Cardiac Surgery Pearls of Wisdom

Fun and Focused

Class C150M605

Cheryl Herrmann
Cardiac Clinical Nurse Specialist
APN, CCRN, CCNS-CSC-CMC

UnityPoint Health Peoria
Heart of IL AACN – President
www.cherylherrmann.com

Speaker Disclosures

- AACN Speaker Bureau
- Cross Country/Vyne Education Speaker Bureau
- Novartis Speaker Bureau

- Handouts will be available at www.cherylherrmann.com

Objectives

- Relate hemodynamic concepts of preload, afterload and contractility to medication management of cardiac surgery patients.
- Discuss assessment cues and management of cardiac surgery patients to prevent and treat complications associated with cardiac surgery.
- Differentiate the plan of care for cardiac surgery patients with coronary artery bypass surgery and valvular surgery/repair.

Learn something new

And have fun ☺

Where in the World is Peoria?

"Will it Play in Peoria?"

Are you certified?

1. CCRN
2. CCRN-CSC
3. CSC
4. Other
5. Certification "Wannabe"

polling

Number of years as Cardiac Surgery Nurse?

1. Less than 1 year
2. 1- 2 years
3. 3- 5 years
4. 6 - 10 years
5. > 10 years- almost ancient ☺

Polling

CSC Exam Content

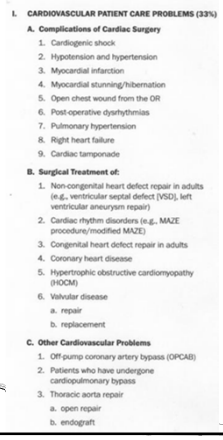
The CSC exam is a 2-hour test consisting of 90 multiple-choice items. Of the 90 items, 75 are scored and 15 are used to gather statistical data on item performance for future exams. Please see the test plan for more information. The CSC exam focuses on adult populations. One hundred percent (100%) of the exam focuses on clinical judgment.

www.aacn.org

Exam Blueprint

- Cardiovascular Patient Care Problems (33%)
- Other Patient Care Problems (24%)
- Nursing Interventions (33%)
- Monitoring & Diagnostics (9%)

Care of the Cardiac Surgery Patient first 48 hours Post op



I. CARDIOVASCULAR PATIENT CARE PROBLEMS (33%)

A. Complications of Cardiac Surgery
1. Cardiogenic shock
2. Hypotension and hypertension
3. Myocardial infarction
4. Myocardial stunning/hibernation
5. Open chest wound from the OR
6. Post-operative dysrhythmias
7. Pulmonary hypertension
8. Right heart failure
9. Cardiac tamponade

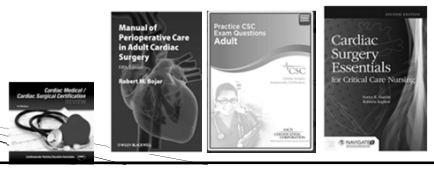
B. Surgical Treatment of:
1. Non-congenital heart defect repair in adults (e.g., ventricular septal defect [VSD], left ventricular aneurysm repair)
2. Cardiac rhythm disorders (e.g., MAZE procedure/modified MAZE)
3. Congenital heart defect repair in adults
4. Coronary heart disease
5. Hypertrophic obstructive cardiomyopathy (HOCM)
6. Valvular disease
   a. repair
   b. replacement

C. Other Cardiovascular Problems
1. Off-pump coronary artery bypass (OPCAB)
2. Patients who have undergone cardiopulmonary bypass
3. Thoracic aorta repair
   a. open repair
   b. endograft

Cardiovascular Patient Care Problems (33%) 30 questions

Resources/Study Books

- Bojar, r. (2011). Manual of Perioperative Care in Adult Cardiac Surgery. 5th ed. West Sussex, UK: Wiley-blackwell.
- Hardin, S, & Kaplow, R. (2016). *Cardiac Surgery Essentials for Critical Care Nursing*, 2nd ed. Jones & Bartlett.
- Todd, B. (2005). *Cardiothoracic Surgical Nursing Secrets.* Mosby/Elsevier.
- Dodge, T. *Fast Facts for the Cardiac surgery nurse*. Springer Publishing
- www.aacn.org



Not studying for CSC

"No worries"

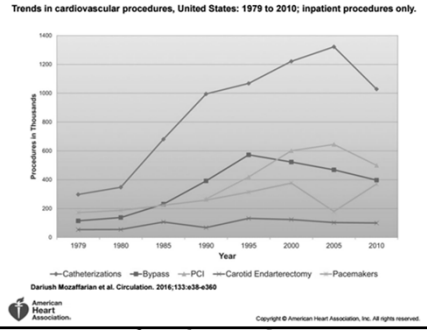
Fun and Focused

1. Valvular Surgery
2. Optimizing Cardiac Output
   - Preload, Afterload, Contractility, Heart Rate
   - Pharmacology
   - Hemodynamic Case Studies and Practice
3. Triad of Disaster – Preventing & Treating Complications

Let's Start!

How has Cardiac Surgery Changed?

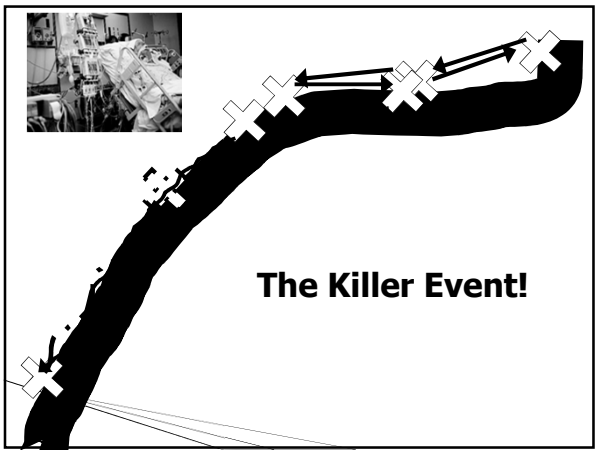
Last Decade, isolated CABG ↓ from 73% to 57% (Vahanian et al. 2011)



Valvular Surgery

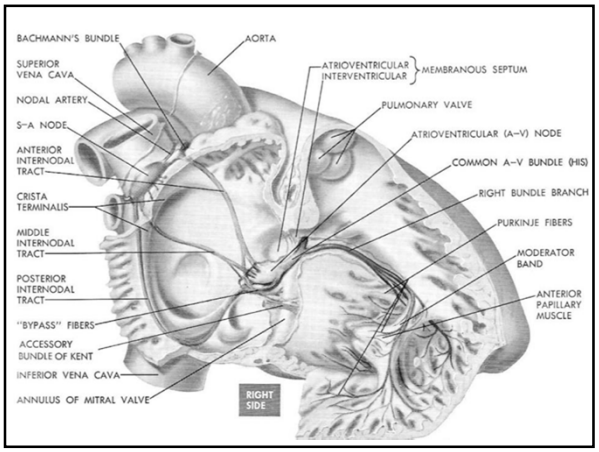
- Increased from 16– 22%
- 43% AVR + CABG
- 38% MVR + CABG
- 1997 – 2006 – percentage of valve surgery patients > 80 y/o increased from 13– 20%
- Mitral Regurgitation often associated with HF

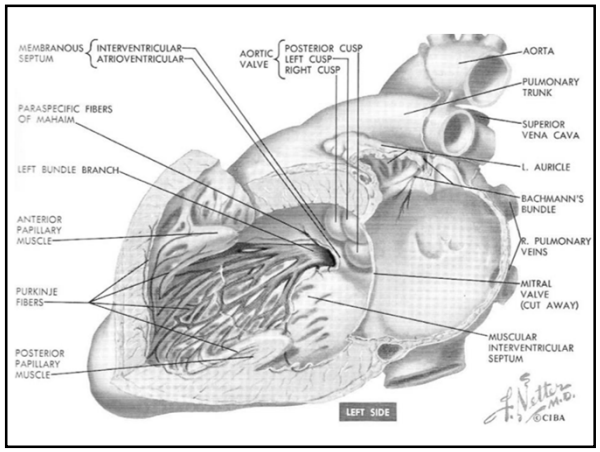
Source: Vahanian et al. 2011



Stop the complications before they start!

