Conquering Complications: Care of the Cardiac Surgery Patient in the Immediate Post op Period

Trauma Triad of Death
- Coagulopathy
- Death
- Acidosis
- Hypothermia
- Decreased myocardial performance

Cardiac Surgery Triad of Disaster
- Coagulopathy
- Hypothermia
- Metabolic Acidosis
- Complications
- Death
- Increased LOS
- Decreased myocardial performance

Hypoperfusion Starts the Triad of Disaster
- Coagulopathy
- Hypothermia
- Metabolic Acidosis
- Complications
- Death
- Increased LOS
- Decreased myocardial performance

Hypothermia
Causes of Heat Loss

- Cooled during cardiopulmonary bypass
- Cold OR room
- Cool room and/or fan on
- Cold fluids
  - 1 unit of pRBC can lower body Temp 0.25°C
  - 1 liter of fluids unit can lower body Temp 0.5°C
- No blankets
- Head uncovered

Alarming Consequences of Hypothermia

1. Increased oxygen debt
   - Cold hemoglobin can not release oxygen to the cells
   - Left shift of the oxyhemoglobin dissociation curve
   - Prolonged ventilation
2. Increased lactic acid production
   - Change from aerobic to anaerobic metabolism
   - Leads to acidosis
3. Coagulopathy
   - Prolonged clotting cascade
   - Platelet dysfunction – platelets are extremely temperature dependent
   - Altered fibrinolytic system
4. Altered cardiovascular function
   - Decreased cardiac output/contractility
   - Risk of arrhythmias
   - Increased SVR due to vasoconstriction

(Cont)
5. Hyperglycemia
   - Decrease insulin production
6. Increased Risk of Infection
   - Impairs neutrophil function
   - Tissue hypoxia from vasoconstriction
7. Altered drug metabolism
   - Delayed emergence from anesthesia
8. Shivering
   - Increases myocardial oxygen demand and consumption

Rewarming techniques

- Warm room – no fan
- Warm blankets – keep patient covered
- Bare Hugger
- Use blood warmer to give blood products
  - Have blood warmer and bare hugger in room

Cardiac Surgery Triad of Disaster

Coagulopathy
Hypothermia
↑ LOS
Complications
Death
Metabolic Acidosis
Decreased myocardial performance
Acidosis Pathophysiology
From Allen C Wolfe Jr., MSN, RN, CFNR, CCNL, CMTE
Clinical Education Director/Clinical Specialist, Air Methods Corporation Denver, Colorado

**Ph < 7.20**
- Decrease in cellular function causing failure to produce ATP (energy stores) to transport proteins across cells and slows or stops transmission of messages

**Driving in a Snow Storm**

**Pathophysiology of Acidosis**
- **Hypothermia**: Causes peripheral vasoconstriction and impairs oxygen delivery to the tissues
- **Hypovolemia**: Caused by bleeding reduces tissue perfusion

  - Cellular metabolism changes from aerobic to anaerobic
    - Serum lactate levels rise
    - Metabolic acidosis develops

**Alarming Consequences of Acidosis**
- Decreased cardiac contractility & cardiac output
- Impaired response to catecholamine
- (ie intropes are not effective)
- Increased PVR
- Vasodilation - decreased SVR
- Bradycardia
- Increased arrhythmia risk
- Coagulopathy
- Compensatory hyperventilation

**Identify Cause of Lactic Acidosis**
- **Type A Lactic Acidosis**
- **Type B Lactic Acidosis**

  - Occurs in the absence of tissue hypoxia
  - May be catecholamine-induced metabolic effect (especially with epinephrine)
  - May be caused by hyperglycemia & alterations in fatty acid metabolism

**Treat the Cause!**

**Disruption of normal regulatory mechanisms during surgery**
- Plasma glucose elevates
- Insulin secretion is depressed
- Elevated blood levels of catabolic hormones render patient resistant to insulin
- Ketones form as a result of incomplete oxidation.
- If not treated, metabolic acidosis may develop within hours
- Insulin corrects abnormality
If Potassium is LOW, Be Careful when giving...

