Treatment of Hypertensive Kidney Disease with Haemodialysis

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Hypertension management symposium
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Principle of Diffusion

- Natural process
- Movement of solute from a region of high concentration to a region of low concentration
- Eg Dior poison, $1130/60 ml
Two new terms

- Java
- Lipton

JAVA and Lipton

- JAVA
  - A very important programming language
  - Invented by engineers from SUN in a coffee shop
  - Java = coffee
JAVA and Lipton

- JAVA
  - A very important programming language
  - Invented by engineers from SUN in a coffee shop
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- Lipton
  - Principle used to explain dialysis
  - Invented by Ho & Ho
  - Lipton = tea
Principle of dialysis

- Diffusion of different substance across a semi-permeable membrane
- Some substance can pass through the membrane, others do not, depending on the molecular size.
- Urea, creatinine, K can go through
- Blood protein and cells cannot.
Principle of haemodialysis

Consider haemodialysis as two circuits

- **blood circuit**
  - blood taken out of body to the DIALYSER, blood returned after cleaning

- **dialysate circuit**
  - dialysate pumped from the haemodialysis machine to the DIALYSER, the waste dialysate is drained away

When to start dialysis

- **Biochemical**
  - when blood urea >35 mmol/l, creatinine >1000 umol/l, creatinine clearance <10 ml/minute
  - for diabetics, start earlier

- **Clinical**
  - when patient develop uraemic symptoms despite conservative treatment
  - when uraemic complications occur
The Allis-Chalmers Dialyzer

Diagram showing the components of the Allis-Chalmers Dialyzer:
- Glass rotating coupling
- Dialyzing membrane
- BY PASS
- Transfusion bottle
- Beck pump
- Arterial cannula
- Patient
- Venous cannula
- Air trap and CL filter
- Blood samples
The Early Dialysis Machine

First Dialysis Machine

At Royal Victoria Hospital, came in 1947 from Holland, made of wood, invented by Dr. Kopf. 4 only in world. I was sent to Royal Vic. with a doctor who knew how to use it. Treatment took 12 hours.
**Dialysate composition**

<table>
<thead>
<tr>
<th></th>
<th>Na</th>
<th>K</th>
<th>Urea</th>
<th>Creat</th>
<th>HCO3</th>
<th>Acetate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>140</td>
<td>4</td>
<td>6</td>
<td>100</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>Uraemic</td>
<td>140</td>
<td>6</td>
<td>35</td>
<td>1100</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>dialysate</td>
<td>140</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>35</td>
</tr>
</tbody>
</table>

**Buffer base in haemodialysis**

- In our body, the normal base buffer is bicarbonate
- In uraemic patients, the bicarbonate level is reduced due to acidosis
- Attempts to correct the acidosis by adding a base in the dialysis bath
- In early days, use acetate as a buffer
Why acetate used?

- Bicarbonate will precipitate with other cations (calcium and magnesium) in the bath
- Acetate will be converted by the liver, heart and muscle cells to bicarbonate
- Acetate is much more stable and is used in early dialysis

Can we use bicarbonate?

- Yes, one way is to bubble carbon dioxide gas
- But this needs a lot of space
Fig 12. Equipment for preparing bicarbonate dialysis fluid in Prof. Alwall’s unit at Lund Hospital, Sweden, used 1946 – 57. Note the CO₂-tubes to the right.
Modern bicarbonate dialysis

- Use to concentrate pumps, one to pump up the bicarbonate solution
- The second to pump the acid mixture.
- Needs more complicated machine, the pH needs to be monitored in addition to the conductivity level

Advantages of bicarbonate dialysis

- Patients tolerate dialysis much better
- Allows higher blood flow and higher efficiency dialysers
- Bicarbonate dialysis together with volumetric volume control device, allows short hour dialysis
- Allows satellite dialysis
The dialyser

