

Cardiac Surgery Advanced Life Support

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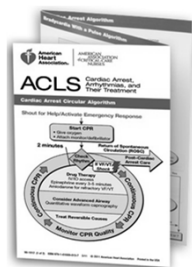
Cardiac Arrest...

- 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



2010 AHA ACLS Guidelines

- Pros
 - EBP resuscitation guidelines
 - Standardized approach
 - Easy to teach and implement



• Cons:

- Do not specifically address cardiac surgery arrests

Cardiac Surgery Arrests

- Hospitals developed own guidelines and protocols
- No standardization

EACTS Guidelines

European Association
for Cardio-Thoracic
Surgery

2009



European Journal of Cardio-Thoracic Surgery 36 (2009) 1–28

EUROPEAN ASSOCIATION
FOR CARDIO-THORACIC
SURGERY

Guideline

Guideline for resuscitation in cardiac arrest after cardiac surgery
Joel Dunning^a, Alessandro Fabbrì^b, Philippe H. Kohl^c, Adrian Levine^d, Ulf Lockowandt^e,
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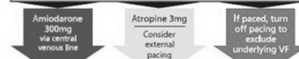
Received 10 November 2008; received in revised form 21 January 2009; accepted 22 January 2009; available online 17 March 2009

CARDIAC ARREST

Assess rhythm



Start basic life support



Prepare for emergency re sternotomy



Airway and ventilation

* If ventilated, turn FiO₂ to 100% and switch off PEEP.
* Change to bag valve with 100% O₂, verify ET tube position and cuff inflation, and listen for breath sounds bilaterally to exclude a pneumothorax or kinked tube.
* If tension pneumothorax suspected, immediately place large bore cannula in the 2nd rib space anterior mid-clavicular line.

Key Points

* DO NOT GIVE ADRENALINE/EPINEPHRINE unless a senior doctor advises this.
* If as BLS to place, change to pressure trigger.
* Do not delay basic life support for defibrillation or pacing for more than one minute.

But we are in the USA~



CALS-S in the USA

California Pacific Medical Center / Sutter Health
Mayo Clinic
Duke University Medical Center
Temple University Hospital Beth Israel
Deaconess Medical Center
Society of Thoracic Surgeons (STS) soon!

www.csu-als.com

CALS - USA

Welcome Location Booking Places to stay Programme Faculty links

Nursing Education
Cardiac Surgical Advanced Life Support (CALS)
CARDIAC
February 29th - April 11th
September 1st - November 1st, 2012

THE CALS USA TEAM

In 2009 Jill Ley attended our CALS course in the UK. She then brought the course back to California Pacific Medical Center and started running very successful courses in San Francisco with a dedicated group of trainers. These courses have grown in popularity and they now offer 4 courses per year at their hospital, and put on the full course in collaboration with our UK team at AACN's National Teaching Institute. Their team can also travel to put on courses for units around the US, by invitation.

Contact her on LeyJ@SutterHealth.org

COURSE DETAILS

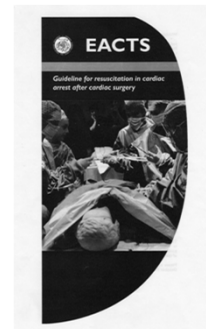
The Name

- CALS
- CSU-ALS

• CALS- S

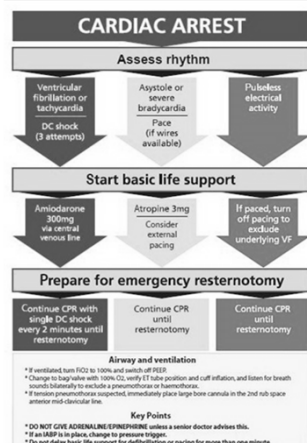
Cardiac Advanced Life Support - Surgery

EACTS



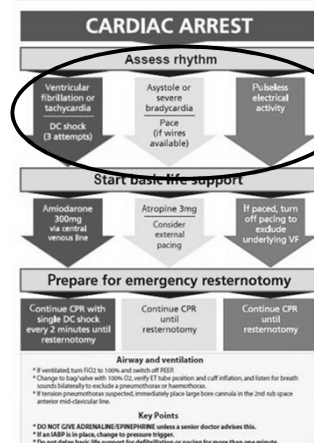
Key Concepts

- Assess Rhythm
- Shock before Compressions
- Pace/Atropine – not Epi
- Identify reversible causes
- Early re sternotomy



Assess Rhythm

- Ventricular Tach or Fib
- Asystole or severe bradycardia
- Pulseless Electrical Activity