Valvular Surgery

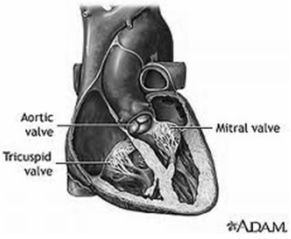




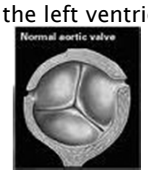
Valvular Heart Disease

- An acquired or congenital disorder of a cardiac valve
- Characterized by
  - Stenosis (obstruction)
  - Regurgitation (backward flow)
- Can occur acutely
- Typically is a chronic progressive disorder
- Causes a significant impact on quality of life
- Medical management delays the inevitable surgery for replacement/repair
- Prosthetic valve creates new problems

Aortic Valve



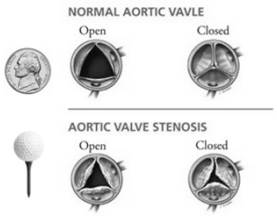
- Has three leaflets or cusps
- Cusps close as the pressure in the aorta becomes *greater than* the pressure in the left ventricle.



Aortic Stenosis

- Aortic valve will not open completely
- Restricts flow of blood from left ventricle to aorta
- Most common valve lesion in USA

1. Small opening causes ↓ blood flow and ↓ CO
2. ↑ Afterload
3. ↑ workload in Left ventricle
4. ↑ pressure in LV
5. LV hypertrophy

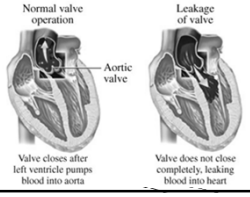


Aortic Regurgitation/Insufficiency

- Aortic valve fails to close completely
- Backflow of blood into the left ventricle during diastole
- Severe AI – most frequently caused by bicuspid valve

1. Volume overload leads to compensatory mechanisms
   - Left ventricular hypertrophy
   - ↑ End-diastolic volume which allows normal EF despite ↑ afterload.

↑ LV afterload as the ↑ volume ejected into the high pressured aorta.

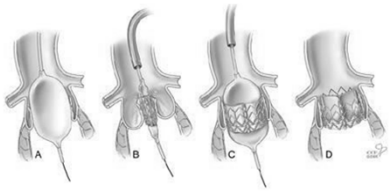


Surgical Treatment for Aortic Valve Disease

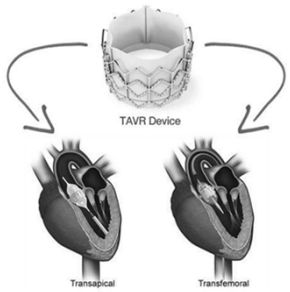
- Aortic Valve Replacement (mainstay)
  - Avoid hypertension and stress on suture line
- Aortic Valve Repair (not mainstream)
- Transcatheter Aortic Valve Replacement (TVAR)

Transcatheter Aortic Valve Replacement (TVAR)

- Trileaflet bioprosthesis mounted on a balloon catheter delivered through the arterial system via a guidewire. Device is inserted into the midpoint of the native valve



Trans Apical vs Trans Femoral



- Femoral most common

https://www.youtube.com/watch?v=ztl3cc2EOmM

TAVR

Pro's

- Less invasive than traditional AVR's
- No sternotomy or cardiopulmonary bypass
- Less ventilation time or extubated in OR
- Shorter ICU length of stay and often discharged within 48 hours postop

Con's

- Elderly population with comorbidities
- Higher risk for delirium due to sedation or pain management
- Screening for physical therapy

Post Op TVAR Femoral

- Usually extubated in OR, if not within 2-4 hrs postop
- Monitor bilateral puncture sites – hold pressure if oozing or bleeding
- Monitor pulses distal to insertion site due to the large catheters and embolization risk
- Monitor neuro assessment due to high risk for strokes
- Maintain SBP between 100mmHg – 130mmHg
  - May use beta blockers or other vasodilators for hypertension
- Discontinue Arterial line after extubation and venous sheath when ACT < 180
- Internal Jugular discontinued on POD 1 and transferred to Telemetry
- All patients assessed for rehab upon transfer from ICU

Post Op TVAR Apical Postop

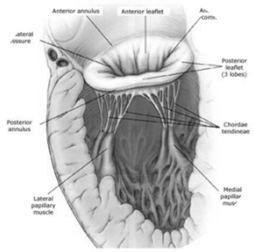
- Monitor hemodynamics, neuro assessment, urine output, & chest drainage same as an open sternotomy incision
- Wean to extubate within 6 hours of anesthesia end time. Encourage incentive spirometer every hour while awake
- Discontinue femoral lines after extubation
- Ice chips and advance diet as tolerated
- Up in chair early am and ambulate with physical therapy or nurses 3-4 times/day
- Discontinue PA catheter and arterial line POD 1

✓

Potential TVAR Complications

- Complete Heart Block due to Aortic Valve edema.
- Hypotension
  - Monitor amount of sedation or vasodilating medications for cause of hypotension
- Check groin sites for bleeding, lower abdomen for signs of retroperitoneal bleed, check peripheral vascular pulses
- Monitor Labs (Hgb/Ht)
- Vasovagal response
- Stroke
  - Assess neuro status with VS's

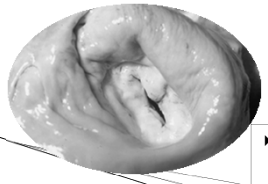
Mitral Valve



- Large anterior leaflet
- Small posterior leaflet
- Chordae tendineae and papillary muscles prevent the prolapse of valve leaflets into left atrium during systole

Mitral Stenosis

- Mitral valve will not open completely
- Restricts flow of blood from left atrium to LV



1. Small opening causes ↓ blood flow and ↓ CO
2. ↑ workload in Left Atrium
3. ↑ pressure in LA
4. LA dilation & hypertrophy
5. ↑ in LA pressure →backflow into pulmonary artery
6. Leads to pulmonary hypertension, congestion, right ventricular hypertrophy and right sided heart failure

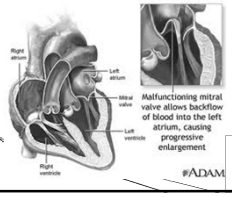
- LV size and contractility = normal in MS

Post op MVR and repair for MS

- Assess for pulmonary hypertension
- Increased PVR leads to RV failure
- Increased CVP = possible RV decompression
- TEE to assess for RV and LV function
- Dobutamine, Milrinone, Norepinephrine to increase contractility of RV and ↓ PVR
- Fluid administration
- PAD does not reflect LA filling pressures related to pulmonary hypertension – Wedge more accurate
- PA catheter may be placed farther in related to dilated pulmonary arteries
- IABP usually not indicated as no LV dysfunction but RV dysfunction

Mitral Regurgitation

- Mitral valve fails to close completely
- Blood is propelled backward into the LA during systole



1. During systole, a portion of blood is ejected back into the LA
2. ↓ blood in LV → ↓ CO
3. ↑ blood in LA → ↑ LA pressures → pulmonary congestion and ↑ pulmonary pressures → RV hypertrophy
4. During diastole, blood continues to flow into LV→ ↑ LV volume
5. LV hypertrophy

- MR = LA enlargement, Left or Right Ventricular Failure

Post op for Mitral Valve Repair for MR

- Immediate ↑ SVR due to no backflow of blood in LA
- Pulmonary hypertension & Myocardial hibernation take time to reverse
- Inotropes (Milrinone, Dobutamine)
- IABP
- Monitor for RV failure

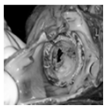
Mitral Valve Repair vs Mitral Valve Replacement

- Repair preserves native valve
- Repair is favored due to disadvantages of prosthetic valves
  - No anticoagulation needed for repair
- Technically more difficult
  - Depends on degree of regurgitation,
  - Pathophysiology of the regurgitation
  - LV function,
  - Ability of surgeon

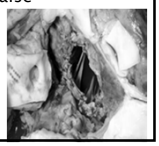
Valve Replacement Considerations

	Tissue	Mechanical
Age	Over 65 yo	Under 65
Longevity	10-15 years	Potentially Lifetime
Anticoagulation	Aspirin lifelong Warfarin – 3 months???	Warfarin lifelong
Reoperation risk	Patient dependent	As low as 1% risk lifetime

Postoperative Valve Considerations



- Physical examination
  - Normal prosthetic heart valve sounds:
    - Mechanical valves:
      - Loud, high-frequency, metallic closing sound
      - Soft opening sound
    - Tissue valves:
      - Closing similar to those of native valves
  - New onset murmurs is a concern
    - murmur – though hard to hear – would raise suspicion