♥ Insulin
♥ Calcium
♥ Digoxin

Serum glucose should not decrease more than 75 - 100 ml/dl per hour to prevent...

♥ Hypoglycemia
♥ Hypokalemia
♥ Cerebral Edema

Severe hypoglycemia can lead to coma and death!

Admission ABGs

Interpret these:

1. Pt A = Respiratory Acidosis
   Pt B = Metabolic Acidosis
2. Pt A = Metabolic Acidosis
   Pt B = Respiratory Acidosis
3. Both metabolic acidosis
4. Both Respiratory Acidosis
Admission ABGs

Answer

Interpret these
1. Pt A = Respiratory Acidosis
   Pt B = Metabolic Acidosis

2.

Metabolic Acidosis

Ongoing Metabolic Acidosis means something is not being perfused

- Type A Lactic Acidosis
  - Reflects impaired tissue oxygenation & anaerobic metabolism resulting from circulatory failure
  - The lactate ion more than the acidemia contributes to potential cardiovascular dysfunction

The Value of Lactate

- Serum lactate levels are used to assess the acid-base state and adequacy of tissue perfusion
- By product of anaerobic metabolism if tissue hypoxia (from hypoperfusion) exists
- A change from aerobic to anerobic metabolism

The Value of Lactate

Serial lactate levels predictor of perfusion

- Normal <2.5mmol/L
- Mild acidosis 2.5-4.9mmol/L (mortality 25-35%)
- Moderate acidosis 5.0-9.9mmol/L (mortality 60-75%)
- Severe acidosis >10mmol/L (mortality > 95%)

Lactate Levels

“Surviving Sepsis 2014”

- Normal 1-2
  - Cells are alive & well
- Moderate 2 - 4
  - DECREASED cellular perfusion
  - Cells STRUGGLE to survive
  - May indicate severe sepsis
- Severe > 4
  - COMPLETE TISSUE HYPOXIA
  - Cells DIE
  - Hypotension refractory to adequate fluid resuscitation indicates septic shock

Lactate is primarily excreted by liver.

Treatment: Treat the Cause

NaHCO₃ (Bicarb) is truly only a “Band-Aid” and should only be used for severe metabolic acidosis = pH < 7.2 & HCO₃ < 6mEq/L

Treat the Cause!
Serum Lactic Acid Levels

- May be the first indication that something is wrong
- Excess lactate demonstrates measurement of tissue oxygen debt
- Results in metabolic acidosis due to tissue hypoperfusion and “starvation”

Base deficit/excess

- Amount of total base (buffer) that is needed to achieve acid-base balance.
- BD/BE is depicted by \( \text{HCO}_3^- \), phosphates, sulfates, proteins and organic acids. To figure BD/BE, lab uses the PH, PaCo2 and Hct.
- Normal -2- +2
- If < -2, the patient is not perfusing

Which patient are you more concerned about?

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<tr>
<td>BE</td>
<td>-4</td>
<td>-8</td>
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Serum Lactic Acid Levels

- Increasing lactic acid levels mean the tissues are hypoperfused and patient is getting worse.
- Decreasing lactic acid levels mean the tissues are getting perfused and the patient is getting better.

Do not draw lactate levels more than every 4 hours.
Lactate level takes 4 hours to rise and 4 hours to release.

Base deficit

- Normal -2 to +2
- Mild Hypoperfusion: -2 to -5
- Moderate Hypoperfusion: -6 to -14
- Severe Hypoperfusion: < -15


Which patient are you more concerned about?

Answer 2
Acidosis Summary

- Acidosis is the #1 negative inotrope!
- Acidosis decreases cardiac contractility!
- Treat acidosis so alpha inotropes work!
  - Direct therapy to improve oxygen delivery and reducing demand and thus decrease acid production.

Treat the Cause!

