Enhanced Middle Molecule Clearance by a Biomimetic Dialyzer Membrane

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Background:
Although polymer dialyzers attain very high small solute clearance rates, polydisperse pore sizes limit middle molecule clearance by conventional polymer dialyzers. We hypothesized that a biomimetic membrane with uniform slit pores would enhance middle molecule clearance.

Methods:
Thin film silicon membrane samples (surface area 1.4 x 10-5 m2) with monodisperse slit-shaped 5-8 nanometer pores ("SNM-HD") were manufactured as previously described, surface-modified with polyethylene glycol and mounted in a custom designed cartridge. Membrane pore size was estimated from hydraulic permeability measurements. Human blood was spiked with PABA and fluorescent-labelled Ficoll, a polydisperse globular polysaccharide. Blood flow was set at 100 ml/min and dialysate flow varied between 70 and 140 ul/min. Blood and dialysate concentrations of PABA and Ficoll were measured by size-exclusion chromatography. Clearance as a function of dialysate flow rate was extrapolated to estimate KoA as a function of molecular weight.

Results:
B2M clearance in high-flux dialyzers is typically 5-8% of the value of urea clearance. PABA clearance was 139 ml/min/m2. 15.7Angstrom Ficoll (same radius as B2M) clearance in the SNM dialyzers was 16.9 ml/min/m2, 3-5 fold higher than reported B2M clearance in polymer dialyzers.

Conclusions:
A biomimetic membrane of uniform slit pores potentially offers much higher middle molecule clearance than conventional polymer dialyzers.