Treatment of Uraemia Using an Ultrafiltration-Filtration System

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Urea and other substances responsible for the development of 'uraemia' are removed by the artificial kidney by means of diffusion. Unlike a dialyser the natural kidney eliminates these substances by filtration. Using this principle for blood purification in uraemia two advantages may be achieved: first, (in contrast to haemodialysis) toxic substances can be removed independent of their molecular weight (Bixler et al, 1968) and second, no dialysis fluid is required. Problems which arise from the sterilisation of large amounts of dialysis fluid may thus be avoided.

The system involves two steps of filtration: in the first step, plasma water containing electrolytes, glucose, urea, creatinine, uric acid, etc is removed from the heparinised blood by ultrafiltration using filter F1 (Figure 1).

![Diagram](image)

**Figure 1.** Ultrafiltration-filtration system for the purification of blood (Flow diagram)
A = blood from the artery, V = blood to the vein, R = roller pump, P1, P2 = pumps, F1 = ultrafilter, F2 = filter, M1 = membrane with large 'pore' diameter, M2 = membrane with small 'pore' diameter, V1, V2 = pressure valves
Figure 2. Reflection coefficient for urea, creatinine and inulin of the ultrafiltration membrane M₁. (n = 12)

Figure 3. Reflection coefficient for urea, creatinine and inulin of the filtration membrane M₂. (n = 12)
The second step of filtration induces a separation of the solutes (electrolytes, urea, creatinine, etc) and water by means of filter F₂. After replacement of electrolytes and glucose this water is infused into the patient. Weight loss of the patient occurs by removal of the retentate of filter F₂, containing urea, creatinine and other toxic substances in high concentration. For ultrafiltration a pressure of 200 to 500 mm Hg is sufficient, preventing the erythrocytes from damage. In the second step a filtration pressure of 40 - 50 atmospheres is necessary.

By a special process, cellulose-nitrate membranes with various 'pore' diameters were manufactured which are able to sustain filtration pressures up to 60 atmospheres. Retention of different substances by natural or artificial membranes is characterised by the 'reflection coefficient' ynos:

$$\delta = 1 - \frac{C_F}{C_R}$$

where $C_F$ is the concentration of a given substance in the filtrate and $C_R$ is its concentration in the retentate. A cellulose-nitrate membrane with low reflection coefficient for urea and creatinine is chosen for ultrafiltration (Figure 2) and a membrane with high reflection coefficient is selected for the second step (Figure 3). Generally filtration or ultrafiltration using artificial membranes is hindered a short time after the beginning by membrane 'polarisation'; that is, the deposition of plasma protein and other substances on the membrane surface. In the system demonstrated above this effect is

Figure 4. Filtration system for blood purification

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prevented by a high flow velocity of the retentate within small channels of the membrane support. Thus the filtration capacity is reduced only 15% (ultrafiltration) and 28% (second filtration) respectively after 5 hours. The demonstrated ultrafiltration-filtration system (Figure 4) has been used successfully in the treatment of uraemic dogs reducing serum creatinine to 18% and BUN to 27% of the initial level within 5 hours.

REFERENCE