Advanced Patient Monitoring

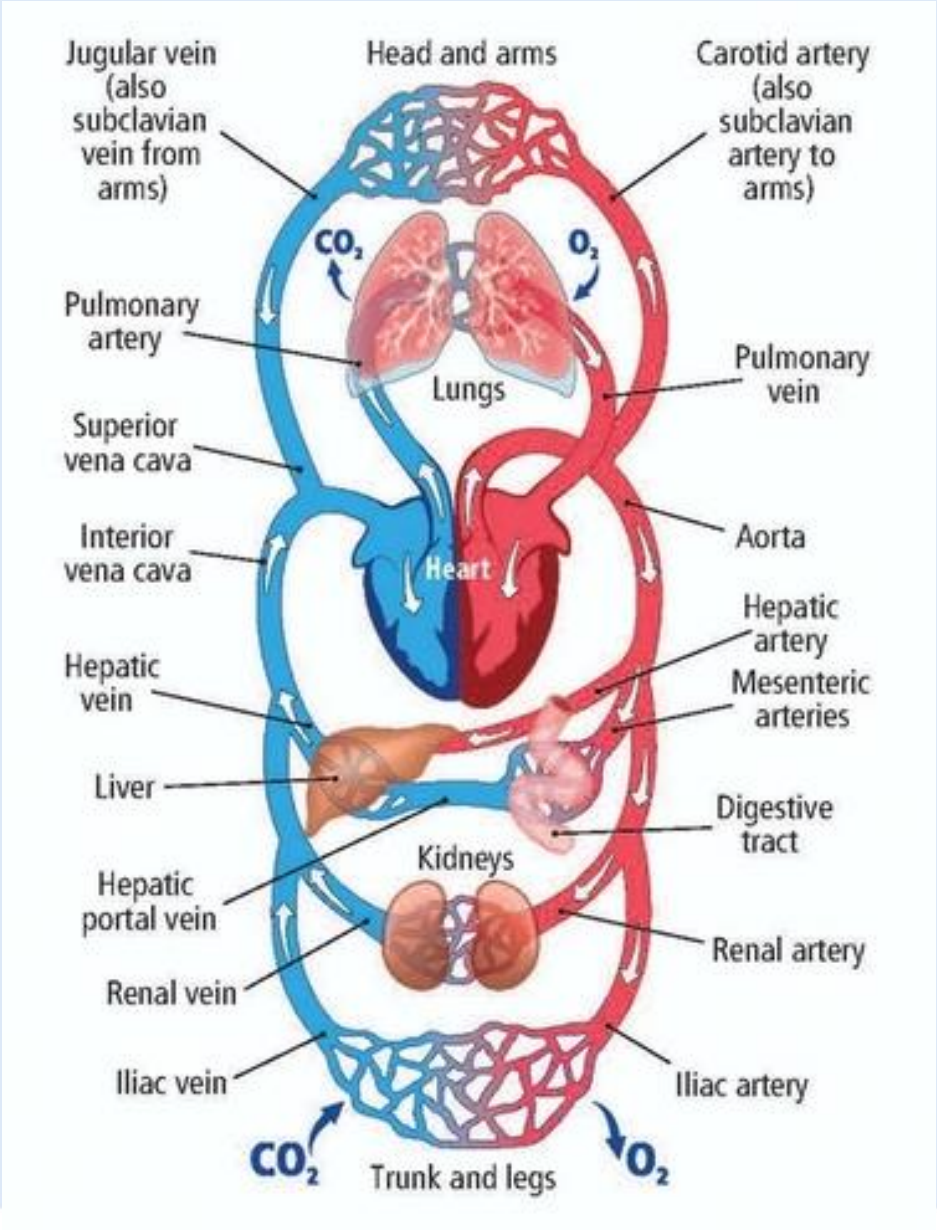
Nursing Upskill ICU & Critical Care

ASPIRUS™
Passion for excellence.
Compassion for people.

Objectives

- Develop a basic understanding of cardiac output
- Identify how decreased cardiac output can affect organ systems
- Identify cares essential to good patient outcomes

Low Resistance
Low Pressure
Reservoir



High Pressure
High Resistance
Pump

What is cardiac output?

