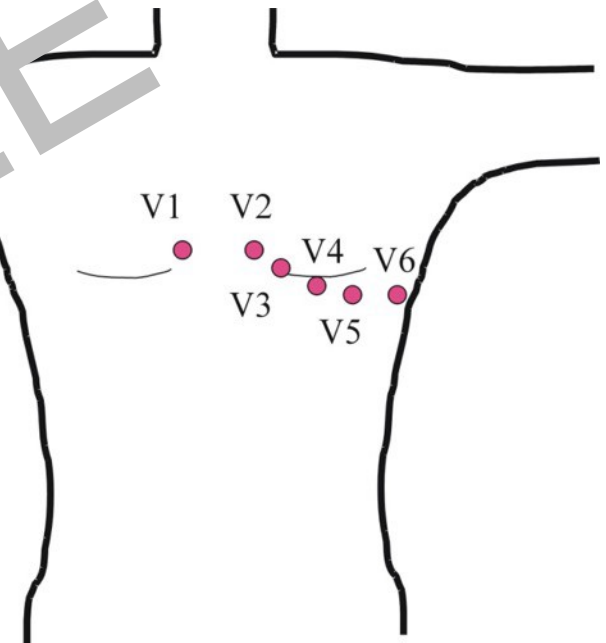
SAMPLE

EKG: Hardwire

- Patient is attached to monitor by a “hardwire”
- Allows for 12 lead monitoring (shows all areas of the heart muscle)
- Primarily used to diagnose ischemia and MI
- Pros:
 - More thorough monitoring by various leads
- Cons
 - Less portable. Not generally connected to central alarm system if arrhythmia arises

12 Lead EKG

- V1** – right sternal border in the 4th intercostal space
- V2** – left sternal border in the 4th intercostal space
- V3** – midpoint on a straight line between V2 & V4
- V4** – 5th intercostal space, midclavicular line
- V5** – anterior axillary line, immediately horizontal to V4
- V6** – midaxillary line, immediately horizontal to V4 & V5



