HIGH EFFICIENCY DIALYSERS
MINIATURE AND CUPROPHAN HOLLOW FIBRE

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Over three quarters of the patients receiving regular dialysis treatment in
Europe use disposable dialysers\(^1\). Advances in manufacturing technology and
the availability of dry cuprophan hollow fibres have led to the availability of
two new categories of dialyser:

1. Miniature Multilayer
2. Cuprophan Hollow Fibre

Three dialysers in the first category (Travenol CP (0.92m\(^2\)), Cobe PPD
(1.3m\(^2\)), Hemoclear (1.4m\(^2\)), and three in the second (Travenol CF (1.5m\(^2\)),
Nephross 16F (1.6m\(^2\)), Cobe HF 130 (1.3m\(^2\)), together with the Cordis
CDAK 1.8m\(^2\) hollow fibre dialyser were studied using standardised techniques\(^2\),
in which the dialysers' small and middle molecular clearance, ultrafiltration
rate, static and dynamic blood compartment volume and residual blood
volume were studied (Table I).

Small and Middle Molecular Clearance

The clearance characteristics indicate that dialysers using Cuprophan hollow
fibres offer an improved level of performance in terms of middle molecular
clearance compared with the CDAK, although their small molecular clearance
is lower. The clear plastic outer casing of the Cobe PPD and the Hemoclear
showed an accumulation of air in the dialysate compartment when used with
the Lucas MKII proportionating system. Subsequent use of these dialysers,
together with the Travenol CP, with the Nycotron ADPAC eliminated this
problem and a marked improvement in the performance of the dialysers was
observed (Table II).

A decrease in clearance with duration of dialysis has been reported for the
Travenol CP by the manufacturers. The miniature dialysers studied all showed
a deterioration in performance during the first four hours of dialysis when
used with the Lucas MKII. Changing to the Nycotron ADPAC gave an
improvement for the Hemoclear and the PPD, but no change for the Travenol
CP suggesting that the observed deterioration in clearance was not due to the
accumulation of air but possibly to membrane creep.
TABLE I  Dialyser Performance Characteristics
Blood Flow 200ml/min
Temperature 38°C
Dialysate Flow  530 ml/min (Lucas MKII)
               610 ml/min (Nycotron ADPAC)

<table>
<thead>
<tr>
<th>Dialyser</th>
<th>Membrane</th>
<th>IN VITRO</th>
<th></th>
<th>IN VIVO</th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Clearance ml/min</td>
<td>UF Rate*</td>
<td>BCV† (ml)</td>
<td>Clearance ml/min</td>
<td>UF Rate†</td>
<td>RBV (ml)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urea</td>
<td>Creat</td>
<td>Vit.B_{12}</td>
<td>Urea</td>
<td>Creat</td>
<td></td>
</tr>
<tr>
<td>Travenol CP</td>
<td>Cuprophan 10 micron</td>
<td>154</td>
<td>122</td>
<td>23.6</td>
<td>0.044</td>
<td>87 (+10)</td>
<td>147</td>
</tr>
<tr>
<td>Cobe PPD</td>
<td>Cuprophan 13.5 micron</td>
<td>139</td>
<td>114</td>
<td>25.8</td>
<td>0.061</td>
<td>92 (+25)</td>
<td>139</td>
</tr>
<tr>
<td>Hemoclear</td>
<td>Cuprophan 11.5 micron</td>
<td>161</td>
<td>128</td>
<td>30.4</td>
<td>0.055</td>
<td>84 (+18)</td>
<td>159</td>
</tr>
<tr>
<td>Travenol CF</td>
<td>Cuprophan HF 16/215Δ</td>
<td>154</td>
<td>126</td>
<td>32.9</td>
<td>0.066</td>
<td>173 (+5)</td>
<td>159</td>
</tr>
<tr>
<td>Nephross</td>
<td>Cuprophan HF 16/200</td>
<td>156</td>
<td>131</td>
<td>40.8</td>
<td>0.081</td>
<td>170 (+2)</td>
<td>156</td>
</tr>
<tr>
<td>Cobe HF 130</td>
<td>Cuprophan HF 16/300</td>
<td>147</td>
<td>115</td>
<td>–</td>
<td>0.052</td>
<td>200 (+0)</td>
<td>141</td>
</tr>
<tr>
<td>CDAK</td>
<td>Cellulose HF 30/300</td>
<td>169</td>
<td>133</td>
<td>24.8</td>
<td>0.045</td>
<td>138 (+0)</td>
<td>175</td>
</tr>
</tbody>
</table>