- CO= HR x SV
  - Amount of blood ejected from the ventricles in one minute (liters per minute)
  - Normal = 4 – 8 liters/minute
  - Pumping effectiveness

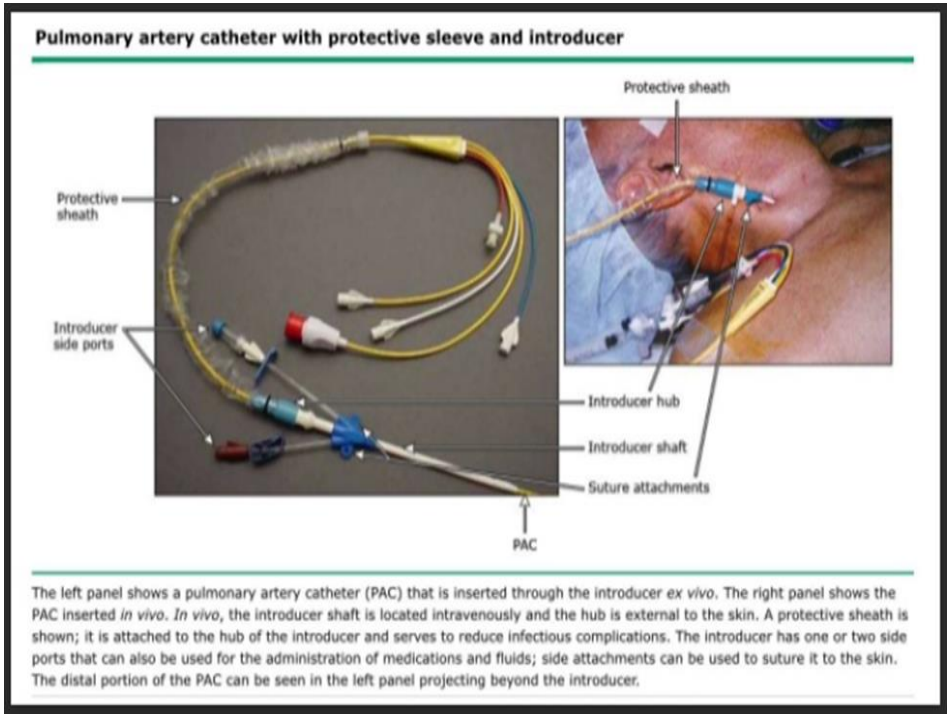
  Need a Pulmonary Artery catheter (Swan-Ganz) for continuous monitoring or Echocardiogram for a “snapshot” to determine CO.

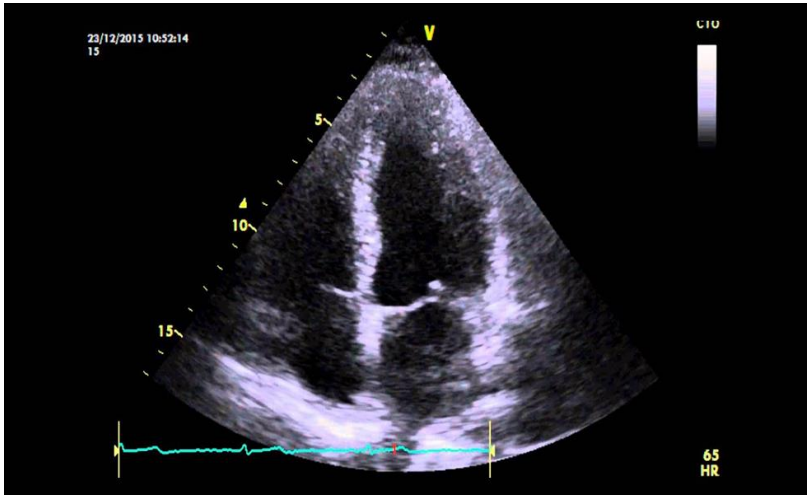
  The SWAN also calculates an index. CO / BSA = CI(2.5-4L/min)

What is stroke volume?