Cardiac Surgery
Triad of Disaster

Coagulopathy

- Hypothermia
- Acidoses
- Underlying diseases
- Medications
- Dilation with fluids

Causes of Coagulopathy

- Bleeding from suture lines
- Clip comes off graft
- Aortic or ventricular rupture
- Chest wall bleeders
- Abnormal clotting factors due to
  - Preop anticoagulant meds
  - Systemic heparinization during CPB
  - Breakdown of factors during CPB

Signs & Symptoms

- CT bleeding > 100 – 200 cc/hr
- Low or labile B/P
- Low CVP or PAD
- Falling SvO₂ and CO/CI
- Abnormal clotting Factors
- Bleeding from line sites, incisions
Treatments

- Monitor CT output. May need to replace CT output cc for cc with packed cells
- Keep sedated and keep B/P < 140 to prevent stress on suture lines
- Keep CT patent by gently milking and stripping
- Use warming blanket to keep normal thermic.
  - Hypothermia interferes with clotting factors

Rule of thumb

- Replace CT output ml for ml
- Minimum after every 4th unit pRBCs
  - Calcium Chloride
  - FFP
- Recommend 1 pRBC to 1 FFP

Treatments: Blood and Blood Products

- Give blood and blood products
- FFP for ↑ PT or PTT
- Platelet Phoresis for ↓ Platelet count
- Cryoprecipitate for ↓ Fibrinogen level
- Packed cells for ↓ H & H

Treatments

- Pharmacological Interventions
  - Protamine to reverse effects of systemic heparinization
  - Aminocaproic Acid (Amicar) to inhibit conversion of plasminogen to plasmin
  - Desmopressin to improve platelet function
  - Recombinant Activated Factor VII (NovaSeven) stimulates the generation of thrombin
- May need to return to surgery to repair mechanical cause of bleeding

Keep blood on HOLD --- communicate with blood bank that you have a bleeder

- May need to use type specific blood
Massive Hemorrhage Protocol

81 y/o male CABG x 3 LAD, Marginal, PDA
Admission vital signs & labs.
What are your priorities?

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<th>MAP</th>
<th>HR</th>
<th>Temp</th>
<th>PAS/PAD</th>
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<td>32/17</td>
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<td>97</td>
<td>750</td>
<td>810</td>
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Treatment:
- Treat high glucose
- Treat low Magnesium
- Fluids for low CI

Postop recovery going well. Extubated at 0015.
Now what?

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1. Routine surgery – continue to monitor
2. Bleeding – call surgeon
3. Hypertensive – start antihypertensive

It’s 0500. What are your priorities?

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<td>810</td>
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1. ANSWER
2. Bleeding – call surgeon
It is 0700, calculate the CT output and the blood products given…. Are you keeping up with the bleeding?

Chest tube output: 1660 ml

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<tr>
<td>0700</td>
<td>300</td>
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</table>

\[\text{Pt received 3 units of pRBCs}\]

\[\text{Preop of bleeding patient}\]

\[\text{9/22 2135 DOS – Just before extubation}\]

\[\text{9/23 0500 POD #1}\]

\[\text{POD #2}\]
2nd Case:
Based on these coag values, what blood products do you expect to be ordered?

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<td>Lactic Acid</td>
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After 5 pRBCs, 1 platelet pheresis, 3 FFP, 10 cryo.
Would you anticipate any further blood products?

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</table>
Cardiac Tamponade: Causes

- Blood accumulated in the chest from:
  - CTs clotted off and unable to drain excess blood
  - Epicardial wire removal
- May occur quickly within minutes of hours or may occur slowly over days or weeks

Cardiac Tamponade: Signs & Symptoms

- Hypotension
- Low urine output
- Rising & equalization of CVP & PAD
- Falling SVO₂, CO/CI
- Sudden decrease in CT output
- Widening mediastinum on CXR
- Neck Vein Distention
- Tachycardia
- Pulses Paradox > 20 mmHG
- Diminished heart sounds
- For tamponade that occurs slowly may also see these S/S:
  - Shortness of Breath
  - Chest Pain
  - Ischemic changes on EKG
  - Nausea

Cardiac Tamponade: Beck’s Triad

- Hypotension
- Neck vein distention
- Muffled heart sounds

Cardiac Tamponade: Treatment

- Urgent surgical exploration to evacuate excess blood & correct cause of the tamponade
- Bedside echo may be used to make differential diagnosis between tamponade & LV failure
- Administer fluids & inotropes or Calcium Chloride until patient can be returned to OR
- Prepare for possible exploration of chest at bedside
It's 2300, what do you want to do?