△ Fibre Internal Diameter
* ml/min/mmHg
† At 100 mmHg TMP
● Increment for 100 mmHg TMP
◇ At 100 mmHg running pressure
◊ Saline Washback (ml)
Table II  Influence of Dialysate De-gassing on the In vivo Performance of Miniature Dialysers

<table>
<thead>
<tr>
<th></th>
<th>Urea</th>
<th>Creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lucas MKII</td>
<td>Nycotron ADPAC</td>
</tr>
<tr>
<td>Travenol CP</td>
<td>111 ± 5.5</td>
<td>147 ± 2.2</td>
</tr>
<tr>
<td></td>
<td>N=14</td>
<td>N=9</td>
</tr>
<tr>
<td>Cobe PPD</td>
<td>139 ± 1.9</td>
<td>139 ± 5.8</td>
</tr>
<tr>
<td></td>
<td>N=10</td>
<td>N=9</td>
</tr>
<tr>
<td>Hemo-clear</td>
<td>147 ± 2.2</td>
<td>159 ± 2.5</td>
</tr>
<tr>
<td></td>
<td>N=5</td>
<td>N=5</td>
</tr>
</tbody>
</table>

N = Dialysers studied
Mean ± 95% confidence limit of mean shown

Ultrafiltration Rate

The Hemo-clear and the PPD have a comparable ultrafiltration. The Travenol CP ultrafiltration rate is lower, due to the dialyser’s reduced surface area. Cuprophan hollow fibre dialysers have a higher ultrafiltration compared with the CDAK, due to the use of thinner fibres.

Static and Dynamic Blood Compartment Volume

The miniature dialysers studied have a low blood compartment volume and compliance, making them ideal for both adult and paediatric use. Hollow fibre dialysers, on the other hand, have a larger blood volume and little or no compliance. Those using Cuprophan fibres were observed to have a higher blood compartment volume than that of the CDAK, despite their reduced surface area.

Residual Blood Volume

Fluid blood retained in all dialysers was less than 5ml. The washback requirements for the miniature dialysers were lower, further enhancing their suitability for paediatric use. The Cobe HF 130 despite its higher blood compartment volume, required a reduced washback compared with other dialysers in the same category.

Conclusions

Miniature multi-layer dialysers offer an attractive alternative in both size and performance, compared with many other dialysers in current clinical use. Their
small blood volume and low residual blood loss make their use ideal for both
adult and paediatric use. The performance of both the Cobe PPD and the
Hemoclear are enhanced by a well de-gassed dialysate. The Travenol CP
dialyser, however, suffers a considerable deterioration in performance with
duration of dialysis irrespective of dialysate de-gassing.

Cuprophan hollow fibres offer a higher level of performance in terms of
ultrafiltration and middle molecular clearance compared with the Cordis
CDAK. However, the Cordis CDAK is now being produced with dry cellulose
acetate fibres so this advantage may be eliminated.

References

1 Gurland, HJ, Brunner, FP, Chantler, C, Jacobs, C, Scharer, K, Selwood, NH,
2 von Hartitzch, B, Hoenich, NA, Samson, P, Erickson, J, Ashcroft, RA and
Kerr, DNS (1973) Kidney Internat. 3, 35