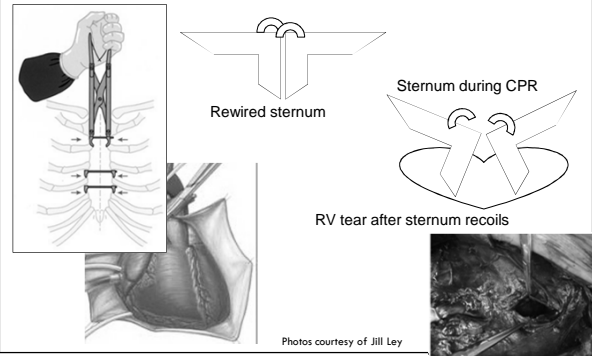
Delay Compressions

If able to shock or pace within 60 seconds

- No evidence to support CPR prior to defibrillation for in-hospital arrests
- Best survival for in-hospital arrests is when defibrillation occurs within two minutes of VF/VT
- Successful restoration of rhythm may occur after the first defibrillation in 86- 96% of patients
- Success declines with each sequential shock with unlikely success after the fourth shock
- Potential trauma or complications from the compressions.
 - The unstable sternum or sternal wires may cause disruption of vascular sutures or right ventricular tear.
- Thus, defibrillation is recommended first, if it can be achieved within sixty seconds

References listed in EACTs Cardiac Surgery Guideline

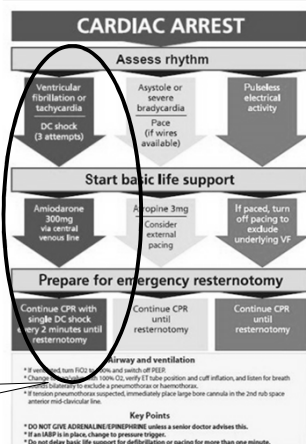
Potential for Right Ventricular Tear After CPR



Ventricular Fibrillation or Tachycardia – shockable rhythm

- If defibrillator available within 30 seconds
- 3 sequential shocks
- Compressions
- Amiodarone
- Prepare for re sternotomy
- CPR with shock every two minutes

2nd person manages airway



No Epinephrine

Unless ordered by senior provider or Cardiovascular Surgeon

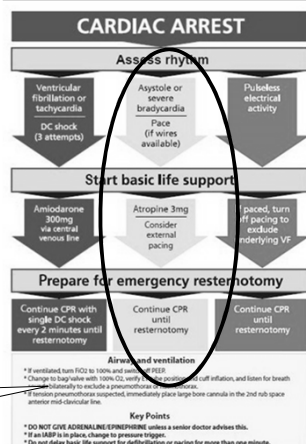
- Restoration of sinus rhythm after early defibrillation or re sternotomy is highly successful
- Administration of epinephrine may result in severe rebound hypertension leading to suture line disruption or aortic rupture



Asystole or Severe Bradycardia

- Pace if wires available
 - DDD 90 bpm and max MA
- CPR
- Atropine 3 mg IV
- Consider external pacing
- Prepare for re sternotomy
- CPR

2nd person manages airway



Pace if wires available DDD 90 bpm and max MA



Atropine 3 mg IV

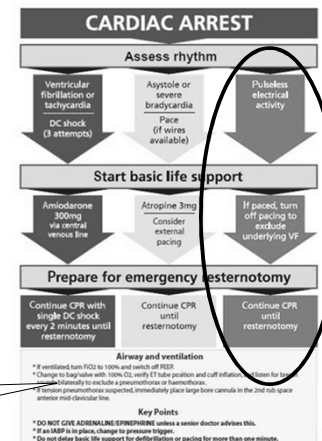
- No evidence available in favor of atropine in cardiac surgery arrests
- Relatively benign drug with few side effects
- Thus recommended for asystole or extreme bradycardia



Pulseless Electrical Activity Nonshockable rhythm

- CPR
- If paced, turn off pacer to assess for VF
- Prepare for re sternotomy
- Determine and treat causes – H & Ts

2nd person manages airway



Pulseless 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

Four Hs	Four Ts
Hypoxia *	Tamponade *
Hypovolemia*	Tension Pneumothorax
Hypokalemia/ Hyperkalemia	Thromboembolism
Hypothermia	Toxin