1. Fluids for hypovolemia
2. Surgery for tamponade
3. Inotropes for cardiogenic shock
4. Diuretics for fluid overload

**DOS**

It's 2300, what do you want to do?

2. Surgery for tamponade

**POD #1**

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<th>Event Description</th>
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<tr>
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<td>Started on Dopamine 2.5 mcg/kg/min</td>
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<tr>
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<td>Epi 3.07 mcg/min</td>
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<tr>
<td></td>
<td>Milrinone 0.5 mcg/kg/min</td>
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<td></td>
<td>1300 – back to OR</td>
</tr>
<tr>
<td></td>
<td>1600 – back to CVICU post removal of blood</td>
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**TAMPONADE!**

**POD #2**

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<td>1600 – back to CVICU post removal of blood</td>
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POD 2 @ 0600

POD 2 @ 1230

POD 3 post evacuation 0600

RRT on Progressive unit called for hypotension CABG POD #5

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Tamponade Pearl

- Hypotension in a cardiac surgery patient…. Think tamponade or you will miss it!
- May occur fast or slow (weeks)
Treatment of Cardiac Arrest
Cardiac Surgery Advanced Life Support

Cardiac Arrest...
• In the immediate postop recovery in a cardiac surgery patient is typically related to reversible causes
  • Tamponade
  • Bleeding
  • Ventricular arrhythmias
  • Blocks associated with conduction problems
• Survival to discharge can be up to 79%
  • If treated promptly

European Association for Cardio-Thoracic Surgery
2009

Cardiac Advanced Life Support - Surgery

Key Concepts
• Assess Rhythm
• Shock before Compressions
• Pace/Atropine – not Epi
• Identify reversible causes
• Early resternotomy

PALS Guidelines
European Association for Cardio-Thoracic Surgery
2009

Pulsless Electrical Activity (PEA)
• Cardiac surgery patients who arrest with PEA are typically experiencing treatable causes
  • Hypovolemia — severe
  • Hypoxia
  • Tamponade
  • Tension pneumothorax
• Prompt treatment results in good outcomes
• To assess for causes of PEA/nonschockable rhythm
  • Consider the 4 “Hs” and 4 “Ts”

Assess for Reversible Causes

<table>
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<td>Tamponade *</td>
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<tr>
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* = Most common causes of cardiac surgery arrests
**Treatment of PEA causes**

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<td>• Treat per airway management and assessment</td>
<td>• Severe hypovolemia is typically due to bleeding</td>
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<tr>
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<td>• Severe hypovolemia and tamponade both require emergent resternotomy to correct</td>
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**Steps to Ensure Adequate Airway and Ventilation**

- Check endotracheal tube (ET) position and end tidal carbon dioxide (EtCO₂) waveform and reading
- Listen for an ETT airleak and verify that is properly inflated
- Listen and look for bilateral breath sounds.
- Consider removing the patient from the ventilator and give 100% oxygen via bag-mask-valve to more easily assess lung sounds and determine lung compliance
- If bilateral lung sounds are present, reconnect the ETT to ventilator.

**Steps to Ensure Adequate Airway and Ventilation (continued)**

- Feel the trachea to verify it is midline.
- If a tension pneumothorax is suspected, insert a large bore needle into the 2nd intercostal space, midclavicular line.
- If unable to ventilate the patient with a bag-mask-valve, attempt to suction the ET tube.
  - If unable to pass the suction catheter, ETT occlusion or malposition should be suspected.
  - Remove the ETT and ventilate with a bag-mask-valve.

