Cellulose Acetate and Cuprophane for Hemodialysis: Effects on Protein Catabolic Rate

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Dear Sir

It has been suggested that in dialyzed uremic patients the protein catabolic rate (PCR) is directly dependent upon the amount and type of hemodialysis (HD) treatment they receive as measured by the normalized whole-body urea clearance (Kt/V). Different treatment methods may influence the interrelationship of PCR and Kt/V in different ways: to obtain an equal PCR, a higher Kt/V must be prescribed when using cellulosic membranes for HD [1].

The most obvious explanation for this is related to the different solute clearance profiles that exist with synthetic membranes and cellulosic ones. On the other hand, bio-compatibility may influence the nutritional problems of HD [2]. A clinical trial has been performed in which the effects of two cellulosic membranes (cuprophane, CU, and cellulose acetate, CA) with similar permeability and different biocompatibility [3, 4] on the PCR were assessed.

Forteen stable patients with chronic renal failure on HD treatment for more than 6 months were included. The patients received HD first by dialyzers containing CU membranes or by CA hollow-fiber dialyzers. Each of two dialyzers was used for 78 consecutive HD treatments over a period of 6 months. The studies were carried out every 2 months spanning a total of 12 months. Blood samples were collected from the arterial line at the start and at the end of the midweek session. Kt/V, time-averaged concentration of

urea (TAC) and PCR were estimated using a simplified model [5].

No differences were found for Kt/V between CU and CA HD (1.02 ± 0.12 vs. 1.06 ± 0.11). TAC values were significantly lower when patients were dialyzed by CU membranes (CU 54.6 ± 13.9 , CA 63.6 ± 17.3 mg/dl, $p < 0.05$). Also PCR values were lower when patients were dialyzed by CU dialyzers (CU, 1.04 ± 0.28 , CA 1.25 ± 0.37 mg/kg/day, $p < 0.01$). There was a trend toward an increase in total protein when using CA dialyzers (CU 6.93 ± 0.32 , CA 7.07 ± 0.35 g/dl, n.s.). A slight increase in albumin was observed during treatment with CA membranes (CU 4.33 ± 0.19 , CA 4.42 ± 0.22 g/dl, n.s.).

A linear correlation between Kt/V and PCR existed for both membranes (CU, $r = 0.35$, $n = 42$, $p < 0.05$; CA, $r = 0.41$, $n = 42$, $p < 0.01$). The slope of the regression line for the dialyzers containing the CA membrane was greater (CA 1.19, CU 0.83), although this difference was not significant.

In dialyzed uremic patients who do not have extraneous factors (e.g. malignant disease), the PCR seems to be directly dependent upon the amount and type of HD treatment they receive as

measured by Kt/V [1]. In normal patients and in those with stable chronic renal failure, the level of urea is known to vary directly with dietary protein intake and this parameter and the PCR will be nearly equal so that monitoring changes in the body pool of urea is a way to assess protein intake [6, 7]. In fact, the calculated value of PCR has proved a more reliable estimate of dietary protein intake than dietary histories. The results of the study suggest that in patients dialyzed with CA membranes the PCR is significantly increased compared to the PCR when the same patients are dialyzed with CU dialyzers, a less biocompatible cellulosic membrane with a similar solute/clearance profile. A possible explanation relates to differing degrees of complement and interleukin-1 activation induced by these membranes and, hence, of the catabolic process induced by the HD therapy itself. The HD procedure may give rise to an inflammatory reaction, the intensity of which depends on the membrane material used, being more prominent with cellulosic than with synthetic membranes [8, 9]. Recently it has been observed that interleukin-1, tumor necrosis factor and endotoxin may induce net catabolism of muscle protein by enhancing oxidation of branched-chain amino acids due to stimulation of branched-chain ketoacid dehydrogenase [10]. It has been demonstrated that in vivo blood membrane interaction in a dialyzer without dialysate stimulates net protein catabolism, especially when using a CU membrane. It has also been observed that sham dialysis with CU, but not with more biocom-

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patible membranes, produced an increased release of 3-methylhistidine from the leg musculature, which indicates that increased protein breakdown plays an important part in the net catabolic process induced by blood-membrane contact [10].

CA membranes have been reported to have a lesser ability to activate granulocytes and plasma complement in comparison with CU [3, 4]. Furthermore, sham HD with CA membranes did not result in a significantly increased release of 3-methylhistidine; thus, protein catabolic effects were not found [10].

In conclusion, these observations suggest that the PCR is dependent upon the type of cellulosic HD membrane used. This difference may be produced by the various degrees of biocompatibility of these membranes.

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