* = Most common causes of cardiac surgery arrests

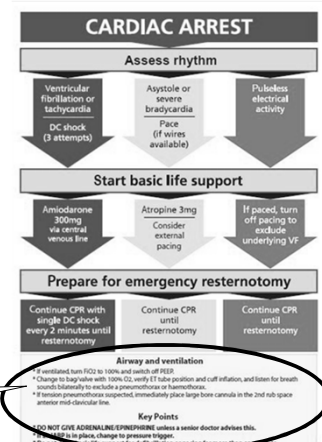
Treatment of PEA causes

Hypoxia	Hypovolemia and Tamponade
<ul style="list-style-type: none"> • Treat per airway management and assessment 	<ul style="list-style-type: none"> • Severe hypovolemia is typically due to bleeding • Severe hypovolemia and tamponade both require emergent re sternotomy to correct

Airway and Ventilation

- If ventilated, turn FiO₂ to 100% and turn off PEEP
- Assess for airway patency and lung sounds

2nd person manages airway



Steps to Ensure Adequate Airway and Ventilation

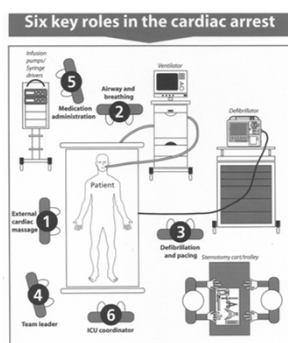
- Check endotracheal tube (ET) position and end tidal carbon dioxide (EtCO₂) waveform and reading
- Listen for an ETT airleak and verify that is properly inflated
- Listen and look for bilateral breath sounds.
 - Consider removing the patient from the ventilator and give 100% oxygen via bag-mask-valve 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, mid-clavicular 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.

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



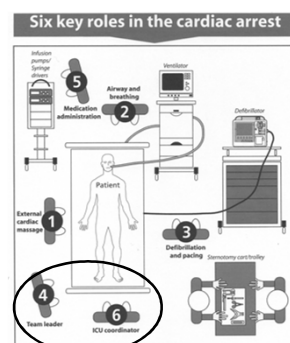
Six Key Roles

Team leader

- Conducts the management of the arrest
- Ensures the protocol is followed
- Assigns roles

ICU nursing Coordinator

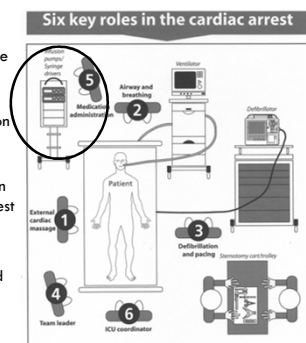
- Manages the arrest from the peripheral bedside
- Resternotomy preparation
- Managing additional personnel
- Calling for expert assistance as needed
- Reporting back to the team leader



Six Key Roles

Medication Administration

- CALS-S recommends as best practice to **stop all medication infusions**
- Continuing pre-arrest medication infusions is unlikely to assist resolution of the cardiac arrest
- An inadvertent flushing of a vasodilator or residual medication in a central line lumen causing the arrest
- May be restarted as needed for hemodynamic stability
- Sedative infusions may be continued if there is a concern about patient awareness.

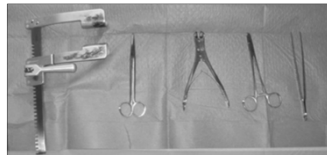


Emergent Resternotomy

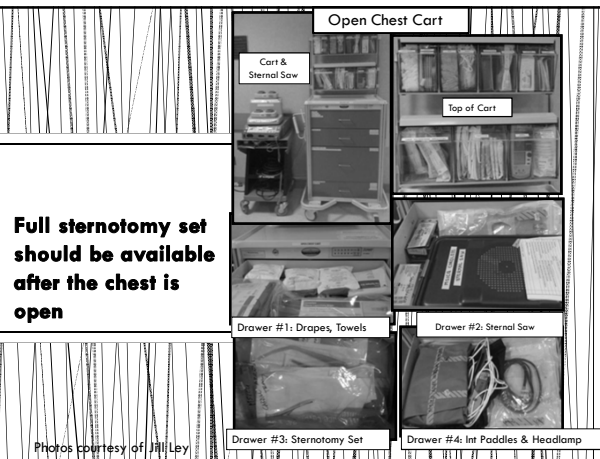
- In all three arms of the algorithm, prepare for emergent resternotomy if:
 - The initial treatment is unsuccessful
 - Resuscitation efforts are likely to last longer than 5 – 10 minutes
- Internal cardiac massage is superior to external cardiac massage in cardiac surgery patients

Small Resternotomy Set

- Sterile all-in-one thoracic drape
- Scalpel
- Wire cutter
- Heavy needle holder
- Sternal retractor.