All Valve Surgeries Postoperative Considerations

- Prosthetic heart valve malfunction:
  - Acute prosthetic valve failure:
    - Sudden onset of dyspnea, syncope, or precordial pain
    - Sudden death
    - Hyperdynamic precordium
    - Pronounced JVD
  - Subacute valve failure:
    - Gradually worsening congestive heart failure
    - Unstable angina
    - Hemolytic anemia
    - Asymptomatic

Postoperative Valve Considerations

- Embolic complications
  - Stroke
  - TIA
- Anticoagulant-related hemorrhage
  - Hemorrhage site – brain, abdomen, etc.
- Dysrhythmia
  - AV Block
  - Atrial dysrhythmias

Prosthetic Valve Endocarditis

- Blood borne bacterial traveling to the heart and growing on the valve
- Dental or other procedures may provoke bacteremia

What is SBE?
Subacute bacterial endocarditis

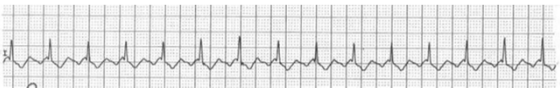
- Antibiotic prophylaxis is indicated for the following high-risk cardiac conditions:
  - Prosthetic cardiac valve
  - History of infective endocarditis
  - Congenital heart disease (CHD)
  - Cardiac transplantation recipients with cardiac valvular disease
- For these procedures
  - Dental
  - Invasive respiratory (bronch)

Standard general prophylaxis

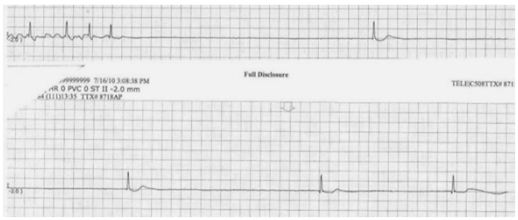
- Amoxicillin
  - Adult dose: 2 g PO
  - Pediatric dose: 50 mg/kg PO; not to exceed 2 g/dose
  - Administer once as a single dose 30-60 min before the procedure.
- Ampicillin, Clindamycin, Cephalexin, Cefazolin, or Ceftriazone
  - May be used if allergic or unable to take oral
  - See guidelines for specific doses

Case Study

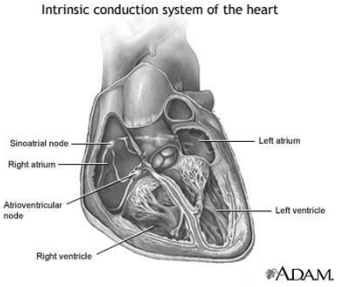
- Ms Leaky, a 47 y/o. had a MVR. Today on POD #4, she is being transferred to the progressive care unit.



At 1508 Ms Leaky's rhythm changes to this.



Damage to His bundle may result in BBB or CHB



The left ventricle is normal size in which valvular disease?

1. Aortic Stenosis
2. Aortic Insufficiency
3. Mitral Stenosis
4. Mitral Regurgitation

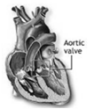
ANSWER

1. .
2. .
3. Mitral Stenosis

Valvular Pearls

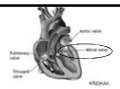
	MS	MR	AS	AR/AI
Heart Sounds	Mid diastolic murmur at the apex S3, S4 RV heave	Holosystolic murmur high pitched Widely split S2 S3, S4	Systolic ejection murmur harsh at right sternal border	Decrescendo diastolic blowing murmur – best heard sitting upright
Symptoms	Dyspnea Pulmonary Hypertension Pulmonary symptoms	Peripheral edema Cough LV failure New onset AFib	Syncope Dyspnea Angina	Fatigue Dyspnea Angina Palpitations Wide pulse pressure > 50 mmHG ▸ Austin Flint murmur ▸ Hill Sign ▸ Duroziez sign ▸ Corrigan pulse ▸ de Musset sign
Atrial size	LA enlarged	LA enlarged	LA enlarged	LA enlarged
Ventricular Size	**LV normal**	LV enlarged	LV enlarged	LV enlarged

Valvular Surgery Pearls
Aortic Valve



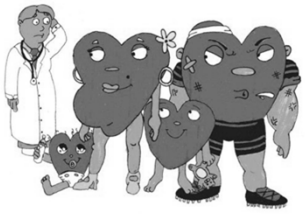
	Aortic Stenosis	Aortic Regurgitation
Preop	LV hypertrophy ↑ SVR s/s heart failure	LV hypertrophy
Post op	LV may not anticipate ↓ in SVR and continue to pump hard Avoid hypertension and stress on suture line	IV vasodilators to ↓ SVR Inotropic support to promote empting LV: Milrinone/Dobutamine IABP

Valvular Surgery Pearls
Mitral Valve



	Mitral Stenosis	Mitral Regurgitation
Preop	Nx LV function Pulmonary Hypertension RV failure High atrial & pulmonary pressures Pulmonary congestion	Enlarged left atrium Both common to have atrial fibrillation
Post op	Assess pulmonary hypertension (PVR) Dobutamine or Milrinone + Norepinephrine to ↑ contractility of RV & ↓ PVR Fluids ↑ CVP may indicate RV decompression Treat atrial fibrillation	Immediate ↑ SVR due to no backflow of blood in LA Pulmonary hypertension & myocardial hibernation take time to reverse Inotropes (Milrinone, Dobutamine) + epinephrine IABP Monitor for RV failure Treat atrial fibrillation

Optimizing Cardiac Output



Cardiac Surgery
Hemodynamics/Medications

Terms used to describe Cardiac Drug Effects

- **Inotropic:** Effect on contractility
  - **Positive = increase in contractility**
  - **Negative = decrease in contractility**
- **Chronotropic**: Effect on Heart Rate
  - **Positive = increase in Heart Rate**
  - **Negative = decrease in Heart Rate**
- **Dromotropic:** Effect on Conductivity
  - **Positive = increase in conductivity**
  - **Negative = decrease in conductivity**

Cardiac Index
CI = CO/BSA

- Cardiac output divided by body surface area (BSA)

- Normal range = 2.5 – 4 l/min/m^2
- Subclinical: 2.2 - 2.7 l/min/m^2
- Low perfusion: 1.8 - 2.2 l/min/m^2
- Shock < < 1.8 l/min/m^2

Is a cardiac output of 4.2 l/min. adequate for both Mrs. A, a 5 ft. 98 lb. woman and Mr. B, a 6 ft. 2 in., 240 lb. man?

By using formula CI = CO/BSA

Mrs. A's BSA is 1.36 m^2. Her CI is determined to be 3.08 l/min/m^2.

Mr. B has a BSA of 2.34 m^2, therefore his CI falls below the normal level of 1.79 l/min/m^2.

Determinants of Cardiac Output

Cardiac Output = Heart Rate x Stroke Volume

Stoke Volume

- Preload
- Afterload
- Contractility

Heart Rate

- Increasing Heart Rate is the fastest way to increase CO.
- Overtime, it is not the most efficient way.
- Optimal HR is 60 – 80 bpm

Determinants of CO:

Rate/Rhythm

Low	High
Pacemaker Atropine Isuprel Dopamine	Beta blockers Calcium channel blockers Other

How Cardiac Meds effect Heart Rate

Cardiac Medications & Effect on Cardiac Output

Medication	Heart Rate	Preload	Afterload	Vasodilator	Vasopressor	Contractility
Dopamine Hydrochloride (Intropin)						
Epinephrine (Adrenalin)						
Norepinephrine bitartrate (Levophed)						
Phenylephrine (Neo-Synephrine)						
Vasopressin (Pitressin)						
Nitroprusside (Nipride)						
Nitroglycerin (Tridil)						
Dobutamine hydrochloride (Dobutrex)						
Digitalis (Digoxin, Lanoxin)						
Milrinone (Primacor)						
Calcium Chloride						
Amiodarone hydrochloride (Cordarone)						
Lidocaine (Xylocaine)						
Atropine sulfate						
ACE Inhibitors						
Beta Blockers						
Diltiazem (Cardizem)						
Nicardipine (Cardene)						

www.cherylherrmann.com

The Effect of Cardiac Meds on Heart Rate

Increase HR
- Atropine
- Dopamine/Intopin
- Epinephrine/Adrenalin
- Norepinephrine/Levophed
- Dobutamine/Dobutrex

Decrease HR
- Beta Blockers
- Calcium Channel Blockers

Slight Increase HR

Milrinone/Primacor

No effect on HR
- Phenylephrine/Neo-synephrine
- Vasopressin/Pitressin

Know Normal Values!