- Amount of blood ejected from the ventricle in one contraction.
  - Difference between end-diastolic volume (EDV) and end-systolic volume (ESV).
    - Simply subtract the amount of blood in the ventricle at the end of ejection (ESV) from the amount in the ventricle at the end of filling (EDV) and you are left with SV
- Ejection Fraction (EF)
  - Stroke volume expressed as % of EDV
  - Normal 55-70%

Cardiac output





Swan-Ganz see reference page: 1

Image of Echo see reference page: 2

Cardiac output

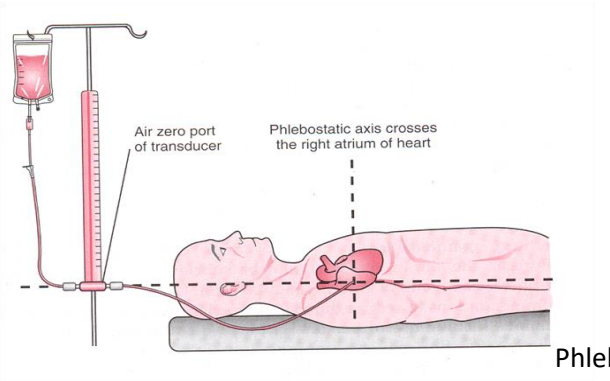
Important things to remember about invasive monitoring (PA, CVP, arterial)

Tubings are pressurized (flush bag must be inflated to 300 mmHg)

Transducer must be at phlebostatic axis (level of right atrium)

If bed moves transducer should be moved also.

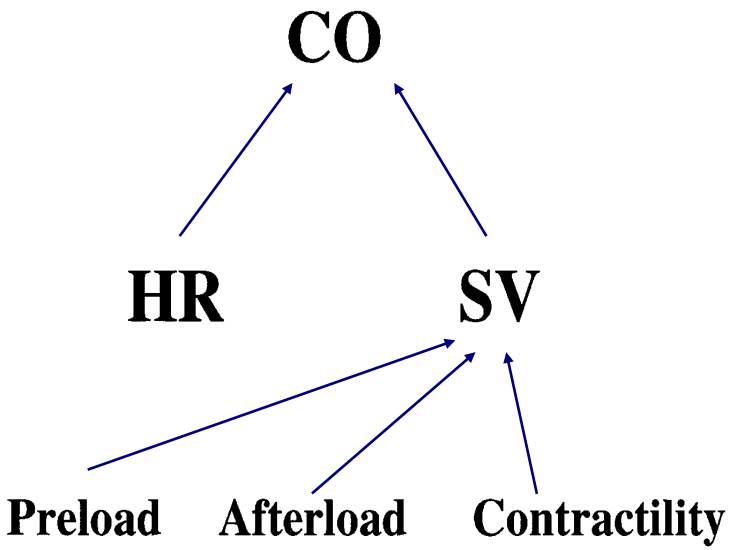
Great care must be taken to not dislodge-they are inserted into arteries or large veins & will bleed a lot if removed without pressure held



Use Curos caps to reduce risk of line contamination

Phlebostatic axis Reference page: 3

Components of Cardiac Output



Heart rate: variable and can be manipulated by medications for example betablockers like Lopressor to lower heart rate or inotropes like Epinpherine that increases heart rate

Stroke Volume: variable and is affected by factors such as hypovolemia, sepsis, fever (low), fluid overload (CHF), use of inotropes, poor contractility of the heart.

Contractility

- Is decreased by some disease processes
  - —Anoxia, acidosis, decreased catecholamine stores
  - —Loss of muscle tissue—as in MI
- Is increased by medication or by its intrinsic ability to accommodate change
  - —Inotropes such as Dopamine, Dobutamine, Epinepherine, Norepipherine

Preload

- Volume (measured as pressure) in the ventricle at end of diastole (filling)
- Significance
  - Inadequate preload results in decreased CO
  - Too much may result in ventricular failure
- Source for RV = Venous return
- Source for LV = Right heart CO (after oxygenation/release of CO2 in the lungs)

Assessment of Preload

Abnormalities that correlate more to Right heart failure

- Weight-compared to baseline
- Peripheral edema
- Sleeping position
- JVD
- Orthostatic BP

Abnormalities that correlate more to Left heart failure

- Lung sounds – crackles
- Breathing and SpO2
- BP, urine output
- LOC
- Fatigue
- Orthopnea
- S_3

Check chart for CXR/ECHO/BNP results in either case

Monitor
Preload

- Central Venous Pressure (2-6 mmHg)
- Pulmonary Artery Pressure (20-30/5-15 mmHg)
- Arterial Pressure (blood pressure)
- I&O-in ICU, hourly O's
- Daily Weights
- Perfusion-pink, warm & dry