Photos courtesy of Jill Ley



Photos courtesy of Jill Ley

Upon calling of cardiac arrest, prepare for emergent resternotomy

- Emergent situation – Aseptic Technique -- hand washing is not necessary prior to sterile gloves
- Two staff members
 - Put on sterile gowns and gloves
 - Prepare the emergency sternotomy set
- A third person should be the circulator to hand-in or open sterile equipment.
- The surgeon and all assistants
 - Wear sterile gowns and gloves, but face-masks and surgical caps are not essential per EACTS guidelines.
 - However, CDC guidelines for invasive procedures recommend personnel wearing face-masks and surgical caps.



Photos courtesy of Jill Ley

Who Does the Resternotomy?

- EACTS guidelines suggest if a surgeon is not immediately available resternotomy by another staff member maybe be lifesaving.
- State licensure regulations determine who is eligible to perform the resternotomy and internal massage.



Photos courtesy of Jill Ley

Practice makes Perfect! Training: Resternotomy Practice



Photos courtesy of Jill Ley

Special Equipment

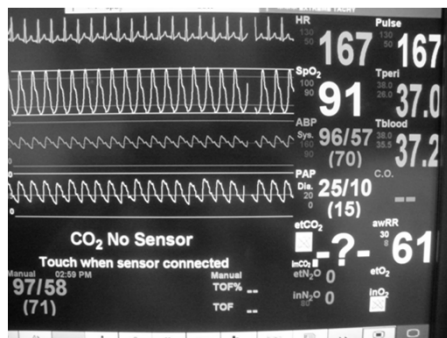
The sternotomy manikin



www.csu-als.com

Photos courtesy of Jill Ley

Sample Scenario Screen



Photos courtesy of Jill Ley

Key Scenarios

- Bleeding
- Ischemia
- Tamponade
- Respiratory failure
- High output failure
- Acute mitral regurgitation
- Bradyarrhythmia
- Ventricular tachycardia
- Supraventricular tachycardia



Photos courtesy of Jill Ley

Benefits of Team Training



- Review equipment
 - Internal paddles, cart trays
 - Pacemakers
- Resuscitation responses
 - Defibrillation/pacing
 - Code management
 - Teamwork
- Pre-resuscitation management
 - Early recognition and management of hypotension
 - Avoidance of full blown arrest
 - Critical thinking skills!

Photos courtesy of Jill Ley

CALS-S vs ACLS

CALS-S	ACLS
For VF/VT	
Defibrillation takes priority; may defer massage for up to 1 minute	External massage should be performed on all patients
3 successive shocks before CPR	CPR → 1 shock → CPR
For Asystole	
DDD pacing at maximal output	External massage & vasopressor
For VF/VT, Asystole, Pulseless Electrical Activity	
No vasopressor unless senior MD	Epinephrine 1000 mcg every 3-5 minutes
Pre-arrest: Epi dose < 100 mcg	+/- vasopressin 40units x 1
Utilize 6 key roles during arrest	Similar roles with emphasis on team leader
Additional 2 people gown & glove	
Rapid re-sternotomy (<5 min) if no response to defib/pacing	N/A

Recopied with permission from Kiermani B, Ley J, Bartley T, Strang T, Levine A, Dunning J. The Cardiac Surgery Advanced Life Support Course, 2nd ed. Lulu Publishers at www.lulu.com . 2012.

Emergency Resternotomy Considerations

- Recommended up to POD #10
- Beyond POD #10, senior clinician should decide
- Internal cardiac massage should still be considered in preference to prolonged external compressions especially if a reversible cause is suspected
- EACTs recommends only use in the ICU
 - May consider use in progressive units in early post op days
 - Cardiovascular ICU nurses would respond and direct the emergent resternotomy

Why Implement?

- What happens when we get standardized, "bundle" approaches to patient care?
 - VAP
 - Sepsis
 - CAUTI

Resources For Evidence & Training

- Literature
 - Published guidelines
 - Pocket guide
 - Course book
 - Listserve
- Web
 - csu-als.com
 - Youtube
 - www.lulu.com
- Other

Herrmann, C. Cardiac Advanced Life Support-Surgical Guideline. AACN Advanced Critical Care 2014; 26 (2).

