DIALYSIS-SYSTEM INCORPORATING THE USE OF
ACTIVATED CHARCOAL

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In 1964 Yatzides demonstrated that uraemic blood can be purified by direct perfusion over 200 grams of activated charcoal. Creatinine, uric acid, aromatic aminoacids and other nitrogenous substances were almost completely eliminated after one passage.

Urea, however, was very poorly adsorbed (approximately 4 g/200 g of charcoal). Considerable adsorption moreover of thrombocytes and plasma protein components occurred. This method is therefore perhaps suitable for acute intoxications but not for intermittent dialysis treatment of chronic uraemic patients. Direct perfusion over charcoal naturally requires a considerable restriction of the amount of charcoal used in order to limit the extracorporeal blood volume. This limitation of the amount of charcoal used and thus of the amount of urea adsorbed, is not necessary if one uses not direct perfusion but dialysis with regeneration by charcoal of a limited amount of bath fluid. This dialysis-adsorption system offers the opportunity to bind the necessary amount of urea.

In Fig. 1 the adsorption isotherm of urea is depicted using activated charcoal at a temperature of 37°. As you see from the graph 8 g of urea can be adsorbed by 1 kg of charcoal at a bath fluid urea concentration of 0.5 g/litre. With this urea concentration, which for good dialysis results is permissible, 6 kg of activated charcoal can bind approximately 50 grams of urea. This amount is usually sufficient in intermittent dialysis.

In the same diagram we also see that the addition of 1% of glucose (which competes with urea for charcoal adsorption) does not considerably influence urea adsorption. In our
clinical experiments we limited the volume of bath fluid to 50 litres. This volume is sufficient to decrease potassium and phosphate concentration by dilution to values which are acceptable, as charcoal does not bind electrolytes. The elimination of creatinine and uric acid proved to be as efficient with charcoal dialysis as with dialysis with great volumes of bath fluid.

Fig. 2 is a diagram of the charcoal dialyser used. Instead of one we now use 2 cylinders, together containing approximately 2.5 kg of activated charcoal granules (Activit-Amsterdam). During dialysis cylinders with fresh charcoal can be easily exchanged for used ones. After passage through the dialyser, the bath fluid is sucked through the charcoal columns, filtered and pumped back into the reservoir.

![Fig. 2.](image)

This apparatus is independent of dialysate installations and can therefore be used in any ward of the hospital, and also at home.

The apparatus has small dimensions and is suitable even for a small room; it needs no more than a normal supply of electricity to work the pump and the water temperature control.

We employed this apparatus in one case of chronic uraemia and compared the results with those of volume dialysis (Fig. 3). Every dialysis was performed with the same dialyser, the same cuprophane surface (one square metre) and the same dialysis-time (8 hours).

We see that with charcoal dialysis using 5 kg of charcoal it was possible to maintain a mean blood urea level of 160-240 mg%. This level was lowered with volume dialysis and in a following period dialysis with 7.5 kg of charcoal was performed.

In this period an average level of 87-104 mg% of urea was maintained. From this diagram we get the impression that from the biochemical point of view, charcoal dialysis can be used instead of volume dialysis. Our first clinical impressions, however, were not so satisfactory. The patient did not feel as much improved after charcoal dialysis as after volume dialysis. We
had the impression that a low grade uraemic neuropathy was progressing faster during the charcoal dialysis-period.

More experience with this method has still to be gained.

**Summary and conclusions**

Using 7.5 kg of activated charcoal and 50 litres of bath fluid in an adsorption-dialysis system, it was possible to maintain a chronic uraemic patient with intermittent dialysis in biochemical balance. The bath fluid is continually recirculated and regenerated by adsorption on charcoal. Potassium and phosphate were sufficiently decreased by dilution in the 50 litres of bath fluid. The limitation of bath fluid-volume offers the possibility of dialysing patients at home or in any ward of the hospital without the necessity for bulky and expensive dialysate producing systems. Although the biochemical results compare favourably with those of dialysis with great volumes, more experience should be gained to decide whether long-term results are as good as with volume dialysis.