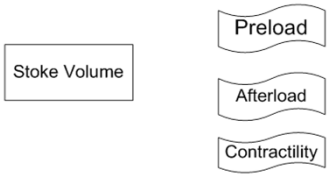
Parameter	Normal Values
Cardiac Output (CO)	4 - 8 l/min
Cardiac Index (CI)	2.5 – 4.2 l/min/m^2
Right atrial pressure (CVP)	0 – 8 mmHg
Pulmonary artery pressure (PAS/PAD)	15 - 30/6 -12 mmHg
Pulmonary artery occlusive pressure	4 – 12 mmHg
Systemic vascular resistance (SVR)	770 – 1500 dyne/sec/cm^5
Pulmonary vascular resistance (PVR)	20 – 120 dyne/sec/cm^5
Stroke Volume (SV)	60 -130 mL/beat
Stroke Volume Index (SVI)	30 – 65 mL/beat/m^2
Arterial oxygenation saturation	95 – 100 %
Venous oxygenation saturation	60 – 80 %

Source: Sited in Cardiac Surgery Essentials, page 148

Determinants of Cardiac Output

Cardiac Output =

Heart Rate x Stroke Volume



Stroke Volume Optimization

Why Stroke Volume Optimization?

- Stroke volume is the first parameter that changes before...
  - Tissue hypoperfusion
    and
  - Organ dysfunction

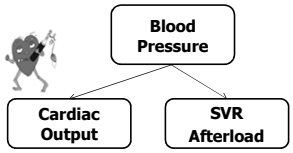
BP = CO x SVR

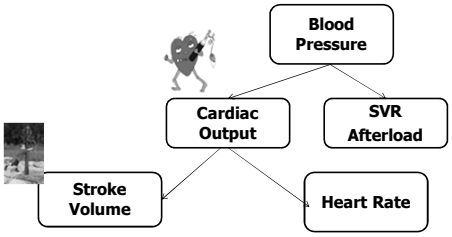
- C0 = Stroke Volume + Heart Rate
- Body compensates to keep BP normal
  - ↓ SV causes ↑ HR
  - ↓CO causes ↑ SVR
- Thus, BP does not change until late.

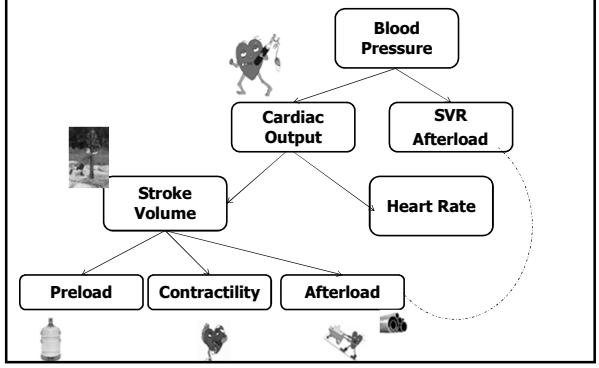
Order of Events

1. Stroke Volume Decreases
   - HR compensated to keep CO normal
2. Cardiac Output Decreases
   - HR compensation fails
   - Vasoconstriction (↑ SVR)
   - BP remains the same
3. Increased oxygen extraction of hemoglobin
   - Peripherally initially(StO_2)
   - Central Later (SvO_2)
4. Blood Pressure, Urine Output Change

Hemodynamics 101







Stroke Volume (SV) Stroke Volume Index (SVI)

- SV: Volume of blood ejected with each beat
  - Normal SV: 60 – 100ml
- SVI: the amount of blood pumped with each beat indexed to BSA
  - Normal SVI: 33 – 47 ml/m2
  - Very powerful indicator of ventricular function

Interpretation of SV/SI

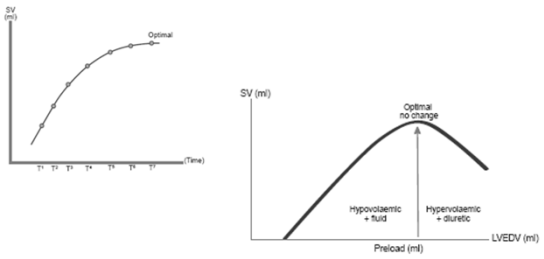
- If <u>low</u>, the cause may be:
  - Inadequate fluid volume: bleeding
  - Impaired ventricular contractility: MI
  - Increased SVR (afterload or resistance to ejection)
  - Cardiac valve dysfunction: mitral regurgitation
- If <u>high</u>, the cause may be:
  - Fluid overload
  - Low vascular resistance: sepsis

SV Pearls

- As HR goes up, SV is going down
- CVP is not a stand alone measure for volume. Use SV
- Volume first, then inotrope

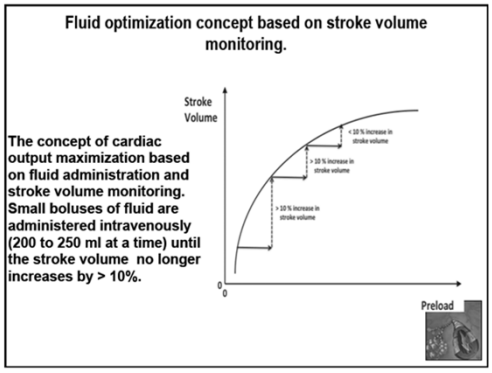
Frank-Starling Law

The longer the muscle is stretched in diastole, to a point, the stronger the contraction in the next systole.



Assessing Fluid Responsiveness

- If SV increases by 10% after fluid bolus = volume responsive.
  - Keep increasing fluids until SV does not increase by 10%
  - Then may need inotrope to push fluids around
- If SV does not increase by 10% after fluid bolus = contractility problem
  - Add inotrope



Source Barbara McLean

Which patient is volume responsive?

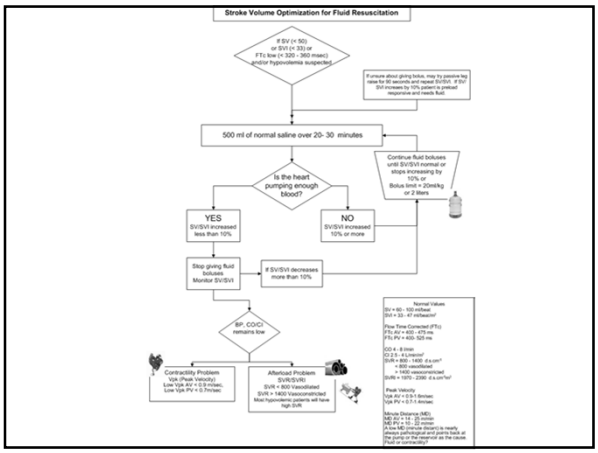
	A	B	C
SV	40	40	40
SV after 500ml bolus	43	45	50

1. Patient A
2. Patient B
3. Patient C
4. B & C
5. A, B, C

Which patient is volume responsive?

	A	B	C
SV	40	40	40
SV after 500ml bolus	43	45	50

1.
2.
3.
4. B & C
5.



Case Study

- 60 y/o admitted to ICU for sepsis related to above knee amputation 6 weeks ago.
- PMH
  - Atrial Fibrillation
  - COPD
  - Heart Failure with EF 45%
  - End Stage Renal Disease – on hemodialysis
  - Type 2 Diabetes

Treated per Sepsis bundles and responded. Transferred to Progressive unit 4 days after admission. It is now 16 hours after transfer from the ICU

- Vital Signs: 4 hours earlier
  - BP 91/52
  - HR 99 A Fib
  - RR 18 T 98.5 oral
- Vital Signs Now
  - BP 60/ doppled
  - HR 128 A Fib
  - RR 20
- Patient was dialyzed yesterday. BP typically drops to 70 – 80s post dialysis.

- Renal MD concerned about giving too much fluid as patient goes into pulmonary edema quickly.
- MD thinking about transfering the patient back to the ICU?
- What do you want to do?