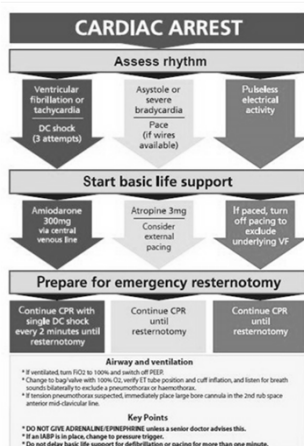


Implementation

- Thorough review of the guidelines to determine the applicability to your institution's cardiac surgery population
- Identify a change champion and key team members
- Get approval Medical Executive Committee
 - Not currently a course in the USA
 - Create written approved internal protocols for management of cardiac surgery arrest patients
- Attend CALS-S or create your own
- Practice

Key Concepts

- Assess Rhythm
- Shock before Compressions
- Pace/Atropine – not Epi
- Identify reversible causes
- Early re sternotomy



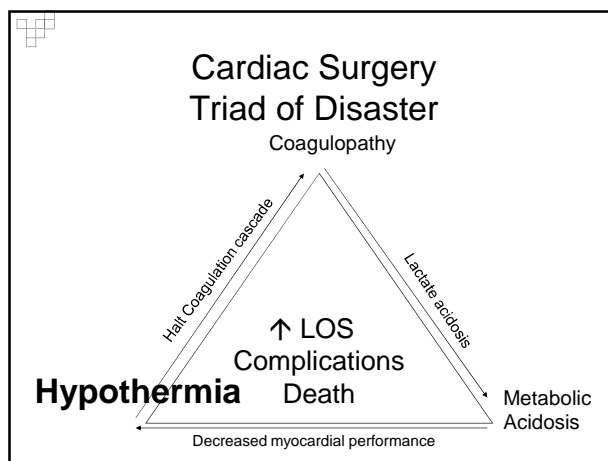
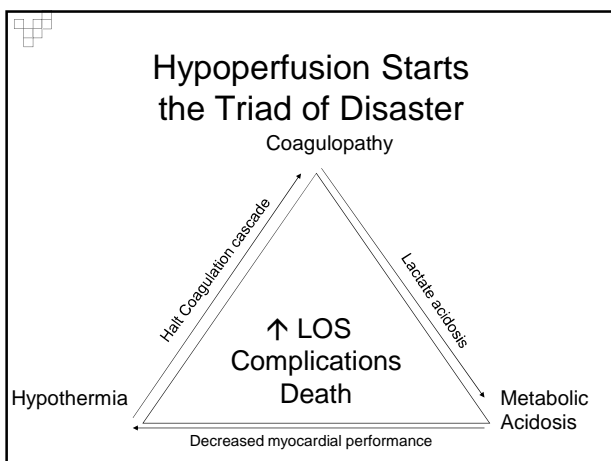
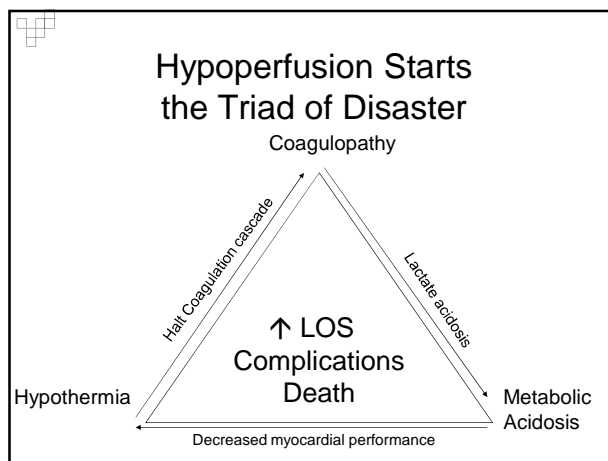
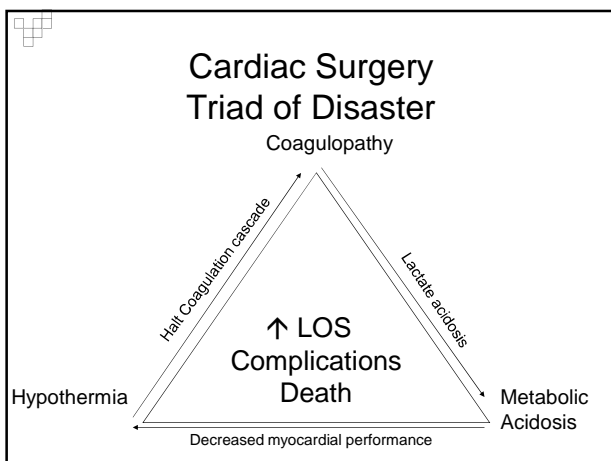
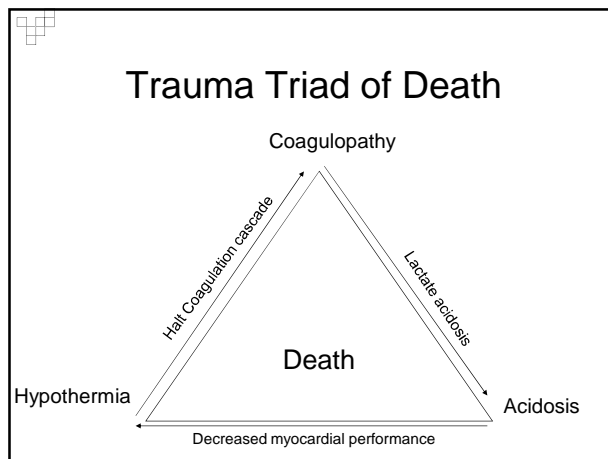
**AN OUNCE OF PREVENTION
IS WORTH A POUND OF CURE.**