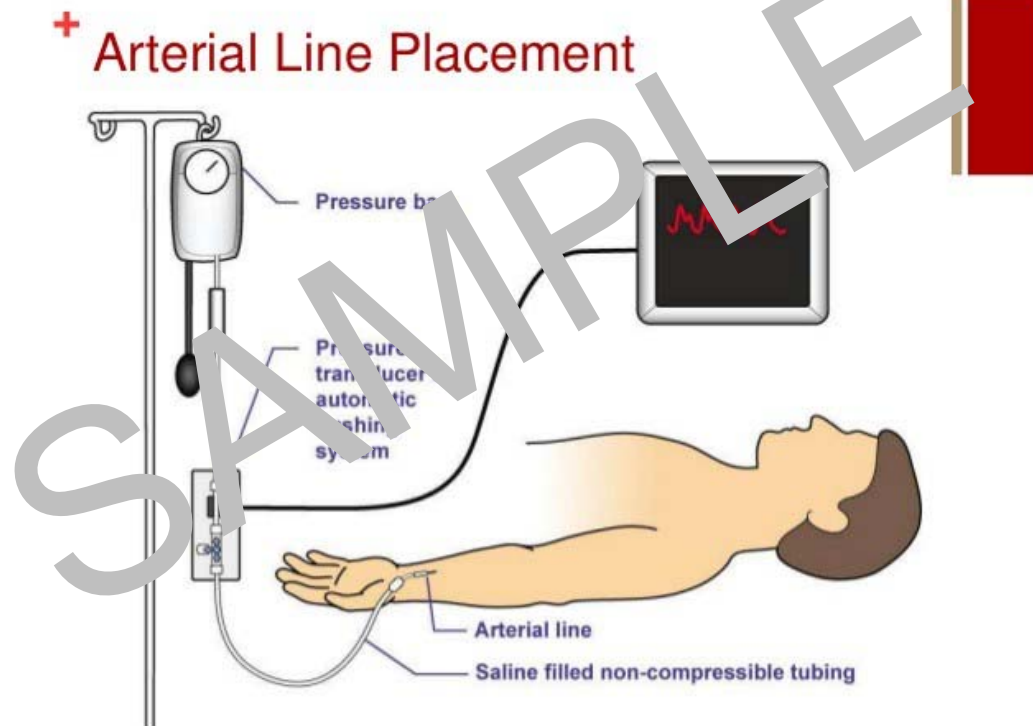
EKG: Telemetry

- Portable
- Does not monitor all 12 leads
- Simple detection of rate and rhythm disturbances
- Unable to use to diagnose ischemia or MI
- Pros:
 - More portable and “user-friendly”
 - Attached to central alarm system
- Cons:
 - Less ability to recognize ischemia/ MI

Blood Pressure Monitoring

- Non-Invasive (NBP)
- Invasive
 - Arterial Blood Pressure (ABP)
 - Radial, Femoral, Pedal, Brachial
 - Central Venous Pressure (CVP)
 - Pulmonary Artery (PA) Catheter

Arterial Lines



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Arterial Blood Pressure

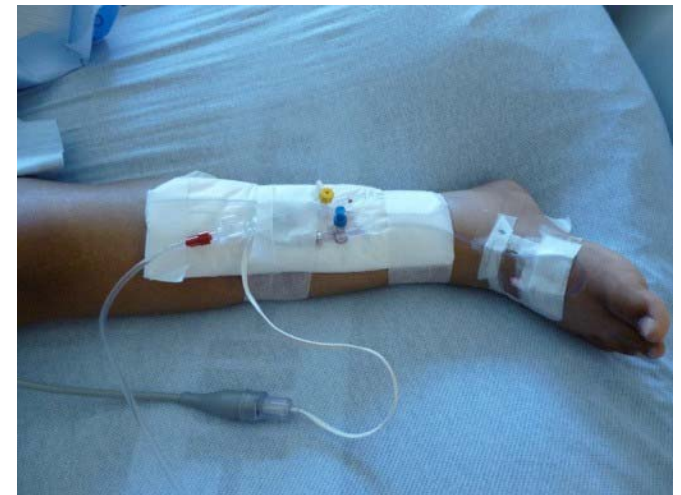
- Radial



Taken by Jason Seltzer 5/2/17 CCU JHH

Arterial Blood Pressure

- Pedal



Taken by Jason Seltzer 3/21/17 SICU JHH

Arterial Blood Pressure

- Used for direct and continuous BP measurements
- Can be also used for easy arterial blood draws
- Transducer provides electrical read-out
- Heparinized d-saline pressure bag attached to prevent clot formation/occlusion of the line

ABP: Waveform

- Left ventricular ejection generates a pressure wave through the peripheral artery system; this waveform is displayed on the bedside monitor
- Each part of the waveform corresponds to a phase of the cardiac cycle



Arterial Blood Pressure

- Transducer should be horizontal and close to the level of the right atrium
- For every 6 inches the arm is raised above or below the heart, BP measurement can change by 10 mmHg
- ABP systolic will be slightly higher and ABP diastolic slightly lower (5-10 mm/Hg) than NBP

Mean Arterial Pressure (MAP)

- Average pressure that pushes blood through the circulatory system, although not a true mathematical mean of systolic and diastolic
 - $MAP = 1/3 (SBP - DBP) + DBP$
- Indication of tissue and organ perfusion
- Generally considered more important than actual blood pressures in the ICU setting

Mean Arterial Pressure (MAP)

- Normal value: 80-100 mmHg
- $\text{MAP} \leq 60$ mmHg indicates that perfusion to vital organs may be compromised
- Important to understand MAP goals for each patient, especially when on vasopressor or vasodilator medications

Arterial Blood Pressure

- Tricks of the trade...
 - MAP may be a better indication of perfusion and medical stability for PT rather than BP. Look at overall trends for clinical decision-making
 - Art line readings will be “positional” with movement. Reposition transducer if needed. Ensure good waveform throughout treatment. If you are unsure whether reading is accurate, check a NBP
 - When switching to and from portable monitoring, the arterial line will need to be “zeroed” to ensure accuracy

Orthostatic Hypotension

Tricks of the trade...

