A Countercurrent Coil Dialyser

D D HILTON, E BOWERS, C BARRATT, G A ROGERS
Wordsley Hospital, Nr Stourbridge, Worcestershire, UK

The coil dialyser is a popular form of artificial kidney. The tension of the winding enables cheap plastic materials to be used to support the blood channel. To date, coils have been made with the dialysate flow transverse in relation to the blood flow and it has been shown that rapid recirculation of the dialysate increases the efficiency.

DESCRIPTION

The countercurrent coil dialyser (Figure 1) is made by winding three concentric tubes. A 7 cm wide flat Cuprophan tube is threaded through tubular mesh which in turn is enclosed in a PVC envelope. The ends are parted and sealed so that blood can flow through the Cuprophan tube and dialysate flows through the interstices of the mesh within the PVC envelope. The blood flows from the centre of the coil outwards and the dialysate flows counter-current to the blood. A blood pump is necessary and the dialysate flow is induced by a negative pressure applied to the outlet. The present coil has a membrane surface area of 0.7 m².

Figure 1. The counter current dialyser showing its construction
RESULTS

The priming volumes of the blood channel at various coil outlet pressures are shown in Figure 2. They were tested under flowing conditions using water in both blood and dialysate compartments. Water is pumped through the blood compartment from a graduated cylinder and recirculated at 150 ml/min. The volume was read off as soon as a steady state had been reached. A manometer was incorporated in the return line and the pressure increased in stages and the volumes recorded. The pressure was allowed to return to zero and the volume again recorded to exclude any undue losses from leakage, ultrafiltration or permanent distortion of the coil.

Urea clearance in vitro is shown for 6 coils in Figure 3. In vivo clearance for urea, creatinine and uric acid are shown in Figure 4.

![Figure 2. Priming volumes of the blood channel at varying coil outlet pressures](image)

![Figure 3. In vitro urea clearances at dialysate flow 500 ml/min](image)
A preliminary clinical trial with 4 coils was carried out and the data are as follows:

<table>
<thead>
<tr>
<th>Patient's weight</th>
<th>Blood pressure</th>
<th>Urea</th>
<th>Creatinine</th>
<th>Blood retention in coil</th>
<th>Duration of dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 69.0</td>
<td>Post 67.9</td>
<td>Pre 110/70</td>
<td>Post 120/65</td>
<td>Pre 155</td>
<td>Post 69</td>
</tr>
<tr>
<td>Pre 68.1</td>
<td>Post 68.25</td>
<td>Pre 110/60</td>
<td>Post 110/50</td>
<td>Pre 162</td>
<td>Post 62</td>
</tr>
<tr>
<td>Pre 68.05</td>
<td>Post 68.6</td>
<td>Pre 130/70</td>
<td>Post 130/60</td>
<td>Pre 169</td>
<td>Post 57</td>
</tr>
<tr>
<td>Pre 68.9</td>
<td>Post 68.6</td>
<td>Pre 120/80</td>
<td>Post 120/70</td>
<td>Pre 147</td>
<td>Post 59</td>
</tr>
</tbody>
</table>

The patient did not require ultrafiltration but it was shown that the coil will ultrafilter at rates up to 400 ml/hr. This is flow rate dependent but could be varied considerably by increasing the coil outlet pressure.

DISCUSSION

If the urea clearance of 94 ml/min at 200 ml/min blood flow and 350 ml/min dialysate flow is taken then reference to Michaels curves (Michaels, 1966) shows a resistance of 44 min/cm. This compares favourably with many other dialysers, for example the Kiiil has been shown to have a resistance of 78 min/cm (Rastogi et al., 1969). Assuming the same resistance the counter current flow would give an advantage of 5 to 10% over co-parallel flow in the range of flows used clinically. Therefore, the present system has two advantages – the long dialysate path and the countercurrent flow. The former is thought to have the greater effect.

In clinical trials using a standard proportionating machine and a dialysate outflow pressure of 70 mm Hg the dialysate flow was only 350 ml/min.
Steps are being taken to improve this flow by altering the thickness of the mesh and the angle of the strands. However, good results have been shown with the lower dialysate flow rate which could result in a saving in dialysate cost.

CONCLUSION

The new coil has been shown to give satisfactory results in vitro tests and preliminary clinical trials and should prove to be a useful disposable dialyser.

ACKNOWLEDGMENT

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REFERENCES