Conquering Complications:

Cheryl Herrmann, APN, CCNS-CSC-CMC





Hypothermia



Causes of Heat Loss

- ♥ Cooled during CPB
- ♥ 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

Causes of Heat Loss

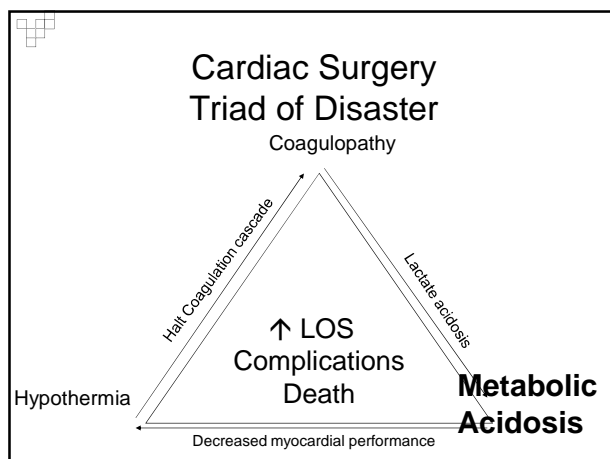
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Ugly consequences of hypothermia

1. Increased oxygen debt
 - Cold hemoglobin can not release oxygen to the cells
 - Left shift of the oxyhemoglobin dissociation curve
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
 - Risk of arrhythmias
 - Increased SVR due to vasoconstriction
5. Hyperglycemia
 - Decrease insulin production
6. Decreased cerebral blood flow
 - 6 – 7% decrease in CBF with body temp decrease of 1° C

Rewarming techniques

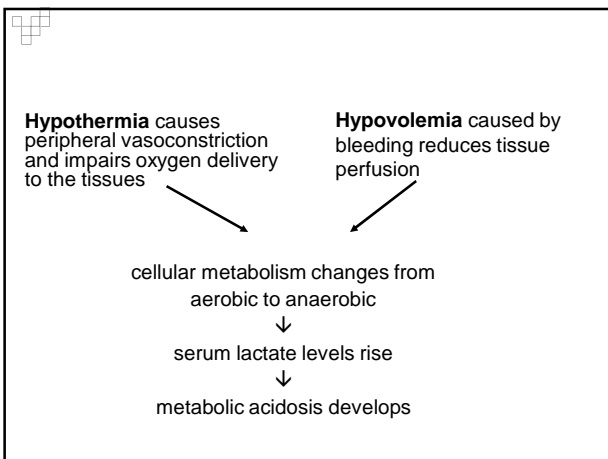
- ♥ Warm room – no fan
- ♥ Warm blankets – keep patient covered
- ♥ Bare Hugger
- ♥ Use blood warmer to give blood products
 - Have blood warmer and bare hugger in room





Ugly 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 acidosis

- ♥ Type A Lactic Acidosis
- ♥ Type B Lactic Acidosis

Metabolic 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

CHECK BLOOD GLUCOSE

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

IDENTIFY & TREAT CAUSE

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 metabsim

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%)

