Goal Directed Perfusion
Clinical case report

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Berlin, Oktober 2015
Goals

- **Patient selection**
  - **Cardiopulmonary Processes evaluation**
    - Retrospective analysis of Connect and GDP - data
      - Cohort 250 patients
      - Patient selection
        - Number of measurements below threshold: 272 l/min.m²
        - Number of minutes below DO₂ - threshold
          - Border line GDP - DO₂ values
          - 81 year old patient
            - Mitral valve insufficiency and Ischemic heart disease (3-vessel disease)
            - Co-morbidities (adiposity, renal dysfunction, nefrosclerosis, DM2, Iron deficiency anemia, hypertension, Hypercholesterolemia)
  - Development of post bypass kidney dysfunction?
  - In retrospective, what could have been improved?
    - CPB flow, RBC transfusion management, hemofiltration (Goal Directed Perfusion):
    - GDP - requirements (CPB - proces)
# Patient demographics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Age (years)</strong></td>
<td>81</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>M</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>186</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>92</td>
</tr>
<tr>
<td><strong>BSA (m²)</strong></td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Body Mass Index (kg/m²)</strong></td>
<td>26.6</td>
</tr>
<tr>
<td><strong>Diagnosis</strong></td>
<td>Ischemic heart disease, mitral valve insufficiency</td>
</tr>
<tr>
<td><strong>Procedure</strong></td>
<td>CABG4, mitral valve plasty</td>
</tr>
<tr>
<td><strong>Risk factors</strong></td>
<td>adiposity, kidney dysfunction, nefrosclerosis, DM-2, Hypertension, TIA, Iron-deficiency anemia, moderate left ventricular function</td>
</tr>
<tr>
<td><strong>Hemoglobin (mmol/l)</strong></td>
<td>6.8 (1 day pre-CPB)</td>
</tr>
<tr>
<td><strong>Creatinin level (umol/l)</strong></td>
<td>174</td>
</tr>
<tr>
<td><strong>CPB Time (min)</strong></td>
<td>190</td>
</tr>
<tr>
<td><strong>Aortic Cross Clamp Time (min)</strong></td>
<td>140</td>
</tr>
</tbody>
</table>
## Extracorporeal Circuit

<table>
<thead>
<tr>
<th>Device</th>
<th>Manufacturer/Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Circuit type</strong></td>
<td>(semi) closed system, Sorin S5 - HLM</td>
</tr>
<tr>
<td><strong>Oxygenator</strong></td>
<td>Sorin Inspire 6 FM</td>
</tr>
<tr>
<td><strong>Venous Reservoir</strong></td>
<td>Collapsible venous reservoir</td>
</tr>
<tr>
<td><strong>Cardiotomy reservoir</strong></td>
<td>Sorin dual chamber cardiotomy reservoir</td>
</tr>
<tr>
<td><strong>Arterial Pump</strong></td>
<td>Centrifugal</td>
</tr>
<tr>
<td><strong>Arterial Line Filter</strong></td>
<td>Integrated in oxygenator</td>
</tr>
<tr>
<td><strong>Surface Coating</strong></td>
<td>Phosphoryl-choline</td>
</tr>
<tr>
<td><strong>Blood gas monitor</strong></td>
<td>Terumo CDI 500 (arterial gas probe, venous HCT, SvO₂)</td>
</tr>
<tr>
<td><strong>Base Priming Solution</strong></td>
<td>Crystalloidal/colloid mixture</td>
</tr>
<tr>
<td><strong>Total Priming Volume (ml)</strong></td>
<td>1740 (de-primed: 1290)</td>
</tr>
<tr>
<td><strong>Myocardial protection</strong></td>
<td>Custodiol solution</td>
</tr>
<tr>
<td><strong>Temperature management</strong></td>
<td>alpha - stat</td>
</tr>
</tbody>
</table>
Extracorporeal circuit
General perfusion data
*Oxygen delivery during cardiopulmonary bypass and acute renal failure after coronary operations. Ranucci et al, TATS, 2005, 80 (6), 2213 - 2220

** O2 delivery and CO2 production during cardiopulmonary bypass as determinants of acute kidney injury: time for a goal-directed perfusion management?. De Somer et al, Crit Care, 2011 (15), R192 - 202
General perfusion data
GDP Data ($O_2ER = \text{VO}_2,\text{i}/\text{DO}_2,\text{i}$)

Calibration CDI500

$O_2ER > 40\%$***

***Transfusions during cardiopulmonary bypass: better when triggered by venous oxygen saturation and oxygen extraction rate, Ranucci et al, Perfusion 2011 (26), July, 327 - 333
**Patient outcome**

**Primary outcome**
- Transfusion 3 packed cells in ICU
- Hb = 6.8 mmol/l
- Slow ICU recovery - > atrial fibrillation - > amiodarone
- Peak post operative serum creatinine: 193 umol/l
- Peak 48 hour post CPB serum creatinine: 188 umol/l
- AKIN score: None

**Secondary Outcomes**
- LOS ICU: 4 days
- LOS Hospital: 12 days
Patient outcome

• **Primary outcome**
  • Transfusion 3 packed cells in ICU
  • Hb = 6.8 mmol/l
  • Slow ICU recovery - > atrial fibrillation - > amiodarone
  • Peak post operative serum creatinine: 193 umol/l (174)
  • Peak 48 hour post CPB serum creatinine: 188 umol/l (174)
  • AKIN score: None

• **Secondary Outcomes**
  • LOS ICU: 4 days
  • LOS Hospital: 12 days
**Discussion**

- **Oxygen delivery, \( \text{DO}_2 \)**
  - Increased blood flow
  - Despite cooling the patient - - > maintained C.I.
  - RBC transfusion
  - Pitfall: High circulating blood volume

- **Carbon dioxide production, \( \text{VCO}_2 \)**
  - Increased \( \text{VCO}_2 \) due to CO2 flush thoracic cavity
Conclusion

1. GDP - parameter requirements

- Calibrated blood gas monitor
- Prevent prolonged ‘blind’ perfusion

**Advise**: Calibrate monitor directly after steady state full flow CPB

- Add remark ‘Calibration BGM’ in data recording for data analysis
2. Per-operative

- GDP - parameters combined with traditional measurements for perfusion adequacy, can be of added value in decision making process and patient metabolic needs during CPB:
  - Red blood cell transfusion
  - Increase blood flow
  - Use of hemofiltration *(when CPB - circuit and patient circulating blood volume allows volume extraction)*

**Pitfall:** Obesity and CO2 - flush thoracic cavity
Conclusion

3. Data analysis

- Combine GDP-connect database with cardiac surgery database
  - Evaluation and recommendation of CPB proces can be considered (i.e. post-CPB AKI).

- Share GDP knowledge with Cardiac Surgery team

- Decision making proces during CPB
  - Combine GDP- and traditional parameters for perfusion adequacy —> To transfuse or not to transfuse

- Increase blood flow or apply hemofiltration
Collaboration

Cardiac surgeon
- Leadership
- Knives
- Sutures

Anesthesiologist
- Pharmaceutics
- Airway management
  Echo cardiography

Perfusionist
- Support cardiac surgeon and anesthesiologist
- Biochemical process control of patient’s body

Patient
Goal Directed Perfusion
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