- Does anything interfere with RV filling…
  - Cardiac tamponade
  - Right sided heart failure
    - Pulmonary Hypertension
  - Superior vena cava obstruction
  - Tachycardias
    - Especially rates >120
    - A-fib (inadequate emptying of atria)

Interventions

To decrease preload

- Interventions
  - Stop fluids
  - Diuretics
  - Aldosterone antagonists
    - ACE-I, ARBs-(ril, sartan)
  - Change blood volume distribution
    - Vasodilators
      - Nitrates, morphine
    - Positioning

Eliminate Volume or Hide it

To increase preload

- Interventions
  - Volume Replacement
    - Crystalloid
    - Colloid
    - Blood/blood products
  - Decrease or stop – diuretics, dilators
  - Vasoconstriction
    - pressors
  - Control HR/dysrhythmias
  - Positioning (trendelenberg/ passive leg raising)

Add Volume or Increase Venous Return

Fluid Type

	Crystalloid	Colloid
Intravascular life	75-80% leaves in 1 hour	Stays longer
Required infusion volume	Large--3mL for 1 mL lost	Better volume expansion-by amount infused
Risk of tissue edema	Yes	Low
Hemodynamic effects	Transient	Prolonged
Coagulation	Dilutional coagulopathy	Less interference
Risk of allergenic response	Low	Rare but possible
Cost	Low	Expensive

Starch solutions increase risk of AKI, coagulopathy & mortality – limit to 1000 mL/day. Rarely used.

Afterload

- Resistance or how much pressure is required to open the aortic valve and push blood into the aorta
- Resistance = work, oxygen consumption
- Clinical significance
  - Force of contraction must be sufficient to cause coronary and peripheral circulation
  - When afterload is too high it can impair ventricular function and decrease CO
- Influenced by:
  - Arterial tone, Valve, blood viscosity

Assessment
Afterload

Increased Afterload Conditions

- High blood viscosity
- Aortic or mitral stenosis
- Arterial vasoconstriction
  - Hypovolemic shock
  - Cardiogenic shock
  - Hypothermia
  - Pulmonary edema
  - Pulmonary embolus
- Pulmonary hypertension
  - Pulmonary disease
  - Idiopathic

Decreased Afterload Conditions

- Arterial and venous dilatation
  - Sepsis
  - Neurogenic or anaphylactic shock
  - Vasodilating drugs
    - Nitroglycerin
    - PDE-5 inhibitors
- Fever

Interventions
Afterload

To treat increased afterload

- Fix problem
  - Diurese?
- IABP
- Vasodilators
  - Nitrates
  - Inotropes
  - Alpha antagonists
  - ACE – inhibitors
  - Calcium channel blockers
  - PDE-5 inhibitors

To treat decreased afterload

- Fix problem
  - Treat sepsis
    - Antibiotics
    - fluids
  - Hypovolemia
  - Shock
- Vasopressors
  - Norepinephrine
  - Phenylephrine
  - Dopamine
  - Epinephrine

Fix the Cause

Resistance
Afterload

- PVR (45-120 dynes) -right heart (pulmonary)
  - Poor lung perfusion/PH/SOB/fatigue
- SVR (800-1400 dynes) -left heart (systemic)
- Diastolic BP
- Skin color, temp, “pale, cool, clammy”
- Capillary refill
- Organ dysfunction
  - Monitor U/O, liver enzymes, metabolic panel, LOC

Pump Performance
Cardiac Output

- Significance
  - Faster the HR the greater the CO-until it's too fast
  - Easiest and quickest way to increase CO.
- Limitations
  - Too fast decreases filling time which decreases CO
  - Too fast impairs diastolic coronary filling
  - HR can be too slow for CO

Lines

- CVAD
  - Introducer- good for pressors and fast infusions
  - SWAN- monitoring & infusion ports for pressors
  - TL, QL- good for pressors
- PICC-SL,DL,TL- good for pressors
- PIV-not for pressors
- Midline-not for pressors
- Arterial line-**NOT** for any medication administration