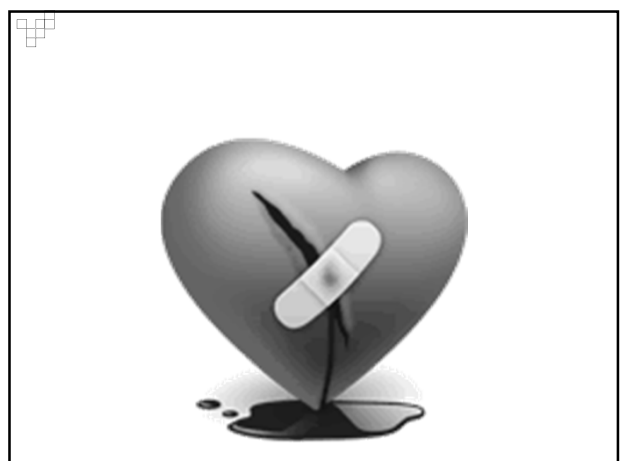
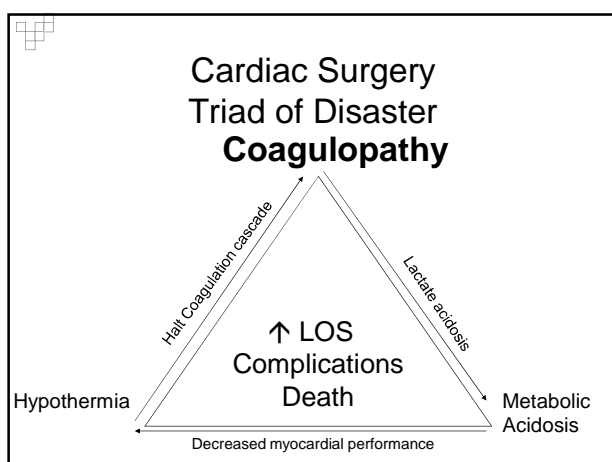
Shoemaker, WC et al. Textbook of critical care. 1995. WB Saunders

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"

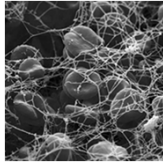
Serum Lactic Acid Levels

- ♥ Increasing lactic acid levels
 - Tissues are hypoperfused
 - Patient is getting worse.
- ♥ Decreasing lactic acid levels
 - Tissues are getting perfused
 - Patient is getting better.



Causes of Coagulopathy

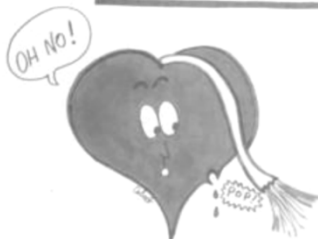
- ♥ Hypothermia
- ♥ Acidosis
- ♥ Underlying diseases
- ♥ Medications
- ♥ Dilution with fluids



BLEEDING



BLOWN GRAFT



Causes

- ♥ Mechanical Causes
 - 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 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
- ♥ Keep sedated – possibly add PEEP

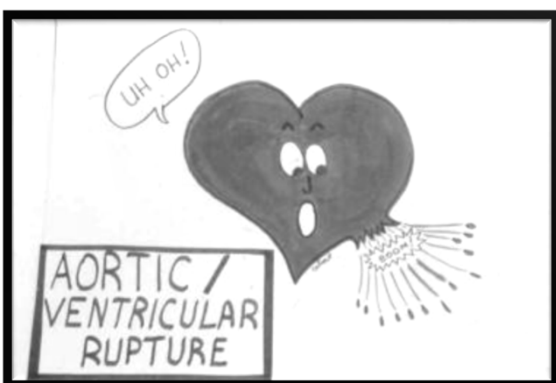
Treatment: Blood and Blood Products

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



Rule of thumb

- ♥ Replace CT output ml for ml
- ♥ After every 4th unit pRBCs
 - Calcium Chloride
 - FFP



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



- ♥ May need to use type specific blood

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
- ♥ May need to return to surgery to repair mechanical cause of bleeding

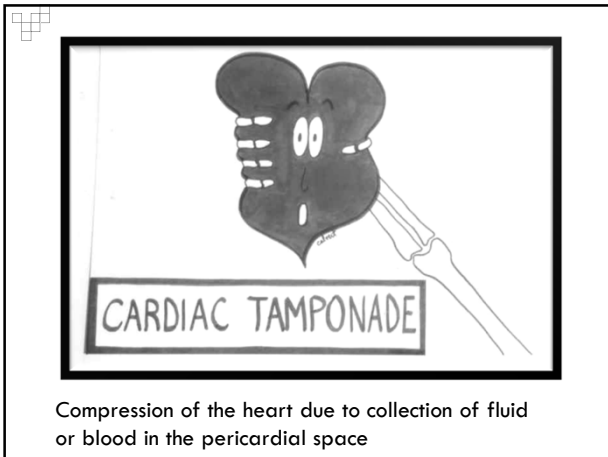
Bleeding patient summary of vital signs

Chest tube output

0100: 250
0200: 290
0300: 130
0400: 300
0500: 190
0600: 200
0700: 300

	2400	7:00am
Art B/P	145/44	91/38
HR	82	108
PAS/PAD	28/12	20/10
CVP	12	6
SVO ₂	71	59
CO	4.5	3.6
CI	2.3	1.8
SVR	1186	1006
Temp	98.6	97