- Drop in systolic BP by 20 mmHg and/or drop in diastolic by 10 mmHg
- Most accurate diagnosis of orthostatic BP is made when BP is measured 3 min after quiet standing (NOT immediately upon standing)
- Not all patients will have associated increased HR (especially if they are on beta-blocker meds)

Central Venous Pressure (CVP)

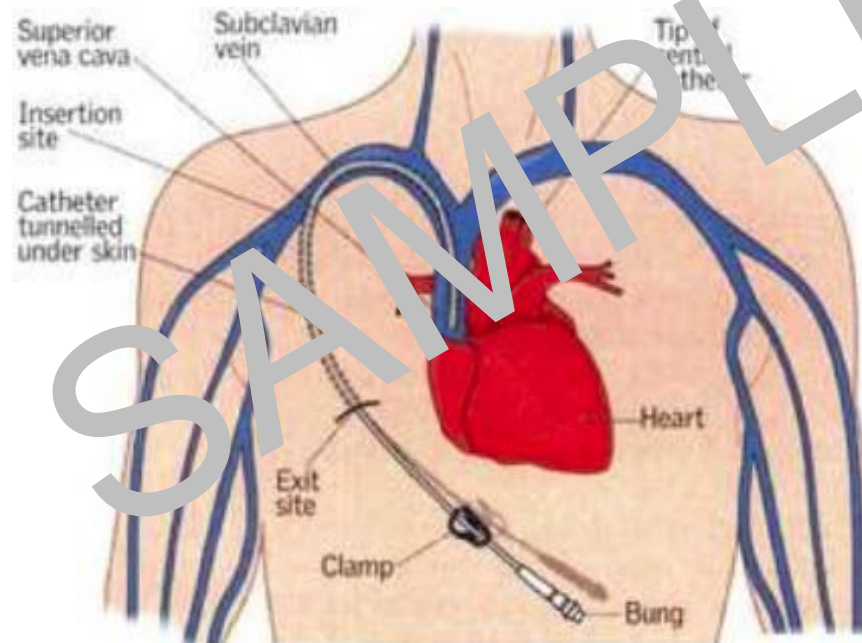
- Direct measurement of the pressure in the right atrium
- Direct relationship exists between cardiac venous return and CVP (i.e. as venous return decreases, CVP also decreases)
- Used to assess right heart function and volume status
- Catheter also provides central IV access for medication administration or blood draws

Central Venous Pressure (CVP) Line

- Equipment: transducer, pressure bag and CVP catheter
 - Single or multiple lumens
 - Common insertion sites: subclavian and jugular
- Catheter tip sits just outside the right atrium in the SVC



+ Central Venous Pressure Monitoring



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Monitoring



CVP

- Patient positioning will affect CVP readings
 - CVP will drop when patient is sitting upright due to gravity's effects on changes in intrathoracic blood volume
- Normative Values: 0-5 mmHg
- Low CVP= hypovolemia
- High CVP= volume overload or R sided heart failure

CVP

Tricks of the trade...

- There is probably little need to monitor CVP continuously during activity. Many times the transducer can be disconnected for ambulation and mobility. Discuss with the patient's nurse
- If CVP is high, may want to consider modifying treatment intervention if patient is in heart failure
- If CVP is low, monitor MAP to ensure adequate perfusion

Pulmonary Artery (PA) Pressure

- Similar insertion sites as CVH, but catheter is advanced through the right side of the heart and into the proximal portion of the pulmonary artery
- Other name- Swan Ganz Catheter