- Dialyser is made of semi-permeable membrane
- blood flow on one side of membrane
- dialysate flow on the other side
- toxins moved from blood to dialysate by diffusion
- water removed by applying a negative pressure
Vascular access refer to the way in which the blood is taken out of the body.
- Blood flow rate 200 - 400 ml/minute
- Peripheral vein cannot maintain this flow rate
- AV shunt, AV fistula, venous cannula
- Graft
AV fistula

- Connect the radial artery to cephalic vein
- Arterial blood flows to the cephalic vein directly
- Needs to insert needles into the fistula
- Need to wait 4 to 6 weeks for fistula to mature
- Long life span, little complications (Gold standard)
**Shorter hours of dialysis**

- High flux dialyser, bicarbonate dialysis, volumetric ultrafiltration control
- Dose of dialysis calculated by Kt/V
- can cut down dialysis time from 8-10 hours to 3-5 hours
- better patient acceptance, high turnover

**Complications with dialysis**

- Increased incidence of heart attacks and stroke
  - The results of chronic renal failure
  - Can be reduced with better control of BP, BS, lipids and phosphate
  - Keep Hb to 11 g/dl with EPO +/- intravenous iron
Chronic dialysis complications

- Carpal tunnel syndrome
- Neck pain and join pain
- Occur after 5 years of dialysis
- Due to accumulation of beta2 microglobulin, causing amyloidosis
- Improved after renal transplantation
Toxin removal by natural kidneys

- Human kidneys remove toxins by filtration
- Filtration means water removal, toxins ‘dragged along’
- Rate of toxin removal independent of molecular size
- Good middle molecule removal
- Good tolerance
Toxin removal by artificial kidneys

- Toxin removed by diffusion
- Depends on molecular size of toxins
- Middle molecules removed at a much slower rate
- Beta 2-microglobulin accumulation – carpal tunnel and bone pain
- Hypotension during dialysis

Haemofiltration

- Mimic natural kidney
- Use a highly permeable membrane
- Remove 20 litres of fluid, toxin removed by ‘solvent drag’
- Replacement fluid given
- Better tolerated, better middle molecule removal
Problem with Hemofiltration

- Highly permeable membrane needed
- Bacterial endotoxin may go into the bloodstream
- 20 litres of replacement fluid – natural kidneys filter 200 litres of filtrate
- Replacement fluid expensive
- More complicated machinery

Hemodiafiltration (HDF)

- 20 litres of ultrafiltration - remove good quantity of middle molecules, not small molecules
- Use conventional dialysis to remove small molecules
- Combines dialysis with haemofiltration (HDF)
Advantages of HDF

- Good small molecule removal
- Good middle molecule removal
- Cost of substitution fluid reduced with online preparation (like dialysate)
- Special test now developed to detect endotoxin
Blood pressure control
Ca and phosphate control
Hb around 11 – 12 g/dl
Nutrition of the patient, serum albumin >30 g/l
Dialysis dose
How to improve outcome

- The most important determinant is the FREQUENCY of dialysis
- Provide quality dialysis
- Affordable Dialysis
- Three times per week

- Daily dialysis in home HD case
Satellite Dialysis

- A satellite centre is built outside the hospital
- More accessible locations
- Only stable patients are included
  - lower staff to patient ratio
  - no need to complicated equipment
  - better patient to staff relationship
Why Satellite Dialysis successful?

- Haemodialysis technique is mature
- Equipment easier to use
  - built in microprocessor
  - volumetric fluid removal control
- Better tolerated dialysis
  - bicarbonate dialysis
  - biocompatible dialysers

Advantages of Satellite Dialysis

- 40% Cheaper than hospital dialysis
- Laboratory fee much cheaper
- Location more convenient, eg, MTR
- No need for home helper
  - relatives more ‘care free’
- Suitable for stable patients
Next Meeting

• Monday 4th December, 2006

• Neurological complications of HP
• Executive summary

• Roasted Pork will be served