USCOM

- SV 19
- SVI 9.2
- CO/CI 2.4/1.2

USCOM

- SV 19
- SVI 9.2
- CO/CI 2.4/1.2
- 500 ml Saline given
- BP 78/45
- SV 31
- Was he fluid responsive?

USCOM

- SV 19
- CO/CI 2.4/1.2
- 500 ml Saline given
- BP 78/45
- SV 31
- 500 ml more saline given to total 1 liter
- BP 98/50
- HR 88
- SV 49
- SVI 23
- CO/CI 4.1/2.0

- Pt was sitting up eating lunch after the boluses and prevented a return to the ICU.

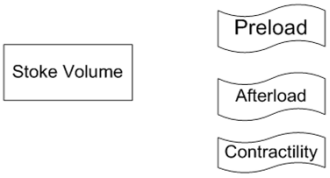
SVV
Stroke Volume Variation

- Only use
  - if on controlled rate ventilator
  - Regular rhythm (no Afib)
- Normal < 10- 15%
  - > 15% likely to respond to fluids
  - 10 – 15% -- probably hypovolemic
- Value should decrease as give volume
- As SV ↑, SVV should ↓

Determinants of Cardiac Output

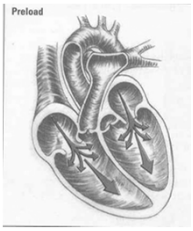
Cardiac Output =

Heart Rate x Stroke Volume



Preload

Myocardial Fiber-Stretch



How full is the tank (heart)?

Empty

Full

Clinical Measurement of PRELOAD

- LEFT VENTRICLE = LVEDP
  - Pulmonary Artery Wedge Pressure: 8-12 mm Hg
  - Pulmonary Artery Diastolic: 8-15 mm Hg
- RIGHT VENTRICLE = RAP
  - Right Atrial Pressure measures the pre-load of RV [normal range 2-5 mm Hg]
  - CVP 4 to 10mm Hg

Decreased Preload

Etiology

- Hypovolemia
- Arrhythmias
- Loss of "Atrial Kick"
- Venous Vasodilation

Cardiac Surgery Specific

- Underlying cardiac disease
- Medications (preop, anesthesia, & vasoactive agents)
- Procedural induced hypothermia
- Rewarming
- Bleeding

Preload

Low	High
Volume	Diuretics
	Venous vasodilators

Decreased Preload

- Anticipate that Cardiac Surgery patients will have a decrease in blood and plasma volume (preload) within the 1st 24 hours post op
- Watch for hypovolemia from rewarming and third spacing!
- FLUID- FLUID- FLUID
  - Drugs don't work if there isn't anything to pump!

Which CABG patient needs volume?

1. CVP 8 mm Hg, SI 35 ml/beat/M^2
2. CVP 8 mm Hg, SI 42 ml/beat/M^2
3. CVP 8 mm Hg, SI 20 ml/beat/M^2

Answer

3. CVP 8 mm Hg and SI 20 ml/beat/M^2

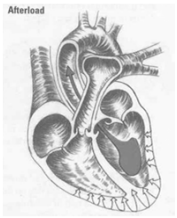
How Cardiac Meds effect preload

- Vasoconstrictors will increase preload when started
- Vasodilators will decrease preload when started

	Cardiac Medications & Effect on Cardiac Output					
Medication	Heart Rate	Preload	Afterload	Vasodilator	Vasopressor	Contractility
Dopamine Hydrochloride (Intropin)						
Epinephrine (Adrenalin)						
Norepinephrine bitartrate (Levophed)						
Phenylephrine (Neo-Synephrine)						
Vasopressin (Pitressin)						
Nitroprusside (Nipride)						
Nitroglycerin (Tridil)						
Dobutamine hydrochloride (Dobutrex)						
Digitalis (Digoxin, Lanoxin)						
Milrinone (Primacor)						
Calcium Chloride						
Amiodarone hydrochloride (Cordarone)						
Lidocaine (Xylocaine)						
Atropine sulfate						
ACE Inhibitors						
Beta Blockers						
Diltiazem (Cardizem)						
Nicardipine (Cardene)						

www.cherylherrmann.com

Afterload



- Afterload is the pressure the ventricle has to generate to overcome resistance to ejection.
  - Any resistance against which the ventricle must pump in order to eject its volume

Afterload;
pushing…

Straw

VS.

Garden Hose

Afterload is measured as SVR and PVR

- Systemic Vascular Resistance (SVR) reflects LV afterload
  - Normal Range = 800-1500 dynes/sec/cm-5
- Pulmonary Vascular Resistance (PVR) reflects RV afterload
  - Normal Range = 20-120 dynes/sec/cm-5

Systemic Vascular Resistance (SVR)

Definition:

A measurement of impedance to left ventricular ejection.

Equation: $SVR = \frac{MAP - CVP}{CO} \times 80$

Normal Range: 800-1500 dyne.sec.cm5

SVR

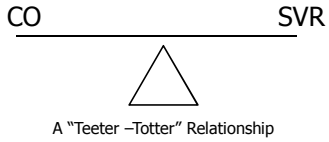
< 800 = vasodilated

> 1500 = vasoconstricted

High afterload (SVR)→ heart is working harder

CO and SVR

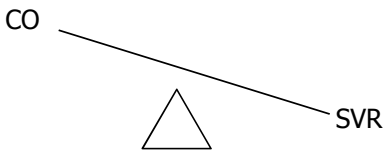
$$SVR = \frac{MAP - CVP}{CO} \times 80$$



A "Teeter –Totter" Relationship

CO and SVR

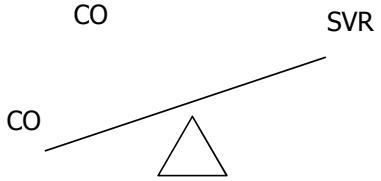
$$SVR = \frac{MAP - CVP}{CO} \times 80$$



A "Teeter –Totter" Relationship

CO and SVR

$$SVR = \frac{MAP - CVP}{CO} \times 80$$



A "Teeter –Totter" Relationship

Most Hypovolemic patients with have a high SVR due to low SV causing low CO. However it is misleading to say the patient is dry if the SVR is high.

Pulmonary Vascular Resistance (PVR)

Definition:

A measurement of impedance to right ventricular ejection.

$$PVR = \frac{MPA - PCW}{CO} \times 80$$

Normal Range: 20 - 120 dyne.sec.cm5

Factors That **Increase** Pulmonary Vascular Resistance

Chemical Stimuli
- Alveolar hypoxia
- Acidosis
- Hypercapnia

Pharmacologic Agents
- Epinephrine
- Norepinephrine
- Dobutamine
- Phenylephrine

Hyperinflation
- Mechanical Ventilation
- Continuous Positive Airway Pressure (CPAP)
- Positive End Expiratory Pressure (PEEP)

Pathologic Factors
- Vascular Blockage
  - Pulmonary emboli, air bubbles, tumor mass
- Vascular wall disease
  - Sclerosis, endarteritis, polyarteritis, scleroderma
- Vascular destruction
  - Emphysema
  - Pulmonary interstitial fibrosis
- Vascular Compression
  - Pneumothorax, hemothorax
  - Tumor mass

Humoral Substances
- Histamine, angiotensin, fibrinopeptides
- Prostaglandin $F_{2\alpha}$
- Serotonin

Factors That **Decrease** Pulmonary Vascular Resistance

Pharmacologic Agents
- Oxygen
- Isoproterenol
- Aminophylline
- Calcium channel blocking agents
- Nitrous Oxide

Humoral Substances
- Acetylcholine
- Bradykinin
- Prostaglandin E
- Prostacyclin
- Sildenafil (Viagra)

Afterload

Decreased	Increased
▪ Vasodilation ▪ Vasodilation from rewarming ▪ Vasodilator therapies ▪ Preop beta blockers ▪ Sepsis	▪ Right ▪ Pulmonary hypertension ▪ Hypoxemia ▪ Pulmonic stenosis ▪ Left ▪ Severe LV dysfunction ▪ Vasoconstriction ▪ Vasopressors ▪ Hypothermia ▪ ↑ catecholamine simulation from surgery

How Cardiac Meds effect Afterload

The Effect of Cardiac Meds on Afterload

Increase Afterload
- Dopamine/Intopin
- Epinephrine/Adrenalin
- Norepinephrine/Levophed
- Phenylephrine/ Neo-synephrine
- Vasopressin/Pitressin