Pulmonary Artery (PA) Pressure

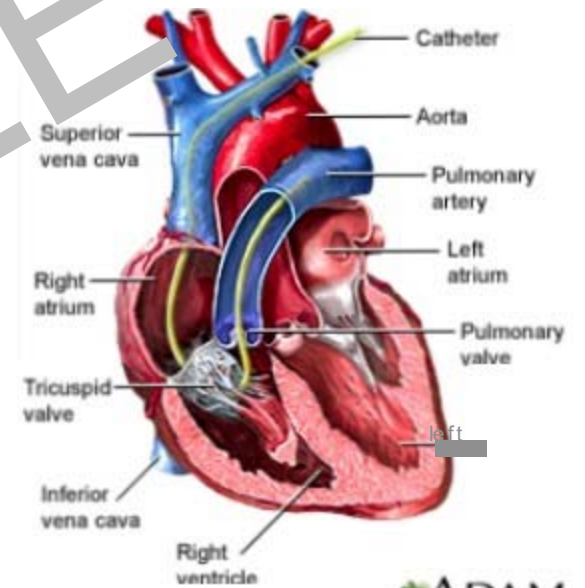
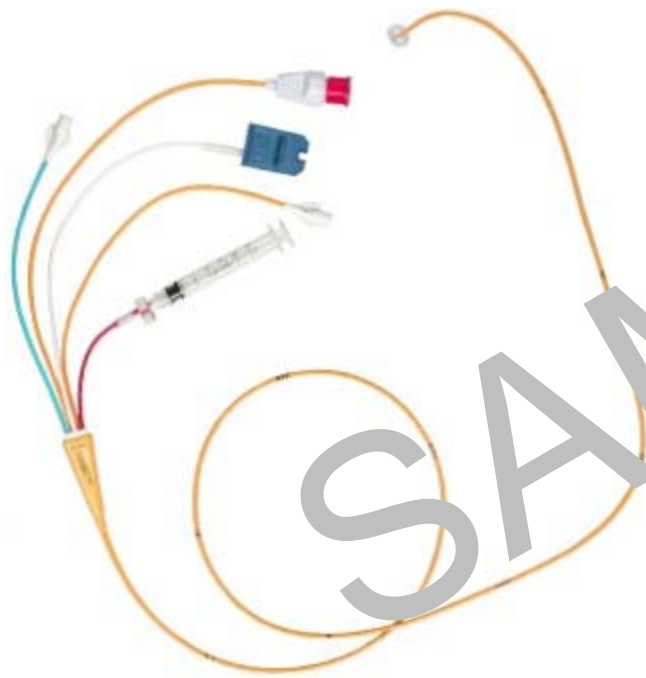
Measures:

- Right atrial, ventricular, and pulmonary arterial pressures (including wedge pressure)
- Cardiac output
- Calculation of systemic and pulmonary vascular resistance (PVR)
- Indirect measurement of L-sided heart function

Central Lines- PA Catheter

Pulmonary Artery (Swan-Ganz) Catheter

- Used when precise measurements are needed about pressures and volume
- Measures left-sided heart pressure, cardiac output, and fluid status



PA Catheter: Normative Values

- Right atrium pressure: 0-8 mmHg
- Right ventricle pressure: 15-25 mmHg systolic, 0-8 mmHg diastolic
- Pulmonary artery pressure: 15-25 mmHg systolic, 6-12 mmHg diastolic
- In general, increased values demonstrates volume overload and/or right sided heart failure. Low values demonstrate hypovolemia

PA Catheter: Normative Values

Pulmonary artery wedge pressure

- Assesses L-sided heart function
- Balloon tip inflated in the pulmonary artery to assess left sided heart function (wedge position)
- Normal value 4-12 mmHg
- Increased wedge pressure: L-sided heart dysfunction and volume overload
- Decreased wedge pressure: hypovolemia

PA Catheters

Tricks of the Trade:

- Mobility is contraindicated when the balloon is in the wedged position within the pulmonary artery (risk of tearing arterial wall)
- Ensure that the catheter is positioned in the “pulled back” position in the pulmonary artery and not in the “advanced” position in the pulmonary capillary bed

PA Catheters

Tricks of the Trade:

- Avoid excessive movement of the line
- Dislodgement of the PA catheter is a very serious event and may cause patient death
- Patients can be mobilized with a PA catheter, but open communication is needed of all health care providers to ensure safety

Continuous Dialysis

CVVHD (Continuous Veno Venous Hemodialysis)

