SAQ Sept 2014 - Cardioplegia

• a) What are the purposes, (3 marks) typical composition(4 marks) and physiological actions of cardioplegia solutions?(5 marks)
• b) By which routes can solutions of cardioplegia be administered? (2 marks)
• c) What are the possible complications of cardioplegia solution administration? (6 marks)
SAQ CARDIOPLEGIA - WEIGHTING

- Purposes........................................3
- Composition....................................4
- Physiological actions......................5
- Routes...........................................2
- Possible complications.................6
PLEGIA = PARALYSIS

- Paraplegia
- Hemiplegia
- Quadriplegia
- Cycloplegia
- Vasoplegia

LIKEWISE CARDIOPLEGIA !!!!!
PURPOSES

• Prompt arrest of cardiac electromechanical activity.
• Combats intracellular ion losses
• Buffers ischemic acidosis
MYOCARDIAL OXYGEN SUPPLY & DEMAND

• Consumption = 80ml/100gm/mt
• Same @ 22°C = 0.3ml/100gm/mt
• Lowest demand = Arrested & Decompressed

• Increased Demand:
  - Contractility
  - Heart Rate
  - Wall tension

• Laplace’s Law ???
LAPLACE’S LAW

DIRECT RELATION BETWEEN WALL TENSION & RADIUS

DECOMPRESS LEFT VENTICLE VIA VENTING Aorta, PV or Apex

\[ \sigma = \frac{Pr}{\eta} \]
• Optimal Composition: Continued Research.
• Potassium – 20 mmol/Ltr.
• Slightly Hyperosmolar: Limits edema
• Alkaline: To address pH changes
• Low Calcium
• Complemented by Substrate/Additives:
  • Aspartate & Glutamate
  • Adenosine
  • Magnesium
  • Arginine
  • N-acetyl Cysteine
  • Nicorandil
MARTINDALE SOLUTION

20ml
Sterile Concentrate for Cardioplegia Infusion
Magnesium Chloride
Potassium Chloride
Procaine Hydrochloride
20ml to be diluted immediately before use with 1 litre Compound Sodium Chloride Injection BPC (Ringer’s Injection)
POM
# HAREFIELD SOLUTION

## CARDIOPLEGIA SOLUTION

### HIGH STRENGTH

Harefield Hospital Formulation

<table>
<thead>
<tr>
<th>Each one litre contains:</th>
<th>mmol content per litre (approx):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Chloride BP</td>
<td>8.600g</td>
</tr>
<tr>
<td>Potassium Chloride BP</td>
<td>6.252g</td>
</tr>
<tr>
<td>Magnesium Chloride BP</td>
<td>16.262g</td>
</tr>
<tr>
<td>Calcium Chloride BP</td>
<td>330mg</td>
</tr>
<tr>
<td>Procaine Hydrochloride BP</td>
<td>1364mg</td>
</tr>
<tr>
<td>in Water for Injections BP</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sodium</th>
<th>147</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>84</td>
</tr>
<tr>
<td>Magnesium</td>
<td>80</td>
</tr>
<tr>
<td>Calcium</td>
<td>2</td>
</tr>
<tr>
<td>Procaine</td>
<td>5</td>
</tr>
<tr>
<td>Chloride</td>
<td>400</td>
</tr>
</tbody>
</table>

---

**NOT FOR INTRAVENOUS USE**

---

**CAUTION** Do not make any additions to this container. Do not use unless the solution is clear.
CARDIOPLEGIA @ CHH

FORMULA A

STERILE NON-PYROGENIC
500ml
U.L.T.H CARDIOPLEGIA SOLUTION
FORMULA A

Millimoles per Litre

<table>
<thead>
<tr>
<th></th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>134</td>
<td>76</td>
<td>2.0</td>
<td>73</td>
<td>364</td>
</tr>
</tbody>
</table>

Contains: Procaine Hydrochloride
4.54 mmol per Litre

KEEP OUT OF THE REACH AND SIGHT OF CHILDREN

FORMULA B

STERILE NON-PYROGENIC
500ml
U.L.T.H CARDIOPLEGIA SOLUTION
FORMULA B

Millimoles per Litre

<table>
<thead>
<tr>
<th></th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>143</td>
<td>27</td>
<td>2.2</td>
<td>23</td>
<td>223</td>
</tr>
</tbody>
</table>

Contains: Procaine Hydrochloride
1.46 mmol per Litre

KEEP OUT OF THE REACH AND SIGHT OF CHILDREN
PHYSIOLOGICAL ACTIONS

- **K⁺:**
  Cessation of electromechanical activity (Depolarized Cardiomyocyte)

- **Mg²⁺:**
  Stabilize the myocardial membrane by inhibiting a myosin phosphorylase / protects ATP reserves.

- **Ca²⁺:**
  Maintains integrity of cell membrane
  No likelihood of Ca²⁺ paradox during reperfusion

- **Procaine:**
  Local anaesthetic on myocardium,
  decreases excitability, conduction, rate & force of contraction.
ROUTES / COMPLICATIONS

ROUTES:
• Antegrade: Coronary Arteries / Ostia
• Retrograde: Coronary Sinus

COMPLICATIONS:
• Hyperkalemia – MI Cardiac arrhythmias
• Access related: Arteries / Sinus / AR
• Inadequate protection – administration
• Ischaemic Injury – Interruption to Substrate (O$_2$)
• Reperfusion Injury – Reintroduction of substrate
MODULATION OF CALCIUM HAEMOSTASIS

• **Final Path:** Within Mitochondria & ETC
• **Channels:** $K_{\text{ATP}}$ & MPTP
• **Effect:** Calcium load in cytosol & mitochondria.

• **STUNNING:** Post Ischaemia/reperfusion
• **HIBERNATION:** Reduced coronary blood flow.

REVASCULARIZATION

INOTROPES
CARDIOPLEGIC TECHNIQUES

- **DELIVERY:** Antegrade / Retrograde
- **FLUID:** Blood / Crystalloid
- **TEMPERATURE:** Warm / Cold
- **ADMINISTRATION:** Continuous / Intermittent

- COLD: 5 – 10°C
- TEPID: 27 – 30°C
- WARM: 37 – 38°C
Further Reading

- MYOCARDIAL PROTECTION
  CEACCP | Volume 9 Number 3 2009

- Hyperkalemic cardioplegia for adult and pediatric surgery: end of an era?
  Frontiers in Physiology  August 2013 | Volume 4 | Article 228 | 1