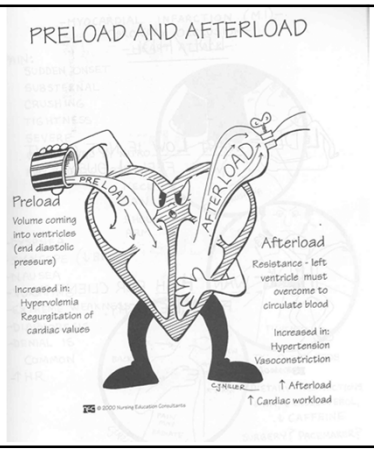
Minimal effect on afterload
- Dobutamine/Dobutrex

Decrease Afterload
- Nitroprusside/Nipride
  - Arterial vasodilator
- Nitroglycerin/Tridil
  - Venous vasodilator
- Beta Blockers
- Nicardipine/Cardene
- ACE Inhibitors

Slight Decrease Afterload
- Milrinone/Primacor

Afterload

Low	High
▪ Vasopressors	▪ Warming blanket ▪ Vasodilators ▪ Calcium channel blockers ▪ IABP



Contractility

Cardiac Squeeze

- Inotropic state of muscle
- Force & velocity of ventricular contractions
- Not directly measurable
- Independent of Starling mechanism

Increased Contractility

- Sympathetic stimulation
- Metabolic states:
  - Hypercalcemia
- Inotropic therapies:
  - Epinephrine
  - Dopamine
  - Digoxin
  - Calcium
  - Dobutamine
  - Milirinone

Stronger contraction = Larger Stroke Volume

Decreased Contractility

- Parasympathetic stimulation
- Negative inotropic therapies
  - Beta blockers
  - Calcium channel blockers
- Metabolic states:
  - Acidosis
  - Hyperkalemia
  - Myocardial ischemia/infarct
- #1 negative inotope is acidosis!

Weaker contraction = smaller Stroke Volume

Etiology of ↓ contractility Cardiac surgery

- Acidosis
- ↑ or ↓ preload
- ↑ afterload
- Factors that affect myocardial contractility directly
  - Ischemia
  - RV or LV failure
  - Aneurysms
- Electrolyte imbalances
- Tamponade

- Acidosis is the#1 negative inotrope!
- Acidosis decreases cardiac contractility!
- Treat acidosis so intropes work!

125

How Cardiac Meds effect Contractility

The Effect of Cardiac Meds on Contractility

Increase Contractility
- Calcium
- Dopamine/Intopin
- Epinephrine/Adrenalin
- Norepinephrine/Levophed
- Dobutamine/Dobutrex
- Milrinone/Primacor

Decrease Contractility
- Beta Blockers
- Calcium Channel Blockers
  - Nicardipine/Cardene
- Lidocaine/Xylocaine

Treating Low Contractility

- Optimize preload & afterload
- Treat underlying causes
- Inotropes
- IABP
- Ventricular assist devices

Cardiac Output Pearls

LOW	CARDIAC OUTPUT Treatment Options	HIGH
Volume	**PRELOAD** CVP, PAD, PAOP	Diuretics Venous Vasodilation
Vasopressors	**AFTERLOAD** SVR,PVR	Vasodilators Calcium Channel Blockers IABP Valve Surgery
Optimize preload Inotropes Calcium Ventricular Assist Devices Avoid/treat acidosis	**CONTRACTILITY** CO/CI indirect measurement	-----
Pacemaker Atropine Isuprel Dopamine	**RATE/RHYTHM**	Beta Blockers Calcium Channel Blockers

Pearls

- Make sure adequate preload before starting inotrope
- Low preload → FLUID
  - Drugs don't work if there isn't anything to pump

Pearls – what to wean first?

- Wean medication that impacts the most stable parameter first
- Wean most potent medication first
  - Vasopressin & Epinephrine → potent vasoconstrictors
    - Decrease blood flow to microcirculation
    - ↑MvO_2

Drug Pearls

- Epinephrine → 1st line drug for borderline cardiac output
- Dopamine→ 1st line drug for low CO state. Also useful to increase urine output
- Dobutamine→ Most useful when CO is marginal & mild ↑ SVR. Moderate pulmonary dilator
- Milrinone→ used for persistent low CO, RV dysfunction, diastolic dysfunction
- Norepinephrine→Low CO with low BP caused by low SVR
- Neo-synephrine→used to ↑ SVR when hypotension exists with normal CO
- Vasopression→ Refractory vasodilatory shock, ↓ SVR

Source: Bojar. R. 2011. Manual of Perioperative Care in Adult Cardiac Surgery,5th ed

Pearls – Management of Low Cardiac Output Syndrome

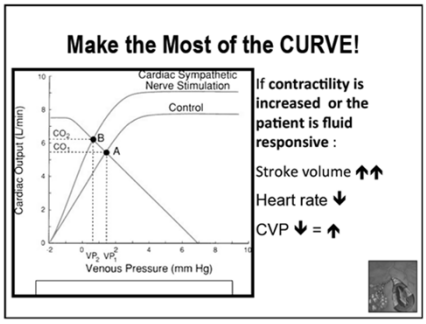
- Look for non cardiac correctable causes (resp, acid/base, electrolytes)
- Treat ischemia or coronary spasm
- Optimize HR 90 – 100 bpm with pacing
- Control arrhythmias
- Assess CO & start inotrope if CI < 2
  - Epinephrine unless arrhythmias or tachycardia
  - Dopamine if low SVR or Dobutamine if high SVR
  - Milrinone/inamrinone

Source: Bojar. R. 2011. Manual of Perioperative Care in Adult Cardiac Surgery,5th ed

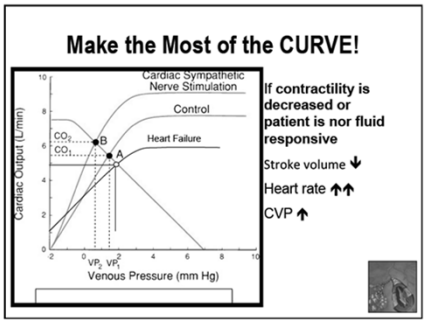
Pearls – Management of Low Cardiac Output Syndrome (cont)

- Start vasodilator if SVR >1500
  - Nitroprusside if high filling pressures, SVR, BP
  - Nitroglycerine if high filling pressures or evidence of coronary ischemia or spasm
- If SVR low
  - Norepinephrine if marginal CO
  - Phenlephrine if satisfactory CO
  - Vasopressin 0.01 – 0.07 units/mins if satisfactory CO
- Blood transfusion if Hematocrit < 26%
- IABP if refractory to pharmacologic interventions
- Ventricular Assist device if no response to above

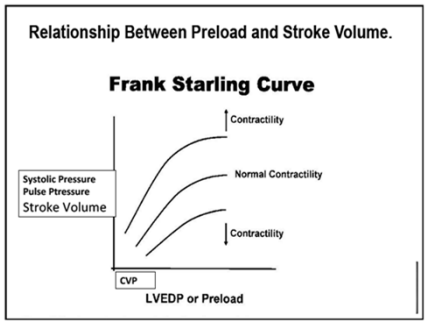
Source: Bojar. R. 2011. Manual of Perioperative Care in Adult Cardiac Surgery,5th ed



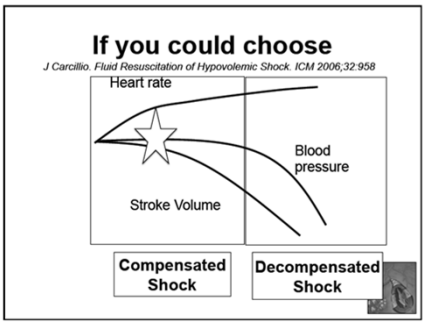
Source Barbara McLean



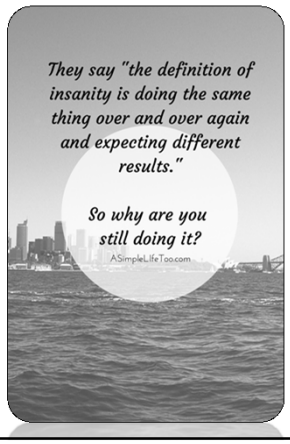
Source Barbara McLean



Source Barbara McLean



Source Barbara McLean



If what you are doing isn't working, change strategies!