- Provided over a prolonged period of time as compared to traditional HD
- Can be used for HD and/or ultrafiltration
- Used in ICUs for patients with critical illness whose hemodynamic status would not tolerate traditional HD
- Access is usually subclavian, IJ, or femoral



SAMPLE

Continuous Dialysis

Tricks of the trade:

- May be difficult to mobilize a patient with femoral access with CVVHD running. Check your hospital policy
- Otherwise, the patient can be mobilized with care taken to avoid tension on the CVVHD lines. Keep in mind that many CVVHD units cannot be unplugged to allow for ambulation



Intracranial Pressure Monitoring

- Intracranial Pressure (ICP)
 - Monitors CSF & brain pressure
 - Normal is 0-15 mmHg
- Can be placed:
 - In lateral ventricles (intraventricular catheter)- most common
 - Between arachnoid membrane and cortex (Subarachnoid screw or bolt)
 - Epidural space (Epidural sensor)

ICP Monitoring

- Intracranial Pressure (ICP)
 - Ideal is to keep ICP pressure below 20-25 mmHg
- Tricks of the Trade
 - Ventricular drains should be clamped before changing the patient position (even the head of the bed), during excessive coughing, and suctioning
 - Take extreme care with ICP monitoring lines. Have someone manage the head with transfers

Intra Aortic Balloon Pump

- Used in severe heart failure
 - Unstable angina
 - Left ventricular failure
 - Cardiogenic shock
- Line placed through the femoral artery to the aorta
- Inflates during diastole (perfuses coronary arteries)
- Deflates during systole
- Increased myocardial perfusion and cardiac output

Intra Aortic Balloon Pump

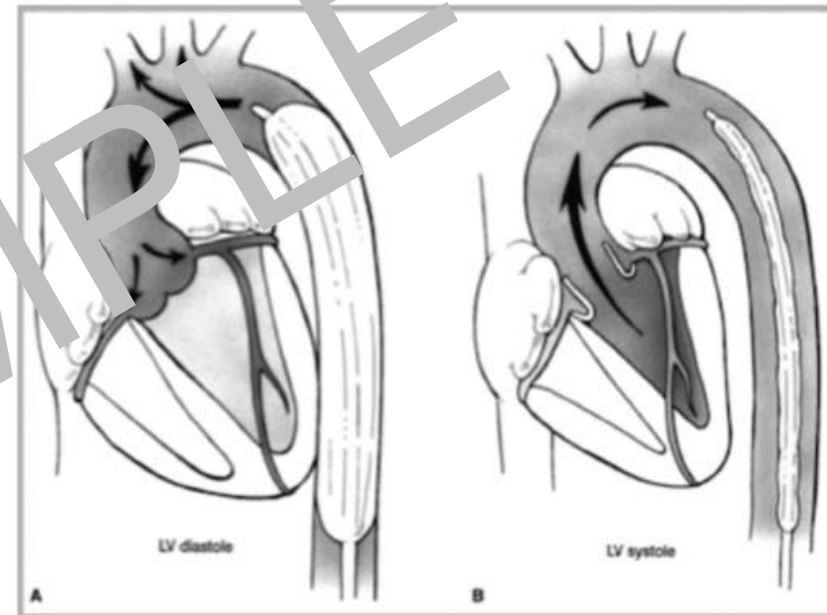


Figure 1. Intra-aortic balloon pump: (A) When the IABP is inflated, coronary blood flow is augmented; (B) deflation results in afterload reduction.

Intra Aortic Balloon Pump

Tricks of the trade:

- Patients are usually on bed rest, but still may benefit from exercises to the uninvolved limbs and focus on pulmonary status
- Limitations on the ability to flex the hip where the line is and how far the head of the bed can be elevated (usually 30 degrees or less for both). Check your hospital policy

Extra Corporeal Membrane Oxygenation (ECMO)

- A type of cardiopulmonary bypass that can be used for days to weeks to allow time for recovery, or as a bridge to transplant
- Patients blood is pumped out through a cannula to a oxygenator that serves the function of the lungs
- Used as a “last chance” effort to save a life