Even if U/S start

MONITORING ONLY

Lines

- Pressurized systems
  - PA, CVP and arterial lines
  - Flush bag is 500ml inside a pressure bag that must be pumped up to and maintained at 300mmHg
  - It takes a while-keep pumping. Then turn stopcock so that it doesn't deflate
  - Transducer must be at the phlebostatic axis+

Lines

- Can draw from line for labs-need a waste
  - —If meds are infusing into CVAD, they need to be paused before waste and sample are taken
  - —Be sure stopcocks are in the correct position
  - —Flush a waste and then the line well with the pig tail to prevent clotting of the line

If numbers don't seem right, assess the line--square wave test, transducer at right level, connections secure, pressure bag inflated, positional at site

Overview of Systems

- Cardiovascular
  - —Heart tones—don’t count-you have a monitor for that, Listen to the sounds for 15-30 seconds
  - —Peripheral pulses
  - —Edema, CRT, CMS
  - —Watch for heart rate and rhythm changes

Overview of Systems

- Neurological
  - PERRLA
  - If awake, talk to them. Ask questions.
  - Note confusion, agitation, decreased LOC
  - “ICU-itis” also known as Delirium-
    - Can be hypo or hyper active
    - Use CAM
      - H-a-v-e-a-h-e-a-r-t, Does a rock float on water?
  - Don’t need to yell. If HOH try to drop the pitch of your voice

Overview of Systems

- Respiratory
  - —Preexisting condition?
  - —Vented?
  - —Assess RR, work of breathing, O2 sats
  - —Listen to lungs anterior and posterior
    - Crackles, wheezes, rhonchi, absent/diminished
    - What could these tell you?
    - Correlate to what is going on with the patient
    - How can we treat? Nebs, inhalers, diuretic

Don’t underestimate the value of good pulmonary toilet.
Cough, Deep Breathe, IS, Vibratory

Overview of Systems

- Gastrointestinal
  - Many pressors decrease blood flow to the GI tract
  - Give stool softeners early-they aren't mobile and on a different diet causes GI issues.
  - Narcotics slow bowel motility
  - Start tube feeding early-if unable TPN?
    - Protein packets are important to healing
    - Watch Na+, may need to add free water
    - May cause diarrhea

Don't forget Blood Glucose monitoring even if not DM. If NPO could go low, if pressors could go high. Optimal glycemic control is very important to outcome. ISTAT BG if on pressors.

Overview of Systems

- Urinary
  - Is foley required? Why? (consider Nurse Driven Foley Removal policy)
  - Many ICU patients require hourly U/O, need urometer on foley
  - If CO is low, less blood flow to kidneys, less filtration of waste-monitor BUN/Creat. Check K+/Mg++ if diuresing
  - Minimal 30 mls/hr
  - May require dialysis if climbing Creat./<min. U/O

Overview of Systems

- Musculoskeletal
  - Range of motion-passive or active if able
    - essential especially if restrained
  - Use wedges or pillows to achieve correct body alignment
  - Consider preexisting joint disease-DJD, Spinal

Overview of Systems

- Skin
  - Color, temp, moisture
  - Condition
    - Edema, fragile, flakiness

Repositioning and protection of the skin is very important. Relieve pressure points-elbows, heels, coccyx, hips. Check under all invasive devices with each turn. Make sure that the wedges or pillows used allow the coccyx/buttocks to be open to air.

Overview of Systems

- Vital signs
  - We have covered HR & BP in the hemodynamics portion
  - We are watching the RR as part of the respiratory assessment
  - Don’t forget to monitor temperature
    - Consider the effects of both room temperature and blankets

Pain is also important, and will be covered in the medication course.

Overview of Systems

- Lab Values
  - Generally we will monitor the metabolic panel daily, and if diuresed K+/Mg++ more often
  - CBC daily, the differential being important with infections
  - ABGs (with lactate) daily and as condition changes
  - PTT, PT/INR, antiXa for monitoring anticoagulation
  - Sometimes will see liver enzymes, cortisol
  - Trop, CK/MB, BNP not routine, but for cardiac pts

The whole patient

- In looking at all of the pieces, it is important that we don't for get who we are treating.
- It is essential to foster trust with the patient
  - Address emotional and spiritual needs
  - Maintain connection to the family
  - Education is essential, so that they can best care for themselves at home.