Medications for Low Cardiac Output

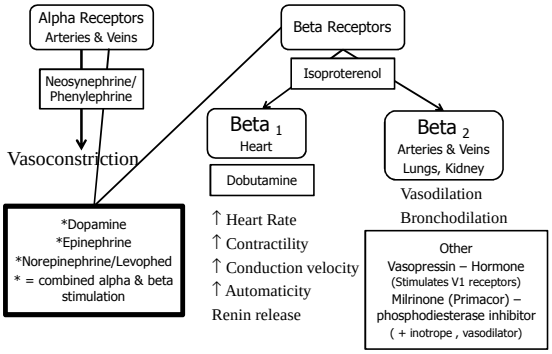


Table 11.5 • Hemodynamic Effects of Vasoactive Medications

Medication	SVR	HR	PCW	CI	MAP	MvO_2
Dopamine	↓↑	↑↑↑	↓↑	↑	↓↑	↑
Dobutamine	↓	↑↑↑	↓	↑	↓↔↑	↑↔
Epinephrine	↓↑	↑↑	↓↑	↑	↑	↑
Milrinone/ Inamrinone	↓↓	↑	↓	↑	↓	↓↑
Isoproterenol	↓↓	↑↑↑↑	↓	↑	↓↑	↑↑
Calcium chloride	↑	↔	↑	↑	↑↑	↑
Norepinephrine	↑↑	↑↑	↑↑	↑	↑↑↑	↑
Phenylephrine	↑↑	↔	↑	↔	↑↑	↔↑
Vasopressin	↑↑	↔	↑	↔	↑↑↑	↔↑
Nesiritide	↓	↔	↓↓	↑*	↓	↓↓

↑ increased; ↓ decreased; ↔ no change; ↓↑ variable effect. The relative effect is indicated by the number of arrows.

Note:
1. The effect may vary with dosage level (particularly dopamine and epinephrine, in which case the effect seen at low dose is indicated by the first arrow).
2. For some medications, an improvement in MAP may occur from the positive inotropic effect despite a reduction in SVR.
3. The effects of inamrinone, milrinone, and calcium are not mediated by α and β receptors.

*indirect effect.

Source: Bojar. R. 2011. Manual of Perioperative Care in Adult Cardiac Surgery,5th ed

Draw arrows to indicated if the hemodynamic parameters would be increased, decreased or normal.

	Hypovolemia	Fluid Overload	LV failure	RV failure	RV & LV failure	Sepsis
CO/CI						
CVP						
PAD						
SV/SVI						
SVR/SVRI						
PVR/PVRI						

Hypovolemia

	Hypovolemia
CO/CI	↓
CVP	↓
PAD	↓
SV/SVI	↓
SVR/SVRI	Normal/increased
PVR/PVRI	Normal

Fluid overload

	Hypovolemia	Fluid Overload
CO/CI	↓	Nx or ↓
CVP	↓	↑
PAD	↓	↑
SV/SVI	↓	↑
SVR/SVRI	Normal/increased	Normal
PVR/PVRI	Normal	Normal

LV Failure

	Hypovolemia	Fluid Overload	LV failure
CO/CI	↓	Nx or ↓	↓
CVP	↓	↑	Normal
PAD	↓	↑	↑
SV/SVI	↓	↑	↓
SVR/SVRI	Normal/increased	Normal	↑
PVR/PVRI	Normal	Normal	Normal

RV Failure

	Hypovolemia	Fluid Overload	LV failure	RV failure
CO/CI	↓	Nx or ↓	↓	↓
CVP	↓	↑	Normal	↑
PAD	↓	↑	↑	Normal
SV/SVI	↓	↑	↓	↓
SVR/SVRI	Normal/increased	Normal	↑	Normal
PVR/PVRI	Normal	Normal	Normal	↑

RV & LV Failure

	Hypovolemia	Fluid Overload	LV failure	RV failure	RV & LV failure
CO/CI	↓	Nx or ↓	↓	↓	↓
CVP	↓	↑	Normal	↑	↑
PAD	↓	↑	↑	Normal	↑
SV/SVI	↓	↑	↓	↓	↓
SVR/SVRI	Normal/ increased	Normal	↑	Normal	↑
PVR/PVRI	Normal	Normal	Normal	↑	↑

	Hypovolemia	Fluid Overload	LV failure	RV failure	RV & LV failure	Sepsis
CO/CI	↓	Nx or ↓	↓	↓	↓	↑
CVP	↓	↑	Normal	↑	↑	↓
PAD	↓	↑	↑	Normal	↑	↓
SV/SVI	↓	↑	↓	↓	↓	↓
SVR/SVRI	Normal/ increased	Normal	↑	Normal	↑	↓
PVR/PVRI	Normal	Normal	Normal	↑	↑	↓

Hemodynamics Let's Practice!

Practice!
http://pie.med.utoronto.ca/edwards

Case #1 What's abnormal?

	CABG on admission Dopamine 2.5 mcg/kg/min
CO/CI	3.7/1.8
SBP/DBP	115/53
MAP	71
HR	85
$Sv0_2$	38
CVP	9
PAS/PAD	26/16
PAM	21
PAW	20
SV	44
SVR	1339
SVRI	2779
PVR	22
PVRI	45

How do you want to treat?

	CABG on admission Dopamine 2.5 mcg/kg/min
CO/CI	3.7/1.8
SBP/DBP	115/53
MAP	71
HR	85
$Sv0_2$	38
CVP	9
PAS/PAD	26/16
PAM	21
PAW	20
SV	44
SVR	1339
SVRI	2779
PVR	22
PVRI	45

1. Fluid
2. Increase dopamine
3. Decrease dopamine
4. Add another pressor

Answer How do you want to treat?

	CABG on admission Dopamine 2.5 mcg/kg/min
CO/CI	3.7/1.8
SBP/DBP	115/53
MAP	71
HR	85
$Sv0_2$	38
CVP	9
PAS/PAD	26/16
PAM	21
PAW	20
SV	44
SVR	1339
SVRI	2779
PVR	22
PVRI	45

1. Fluid

What's abnormal?

	CABG on admission Dopamine 2.5 mcg/kg/min	**30 minutes later after 250 ml 5% albumin**
CO/CI	3.7/1.8	4.9/2.4
SBP/DBP	115/53	123/55
MAP	71	74
HR	85	88
$Sv0_2$	38	39
CVP	9	10
PAS/PAD	26/16	29/18
PAM	21	23
PAW	20	21
SV	44	56
SVR	1339	1055
SVRI	2779	2166
PVR	22	33
PVRI	45	68

How do you want to treat?

	CABG on admission Dopamine 2.5 mcg/kg/min	**30 minutes later after 250 ml 5% albumin**
CO/CI	3.7/1.8	4.9/2.4
SBP/DBP	115/53	123/55
MAP	71	74
HR	85	88
$Sv0_2$	38	39
CVP	9	10
PAS/PAD	26/16	29/18
PAM	21	23
PAW	20	21
SV	44	56
SVR	1339	1055
SVRI	2779	2166
PVR	22	33
PVRI	45	68

1. Fluid
2. Increase dopamine
3. Decrease dopamine
4. Add another pressor

Answer How do you want to treat?

	CABG on admission Dopamine 2.5 mcg/kg/min	**30 minutes later after 250 ml 5% albumin**
CO/CI	3.7/1.8	4.9/2.4
SBP/DBP	115/53	123/55
MAP	71	74
HR	85	88
$Sv0_2$	38	39
CVP	9	10
PAS/PAD	26/16	29/18
PAM	21	23
PAW	20	21
SV	44	56
SVR	1339	1055
SVRI	2779	2166
PVR	22	33
PVRI	45	68

1. Fluid

	CABG on admission Dopamine 2.5 mcg/kg/min	**30 minutes later after 250 ml 5% albumin**	**36 hours later** 500 ml 5% albumin & Dopamine 1 mcg/kg/min
CO/CI	3.7/1.8	4.9/2.4	6.5/3.1
SBP/DBP	115/53	123/55	133/40
MAP	71	74	69
HR	85	88	75
$Sv0_2$	38	39	55
CVP	9	10	12
PAS/PAD	26/16	29/18	40/19
PAM	21	23	27
PAW	20	21	26
SV	44	56	86
SVR	1339	1055	701
SVRI	2779	2166	1455
PVR	22	33	12
PVRI	45	68	26

Case 2: Identify abnormal hemodynamic parameters and what you would do?