**Prepare for Emergency Resternotomy**

**Six Key Roles**

1. External cardiac massage
2. Management of airway and breathing
3. Defibrillation
4. Team leader
5. Medication administration
6. ICU nursing Coordinator

**Conquering Complications:**

Not related to the Triad of Disaster

- Coagulopathy
- Cardiac Surgery Complications
- LOS
- Hypothermia
- Metabolic Acidosis
- Death
- Decreased myocardial performance

**Cardiac Vasoplegic Syndrome post Cardiac Surgery**

Sara Caruso, RN, BSN, CCRN-CSC
CABG x 3, on Insulin drip, Epinephrine drip, & predecex drip
PMH: ½ ppd smoker x20 years, depression with use of SSRI’s, EF = 30%, HF -- Coreg and Lisinopril

Admission Vitals

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<td>CO/CI</td>
<td>4.5/2.5</td>
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250ml of 5% albumin x 2 administered with no change in SVR/CVP, Neosynephrine drip is started

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One Hour Later after albumin & Neosynephrine

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What is Cardiac Vasoplegic Syndrome?
(Vasodilatory Shock)

- Arterial vasodilatory state resistant to the usual vasopressors post cardiac surgery
- Severe and persistent form of hypotension with:
  - Normal or high cardiac output
  - Low CVP and PAOP
  - Decreased systemic vascular resistance (SVR) <800
- Low filling pressures that are poorly responsive or unresponsive to volume
- 5-8% of all patients post cardiac surgery
- Increased morbidity and mortality

Why does this happen?

- Huge inflammatory response post cardiac surgery
  - Large quantities of nitric oxide released
    - Cardiopulmonary bypass
    - Surgical trauma
    - Blood loss
    - Blood transfusions
    - Hypothermia
    - Neutralization of heparin with protamine
- Nitric Oxide produces profound vasodilation and vasoplegia
Result: Loss of vasomotor tone and vasodilation

At Risk population:

- Preoperative heart failure
  - EF < 35%
  - End stage HF requiring assist device
- Numerous preop antihypertensive medications
  - ACE inhibitors, ARBs, Beta Blockers, Calcium Channel blockers
- Use of pre and post Amiodarone and Phosphodiasterase inhibitors (Milrinone)

Treatment for Cardiac Vasoplegic Syndrome

Methylene Blue (Tetramethylthionin chloride)
- Interferes with the nitric oxide pathway and inhibits the vasorelaxant effect on smooth muscle
- Can raise mean arterial pressures while minimizing the use of vasopressors
- Usually given pre-op or inter-op to prevent CVS
- Bolus dose of 1-2mg/kg over 10-20 min followed by an infusion of 0.25mg/kg/hr for 48-72 hours, do not exceed 2mg/kg
Treatment for Cardiac Vasoplegic Syndrome
Phenylephrine, Norepinephrine or Vasopressin
♥ Treats refractory hypotension when used in conjunction with Methylene Blue
♥ Potent vasoconstrictor

Nursing Role
♥ Early identification of Cardiac Vasoplegic Syndrome
♥ Notification to cardiac surgeon
♥ DO NOT KEEP GIVING VOLUME!

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Needs Methylene Blue and Vasopressin

Walk To Recovery
♥ Chairs for Meals
♥ Scheduled Walks
1st Walk: Between 06 – 08
2nd Walk: Before Lunch
3rd Walk: Before 1330
4th Walk: Before Dinner
5th Walk: After Dinner
6th Walk: Before Bed

Do you feel like you ran a marathon?
Warning Signs of Trouble

- Tachycardia
  - Persistent tachycardia is a compensatory mechanism
- Cool extremities
- Diminished peripheral pulses
- Changes in mentation
- Decreased urine output
- Hypotension

Pay Attention to the Things

You will save more lives by being Meticulous than by being Brilliant

Next Steps

- Make a study action plan
- Set the target test date
- Get a study partner

Don’t miss the obvious!

- Take out your cell phone
- Take a selfie

An Ounce of Prevention is Worth a Pound of Cure.
CCRN or CSC

By __________
(insert date)

Place selfie here

Challenging Complex
Cardiac Pulmonary
Case Studies

See you at the
CERTIFICATION
CELEBRATION

cherrmann@frontier.com
www.cherylherrmann.com

UnityPoint Health, Peoria
Heart of IL AACN – President