Hemodynamic Management for Neurogenic Stunned Myocardium

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For a voodoo death to become a reality, the following must happen:

1. Belief (victim must believe in harm caused)
2. Attitude of helplessness is essential
3. Social pressure and reinforcement

Walter Cannon 1942

- A young man who had fallen ill when the local witch doctor had pointed a bone at him; meant curse of death; when it was explained to him that it was a mistake, the young man got healthy immediately
Voodoo death

• Aka “psychogenic death or psychosomatic death”
• Sudden death by a strong emotional shock, such as fear
• Sympathetic surge causing a fall in blood pressure due to “reduction in circulating blood volume”

Reduction in blood volume explanation

• Constant release and injection of adrenaline into the small arterioles → potent vasoconstriction → reduction in flow and end organ perfusion
• AMAZING: all from the emotion
Martin A. Samuels, MD
Professor and Chair of Neurology
Harvard Medical School – Brigham & Women’s Hospital, Boston

• Dr. Samuels' studies build on Walter B. Cannon's initial concept of "voodoo" death which focused on death from fright.
• brain releases an overdose of norepinephrine to the heart resulting in takotsubo cardiomyopathy or sudden death
• "Although this situation is rare and most survive such a reaction, several cases show the lethality of takotsubo cardiomyopathy," said Dr. Samuels. "I found this level of reaction in individuals attacked by a bear or experiencing an earthquake. They are killed on the spot because in a fraction of a second this overdose of neurochemicals into the heart can be life threatening.

Immediate death
Broken heart/takotsubo/stress/neurogenic/stunned cardiomyopathy

Contraction band necrosis

- Myocardial fibers begin to lose cross striations and the nuclei are not clearly visible
- Check out the darker pink wavy contraction bands extending across the fibers
It is very similar to the acute myocardial infarction but

- There is no coronary artery disease
- “Cerebral T” – Circulation 1954

So what happens in the ER?

- Elevated Troponin levels
- EKG with acute T wave inversions
- May have ST depression
- Cardiogenic pulmonary edema
- Hypotension
- Acute renal failure
So how do you know if you are dealing with acute coronary syndrome vs neurogenic stunned myocardium?

- Murthy et al JICM 2015:
  a. QTc prolongation
  b. ST depression or elevation
  c. T wave inversions
  d. “modest” rise in troponin
  e. Basal and mid-ventricular segments of the LV dysfunction

Murthy et al. JICM 2015

- “neurogenic stunned myocardium poses therapeutic challenges in the setting of coexisting vasospasm”

- “Overall good prognosis IF RECOGNIZED EARLY with appropriate management of hemodynamic and cardiopulmonary parameters”
Well what is APPROPRIATE hemodynamic management?

• 1. Reduce myocardial O₂ demand and Reduce afterload
  – Sedation, avoid agitation, avoid pain
  – Avoid tachyarrhythmias
  – Lower SBP
  – Reduce afterload/ avoid peripheral vasoconstriction

• 2. Maintain optimal intravascular volume
  – SVV 8-11% (avoid hypo or hypervolemia)
  – Urine output >0.5mL/kg/hr

3. Maintain minimal end organ perfusion pressure
   - MAP>60-70
   - SBP 100-140mmHg
4. For low EF (<25%) etc, Use inotropic agents that have some vasoconstriction property

- norepinephrine (0.1-1ug/kg/min) IV drip
- dopamine (1-50ug/kg/min) IV drip
- Milrinone (0.375-0.75ug/kg/min) IV drip
- dobutamine (2-40ug/kg/min) IV drip

Pure inotropes

- Dobutamine/Milrinone:
  - BP may drop initially
  - May need to use vasoconstrictor along with it
Avoid pure alpha 1 agonists

• Phenylephrine drip- only increases SBP by vasoconstriction: may cause further myocardial injury and even lead to …
Summary: stunned myocardium

1. Secure the aneurysm
2. Obtain ECHO and complete intravascular volume data
3. Avoid sympathetic surge: fever, tachycardia, pain, agitation ect- intubate and sedate
4. Lower afterload
5. Maintain CI with inotropic pressors
6. Avoid pure alpha 1 peripheral vasoconstrictor
7. Maintain euvolemia

What if you have stunned myocardium and vasospasm at the same time?

1. Typically, stunned myocardium is day 0-5
2. Typically vasospasm is day 3-10
3. The overlap may be short
4. If they do overlap:
   1. No HHH therapy
   2. Use mechanical means – IA balloon angioplasty, rather than multiple IA nicardipine or verapamil
   3. Maintain SBP 120-140mmHg not higher
   4. Maintain euvolemia
Time for a quiz

Periop case 1

• 68 year old man with history of hypertension, hyperlipidemia, presents after a motor vehicle accident. Patient complained of headache followed by lethargy, dysarthria and right hemiparesis.

• ER: BP 132/78mmHg, HR 120/min in sinus, RR 18 labored breathing, Temp 99F
L. Sided epidural, mass effect and subfalcine herniation

What to do:

• Basic ABC, ICP monitoring
• Emergent decompressive surgery
Hemodynamic targets for O.R.

- Cerebral perfusion pressure (CPP, MAP-ICP) >60mmHg
- ICP 20’s mmHg
- Thus MAP target: 80-90mmHg

In the operating room

- MAP = 70mmHg
- ICP = 24mmHg
- CPP = 46mmHg
Remember your frustration? When someone orders vigileo and nobody ever looks at the numbers or do anything about the numbers? And you wonder

What are we doing with the numbers?

Using radial A-line and R. subclavian central line

**HR = 120 beat/min, MAP = 60mmHg, CPP = 46mmHg**

- **CO** = 3.8 L/min [4.8 L/min]
- **CI** = 2.2 L/min² [2.5-4 L/min/m²]
- **SV** = 30mL/beat [60-100mL/beat]
- **SVI** = 15mL/beat/m² [33-47mL/beat/m²]
- **SVV** = 19% [<15%]
- **SVR** = 900 dynes - sec/cm² [800-1200 dynes-sec/cm²]
- **SVRI** = 2150 dynes - sec/cm²/m² [1970-2390 dynes-sec/cm²/m²]
- **ScvO2** = 60% (>70%)
Periop/ICU case 2

- 55 year old woman history of HTN presents with severe bifrontal headache

- Patient collapsed after vomiting at home
- ER:
  - BP 190/102mmHg, HR: 102 beat/min, sinus
  - RR: 18 labored, Temp: 99F
• ABC,
• EVD
• Angio shows wide neck A-comm aneurysm
• Clip ligation is the plan
Hemodynamic parameters in ER-Neuro ICU

- MAP target pre-clipping: 80-90mmHg
- ICP target <20mmHg
- CPP target 60-70mmHg

- Patient data:
  - MAP 90mmHg
  - ICP 20mmHg
  - CPP 70mmHg

While waiting to move to OR, patients desats, and BP drops

- Troponin = 2.4
- BP drops .. MAP 50mmHg
- Echo: global hypokinesis with “cerebral T”
Hemodynamic parameters?

CO = 2.0 L/min  [4-8 L/min]
Cl = 1.2 L/min$^2$  [2.5-4 L/min/m$^2$]
SV = 90mL/beat  [60-100mL/beat]
SVI = 43mL/beat/m$^2$  [33-47mL/beat/m$^2$]
SVV = 6%  [<15%]
SVR = 900 dynes-sec/cm$^5$  [800-1200 dynes-sec/cm$^5$]
SVRI = 2150 dynes - sec/cm$^5$/m$^2$  [1970-2390 dynes-sec/cm$^5$/m$^2$]
ScvO2 = 62%  [>70%]