Dopamine 2.5 mcgkg/min, Epi 3.07 mcg/min Milrinone 0.5 mcg/kg/min

	1300
Art BP	118/71
MAP	80
HR	107
PAS/PAD	37/26
CVP	23
SVO2	45
CO	4.2
CI	1.8
SVR	1316
SpO2	95
SV	39
UO	60

T2

Case 2: Identify abnormal hemodynamic parameters and what you would do?

Dopamine 2.5 mcgkg/min, Epi 3.07 mcg/min Milrinone 0.5 mcg/kg/min

	1300
Art BP	118/71
MAP	80
HR	107
PAS/PAD	37/26
CVP	23
SVO2	45
CO	4.2
CI	1.8
SVR	1316
SpO2	95
SV	39
UO	60

1. Treat hypovolemia
2. Treat tamponade
3. Treat cardiogenic shock
4. Treat fluid overload

T2

Case 2: Identify abnormal hemodynamic parameters and what you would do?

	1300
Art BP	118/71
MAP	80
HR	107
PAS/PAD	37/26
CVP	23
SVO2	45
CO	4.2
CI	1.8
SVR	1316
SpO2	95
SV	39
UO	60

1. Answer
2. Treat tamponade

T2

Case 2 Answer: Tamponade. If cardiogenic shock would expect a higher SVR and CVP would be lower. Treatment– reexploration of chest.

Dopamine 2.5 mcgkg/min, Epi 3.07 mcg/min Milrinone 0.5 mcg/kg/min .

	1300
Art BP	118/71
MAP	80
HR	107
PAS/PAD	37/26
CVP	23
SVO2	45
CO	4.2
CI	1.8
SVR	1316
SpO2	95
SV	39
UO	60

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min
CO/CI	3.3/1.5
SBP/DBP	107/47
MAP	66
HR	67
$Sv0_2$	62
CVP	10
PAS/PAD	37/19
PAM	26
SV	50
SVR	1259
PVR	179

What's abnormal?

- NSTEMI 2 days ago with EF 30%
- PMH
  - Stent to RCA = 5 years ago
  - Moderate COPD
  - Smoker
  - Diabetes
  - RBBB

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min
CO/CI	3.3/1.5
SBP/DBP	107/47
MAP	66
HR	67
$Sv0_2$	62
CVP	10
PAS/PAD	37/19
PAM	26
SV	50
SVR	1259
PVR	179

How do you want to treat?

1. Fluid
2. Increase phenylephrine
3. Decrease phenylephrine
4. Add another pressor

- NSTEMI 2 days ago with EF 30%
- PMH
  - Stent to RCA = 5 years ago
  - Moderate COPD
  - Smoker
  - Diabetes
  - RBBB

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min
CO/CI	3.3/1.5
SBP/DBP	107/47
MAP	66
HR	67
$Sv0_2$	62
CVP	10
PAS/PAD	37/19
PAM	26
SV	50
SVR	1259
PVR	179

How do you want to treat?

1. Fluid

- NSTEMI 2 days ago with EF 30%
- PMH
  - Stent to RCA = 5 years ago
  - Moderate COPD
  - Smoker
  - Diabetes
  - RBBB

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	250 ml 5% albumin x 2 = 500 ml Phenylephrine at 50mcg/min
CO/CI	3.3/1.5	3.4/1.6
SBP/DBP	107/47	107/45
MAP	66	64
HR	67	63
$Sv0_2$	62	66
CVP	10	11
PAS/PAD	37/19	39/19
PAM	26	27
SV	50	53
SVR	1259	1199
PVR	179	188

Was he fluid responsive to the 500 ml Albumin?

1. Yes
2. No

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	250 ml 5% albumin x 2 = 500 ml Phenylephrine at 50mcg/min
CO/CI	3.3/1.5	3.4/1.6
SBP/DBP	107/47	107/45
MAP	66	64
HR	67	63
$Sv0_2$	62	66
CVP	10	11
PAS/PAD	37/19	39/19
PAM	26	27
SV	50	53
SVR	1259	1199
PVR	179	188

Was he fluid responsive to the 500 ml Albumin?

1. No

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	250 ml 5% albumin x 2 = 500 ml Phenylephrine at 50mcg/min
CO/CI	3.3/1.5	3.4/1.6
SBP/DBP	107/47	107/45
MAP	66	64
HR	67	63
$Sv0_2$	62	66
CVP	10	11
PAS/PAD	37/19	39/19
PAM	26	27
SV	50	53
SVR	1259	1199
PVR	179	188

He needs something to pump the fluid (increase the contractility). What do you want to use?

1. Dopamine
2. Increase Phenylephrine
3. Epinephrine
4. Milrinone
5. Calcium

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	250 ml 5% albumin x 2 = 500 ml Phenylephrine at 50mcg/min
CO/CI	3.3/1.5	3.4/1.6
SBP/DBP	107/47	107/45
MAP	66	64
HR	67	63
$Sv0_2$	62	66
CVP	10	11
PAS/PAD	37/19	39/19
PAM	26	27
SV	50	53
SVR	1259	1199
PVR	179	188

He needs something to pump the fluid (increase the contractility). What do you want to use?

1.
2.
3.
4. Milrinone

Drug Pearls

- Epinephrine → 1st line drug for borderline cardiac output
- Dopamine→ 1st line drug for low CO state. Also useful to increase urine output
- Dobutamine→ Most useful when CO is marginal & mild ↑ SVR. Moderate pulmonary dilator
- Milrinone→ used for persistent low CO, RV dysfunction, diastolic dysfunction
- Norepinephrine→Low CO with low BP caused by low SVR
- Neo-synephrine→used to ↑ SVR when hypotension exists with normal CO
- Vasopression→ Refractory vasodilatory shock, ↓ SVR

Source: Bojar. R. 2011. Manual of Perioperative Care in Adult Cardiac Surgery,5th ed

RV support

- Volume
- Positive inotrope
- Pulmonary Vasodilator

LV Support

- Decrease SVR (vasodilators)
- Increase contractility
- Assist devices

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	**250 ml 5% albumin x 2 = 500 ml** Phenylephrine at 50mcg/min	**Milrinone started at 0.25mcg/kg/min 1 hour later 250 ml of 5% Albumin given**
CO/CI	3.3/1.5	3.4/1.6	4.7/2.7
SBP/DBP	107/47	107/45	119/49
MAP	66	64	75
HR	67	63	87
$Sv0_2$	62	66	70
CVP	10	11	15
PAS/PAD	37/19	39/19	47/26
PAM	26	27	35
SV	50	53	57
SVR	1259	1199	1119
PVR	179	188	153

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	**250 ml 5% albumin x 2 = 500 ml** Phenylephrine at 50mcg/min	**Milrinone started at 0.25mcg/kg/min 1 hour later 250 ml of 5% Albumin given**	**12 Hours later. Urine output good**
CO/CI	3.3/1.5	3.4/1.6	4.7/2.7	3.8/1.8
SBP/DBP	107/47	107/45	119/49	121/45
MAP	66	64	75	68
HR	67	63	87	90
$Sv0_2$	62	66	70	69
CVP	10	11	15	10
PAS/PAD	37/19	39/19	47/26	43/19
PAM	26	27	35	29
SV	50	53	57	44
SVR	1259	1199	1119	1304
PVR	179	188	153	210

What do you want to do?

1. Fluids
2. Pressors

	CABG x 2 LAD & PDA, EF 30% admission Phenylephrine at 50mcg/min	**250 ml 5% albumin x 2 = 500 ml** Phenylephrine at 50mcg/min	**Milrinone started at 0.25mcg/kg/min 1 hour later 250 ml of 5% Albumin given**	**12 Hours later. Urine output good**
CO/CI	3.3/1.5	3.4/1.6	4.7/2.7	3.8/1.8
SBP/DBP	107/47	107/45	119/49	121/45
MAP	66	64	75	68
HR	67	63	87	90
$Sv0_2$	62	66	70	69
CVP	10	11	15	10
PAS/PAD	37/19	39/19	47/26	43/19
PAM	26	27	35	29
SV	50	53	57	44
SVR	1259	1199	1119	1304
PVR	179	188	153	210

What do you want to do?

1. Fluids
2.

What if you have one hemodynamic value you can't remember the normal?

Don't PANIC!

GO WITH WHAT YOU KNOW!

Practice!
http://pie.med.utoronto.ca/edwards