- ♥ Pt received 3 units of pRBCs



Cardiac Tamponade: Causes

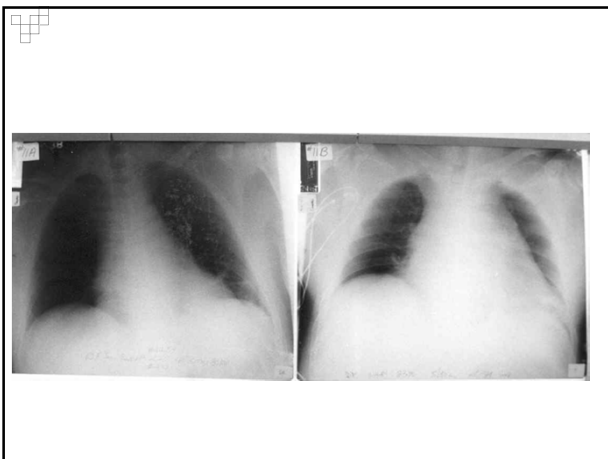
- ♥ Blood accumulated in the chest from:
 - CTs clotted off and unable to drain excess blood
 - Epicardial wire removal
- ♥ May occur quickly within minutes of hours or may occur slowly over days or weeks

Cardiac Tamponade: Signs & Symptoms

- | | |
|--------------------------------------|--|
| ♥ Hypotension | ♥ Neck Vein Distention |
| ♥ Low urine output | ♥ Tachycardia |
| ♥ Rising & equalization of CVP & PAD | ♥ Pulses Paradox > 20 mmHG |
| ♥ Falling SVO ₂ , CO/CI | ♥ Diminished heart sounds |
| ♥ Sudden decrease in CT output | ♥ For tamponade that occurs slowly may also see these S/S: |
| ♥ Widening mediastinum on CXR | ♥ 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

2300 – started tamponading
Started on Dopamine 2.5 mcg/kg/min
Epi 3.07 mcg/min
Milrinone 0.5 mcg/kg/min
1300 – back to OR
1600 – back to CVICU
post removal of blood

DOS	1900	2400	0500	0900	1100	1500	1900	2100
Art B/P	106/85	136/66	122/56	147/59	149/59	140/65	134/62	123/60
MAP	72	81	90	79	76	81	80	77
HR	68	99	105	106	103	111	118	118
PAS/PAD	32/15	32/18	40/21	36/21	35/21	38/23	32/18	32/21
CVP	10	11	15	14	15	16	12	15
SV _O ₂	63	64	65	56	55	49	43	41
CO	5.8	8.3	11	8.8	8.4	6.7	7.0	6.1
CI	2.5	3.5	4.8	3.8	3.6	2.9	3	2.8
SVR	964	674	634	559	616	743	743	92
SpO ₂	96	96	93	92	94	93	92	92
UO	600	325	1000	60	125	400	75	150
CT	60	100	150	50	50	50	75	75

DOS	2200	2300	0400	0800	0900	1100	1300	1600
Art B/P	123/59	92/47	129/67	141/67	108/68	101/62	118/71	126/59
MAP	75	68	88	83	78	73	80	75
HR	124	125	129	137	147	110	107	125
PAS/PAD	33/22	37/26	34/22	34/25	48/21	33/24	37/26	29/20
CVP	16	19	16	19	17	19	23	25
SV _O ₂	40	32	37	48	40	42	45	72
CO	5.2	3.8	5.3	6.3	6.9	3.2	4.2	7.9
CI	2.2	1.6	2.3	2.7	2.9	1.4	1.8	3.3
SVR	600	325	1000	60	125	400	75	150
SpO ₂	92	92	90	91	91	95	95	99
UO	40	30	550	180	45	60	60	60
CT	60	100	150	50	50	50	75	75

Don't miss the obvious!



In Summary Cardiac Arrest...

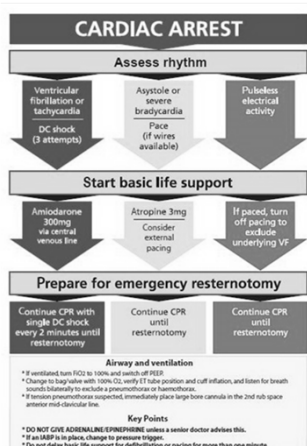
- In the immediate postop recovery in a cardiac surgery patient is typically related to reversible causes
 - Tamponade
 - Bleeding
 - Ventricular arrhythmias
 - Blocks associated with conduction problems
- Survival to discharge can be up to 79%
 - If treated promptly



Implement CAL-S

Key Concepts

- Assess Rhythm
- Shock before Compressions
- Pace/Atropine – not Epi
- Identify reversible causes
- Early re sternotomy



Cardiac Surgery Advanced Life Support

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