Experiences with a One-Compartment Disposable Kiil Haemodialyser

P CONFORTINI, E BRUSCHI, A MUOLO and
A GIONGO
Ospedale Civile, Verona, Italy

The standard Kiil haemodialyser, adopted by the majority of Dialysis Centres, has the undoubted advantages of structural simplicity, working safety and good performance, but has disadvantages due to the need for long preparation times and the risks of cross infection.

Hence the need for a disposable Kiil haemodialyser. The stiffest problem was to conciliate a limited budget with good performance and working safety. We have succeeded in setting up a prototype Kiil disposable, which has been tested by ourselves and others (Barsotti et al, 1969).

Figure 1. Diagram of the disposable dialyser
Working with Dasco (Mirandola, Italy), we have developed the clinically tested type described below (Figures 1, 2 and 3).

The principal characteristics are:

1. Only one dialysing compartment, made by two Cuprophane membranes, for an all-over surface area of 0.6 m².
2. Two sealed thin polystyrene sheets enclose the blood chamber.
3. Between the polystyrene and Cuprophane sheets are interposed two Moplen net sheets.
4. The system is set between two polypropylene plates in a rigid frame; on the inner side of each plate there are two inflatable chambers for adjusting the capacity of the system.

The working pressure is 150 mm Hg. With this level the blood circuit capacity is approximately 200 cc. We have then a dialysing surface equal to approximately 60% that of the two-compartment Kiiil.
We have noticed that in the plexiglass plates Kiil dialyser the blood and dialysate distribution is not uniform in the different areas. Furthermore, a portion of the dialysing membranes is not in use, by reason of its adhesion to plate edges and to longitudinal groove ribbings. The two-compartment Kiil dialyser is therefore to be considered as a low-performance apparatus.

The dialysate, after having flowed across a Kiil haemodialyser, has not lost its dialysing properties, as shown by measurements of its different elements and clinical observations relating to patients dialysed by means of Kiil dialysers placed in series (Roozendal, 1966).

Therefore, we have modified the dialysate circulation in our prototype (Figure 2). The dialysate runs counter-current at a flow rate of 500 ml/min, first in contact with the lower side of blood chamber, and afterwards, always counter-current, with the upper side. In this way we obtain a quantity equal to 1000 ml/min of dialysate in contact with the dialysing membrane.

The uniform distribution of dialysate is obtained by means of a double
entrance and a double exit for each layer, thus ensuring a quick renewal in all areas and avoiding comparative stagnation areas, which are the cause of low performance and probable bacterial growth.

The presence of Moplen net instead of the former grooves, transforms the dialysate and the blood flow from laminar to turbulent, and enhances the dialysing process. The uniform distribution of blood is obtained by means of a double entrance and a double exit.

Table I. Blood levels of urea, creatinine and uric acid before and after dialysis with a Kiil dialyser and the disposable dialyser (5 patients)

<table>
<thead>
<tr>
<th>PATIENT</th>
<th>WEIGHT (Kg)</th>
<th>BLOOD FLOW (mL/min)</th>
<th>AGE</th>
<th>SEX</th>
<th>UREA (mg%)</th>
<th>CREATININE (mg%)</th>
<th>URIC ACID (mg%)</th>
<th>UREA (mg%)</th>
<th>CREATININE (mg%)</th>
<th>URIC ACID (mg%)</th>
<th>UREA (mg%)</th>
<th>CREATININE (mg%)</th>
<th>URIC ACID (mg%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.M.</td>
<td>40</td>
<td>150</td>
<td>15</td>
<td>M</td>
<td>2.75</td>
<td>16.6</td>
<td>19</td>
<td>30</td>
<td>6.5</td>
<td>4.0</td>
<td>202</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Z.P.</td>
<td>62</td>
<td>150</td>
<td>23</td>
<td>M</td>
<td>2.30</td>
<td>19</td>
<td>16</td>
<td>110</td>
<td>10.8</td>
<td>4.9</td>
<td>250</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>R.R.</td>
<td>54</td>
<td>180</td>
<td>44</td>
<td>F</td>
<td>2.25</td>
<td>15.8</td>
<td>12</td>
<td>110</td>
<td>7.6</td>
<td>3.8</td>
<td>200</td>
<td>15.9</td>
<td>10</td>
</tr>
<tr>
<td>L.G.</td>
<td>60</td>
<td>300</td>
<td>29</td>
<td>M</td>
<td>2.50</td>
<td>15.2</td>
<td>13.9</td>
<td>85</td>
<td>1.5</td>
<td>4.9</td>
<td>205</td>
<td>14.6</td>
<td>13</td>
</tr>
<tr>
<td>R.C.</td>
<td>62</td>
<td>270</td>
<td>34</td>
<td>M</td>
<td>2.40</td>
<td>18.2</td>
<td>11.0</td>
<td>110</td>
<td>9.0</td>
<td>4.4</td>
<td>190</td>
<td>18.4</td>
<td>12</td>
</tr>
</tbody>
</table>

With this apparatus we have treated five patients for 24 hours a week, for a total of 6 months. The patients (Table I) were either suffering from viral hepatitis, or had had it recently. Urea, creatinine and uric acid measurements were carried out before treatment, six hours after starting and at the end. 'Extraction curves' were plotted, relating to those substances, for each dialysis and for each patient. Finally, the 'average extraction curve' for the three substances for each patient was obtained and compared with analogous determinations made during dialyses using the standard Kiil haemodialyser. The results of one such comparison are shown in Figure 3 and the collated results in Table I.

In all patients, a 10% lower performance in respect of urea was noticed in the disposable Kiil as compared to the standard Kiil, while as regards
creatinine and uric acid, the reduced performance was slightly accentuated and showed a greater irregularity from one patient to another, in close connection with the patient's weight and therefore with the quantity of substance to be extracted. It is known that creatinine and uric acid have a much smaller diffusibility than urea.

On the whole, results conformed to our expectations. No problem has arisen in respect of ultrafiltration, which has kept approximately to the values of 350–400 ml/hour, with a negative pressure of 150 or 200 mm Hg. The average blood flow rate ranged from 300 ml/min (Case LG) to 150 ml/min (Case BM). Those flows were obtained without the help of blood pumps and are slightly higher than those obtained in the same patients with the two-compartment Kiil dialyser. We can safely state, then, that the disposable Kiil dialyser tested by us is a low resistance and low capacity (200 cc) machine.

The rupture percentage of Cuprophane membranes has been 5%, approximately the same as in the two-compartment Kiil.

The advantages of the disposable Kiil are those common to all disposable types: speedy and safe working, total prevention of infection spread and faultless sterilisation with ethylene oxide.

Figure 4. The disposable dialyser in use. Note the position of the boards and clamping frame
The costs of a dialysis performed by means of our disposable Kil haemo-
dialyser are strictly limited and not much higher than those of a dialysis with
a two-compartment Kil, taking into account the savings effected on staff,
material and time.

No patient suffered from adverse effects ascribable to this apparatus.
The greatest drawback is so far represented by the slightly lower perform-
ance, that may necessitate, with patients weighing more than 60 kg, more fre-
quent dialysis sessions.

The encouraging results obtained so far lead us to believe that this appa-
ratus will be a greater help in dialysis practice.

Another one-compartment model, with a greater dialysis surface, is
under consideration, whose performance will at least be equal to the one of
the two-compartment Kil.

REFERENCES

Barsotti, G., Cioni, L., Moriconi, L., Piloni, N. and Rizzo, G. (1969)
Minerva Nefrologica, 16, 6, 416
Roozendal, K. J. (1966) Proceedings of the European Dialysis and Trans-