Extra Corporeal Membrane Oxygenation (ECMO)

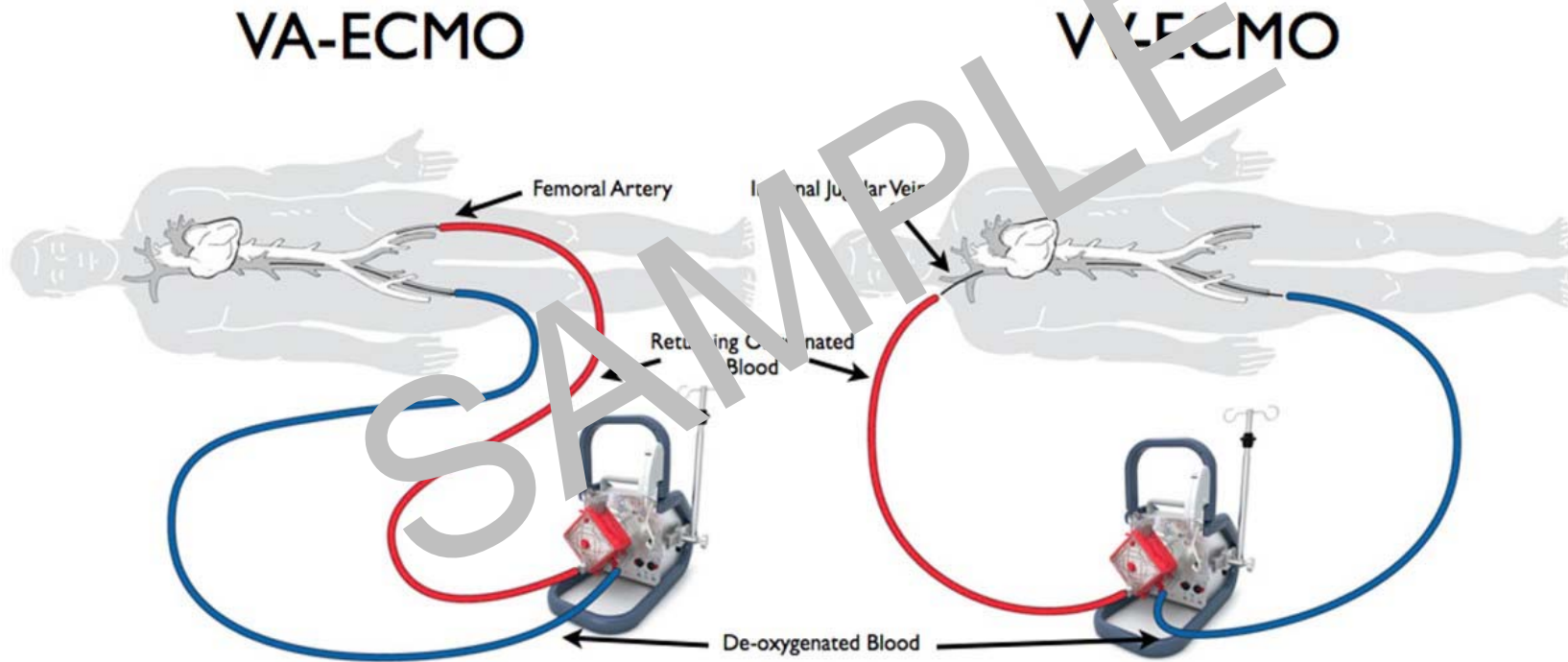
Two types of systems:

- Veno-arterial (less common, used mostly in post-op cardiac surgery patients with persistent heart failure)
- Veno-venous systems (more common, used more for severe resp failure)

Complications:

- Bleeding due to high amounts of anticoagulation needed
- Tubing can become kinked
- Infection

ECMO



Extra Corporeal Membrane Oxygenation (ECMO)

Tricks of the trade:

- Certain patients on ECMO can be mobilized out of bed and ambulate (if not cannulated through femoral access). This requires a team approach from physicians, nurses, rehab staff, and perfusionist team to ensure safety of the patient and equipment

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