4.10 Dialysis as Treatment of End-Stage Renal Disease

Where
\[ C = \frac{(D \times V)}{P} \]

\( D \) = dialysate solute removed per minute;
\( V \) = volume of dialysate in mL/min;
\( P \) = plasma solute concentration

or
\[ C = (D/P) \times V \]

\( C \) = clearance in mL/min;
\( D/P \) = solute equilibrium rate at time t;
\( V \) = volume of dialysate at time t

\[ K_t/V \]

\( K \) = urea clearance in mL/min;
\( t \) = minutes of therapy;
\( V \) = volume of urea distribution or total body water

**FIGURE 4-16** Creatinine and urea clearances rates. These rates are estimated by dividing the amount of solute removed per unit of time by the plasma solute concentration. Alternatively, clearance also can be estimated by multiplying the solute equilibration rate per unit of time by the volume of dialysate into which equilibration occurred over the same unit of time. By convention, the creatinine clearance rate is normalized to body surface area.

The urea clearance is normalized to total body water (volume of urea distribution in the body) and is expressed as \( K_t/V \). The \( K_t/V \) value is a number without a unit (\( \text{mL/min} \times \text{min} / \text{mL} \)). During intermittent dialysis, with a dialysate flow rate of 30 mL/min, the typical urea clearance is about 1.8 to 20 mL/min [18]. Increasing the dialysate flow rates to 3.5 to 12 L/h by rapid exchanges increases the urea clearance rate to a maximum of 30 to 40 mL/min. Beyond this maximum rate, the clearance rate begins to decrease owing to the loss of membrane-fluid contact time with infusion and drainage; inadequate mixing may also occur [19–22]. Clearance could be enhanced by increasing the membrane-solution contact [23]. Continuous dialysis flow techniques using either two catheters or double-lumen catheters also have enhanced the urea clearance rate to a maximum of 40 mL/min. At these high flow rates, poor mixing, channeling, abdominal pain, and poor drainage limit successful application.

**FIGURE 4-17** The mass-transfer area coefficient (MTAC). The MTAC represents the clearance rate by diffusion in the absence of ultrafiltration and when the solute accumulation in the dialysis solution is zero [34–39]. MTAC is equal to the product of peritoneal membrane permeability \( P \) and effective peritoneal membrane surface area \( S \). Thus, when both capillary blood and dialysate flows are infinite, the clearance rate is directly proportional to the effective peritoneal surface area and inversely proportional to the overall membrane resistance. However, infinite blood and dialysate flows cannot be achieved, and the maximum clearance rate is unattainable. The closest measurable value, the MTAC, was introduced. The MTAC represents an instantaneous clearance without being influenced by ultrafiltration and solute accumulation in the dialysate. The MTAC is measured over a test exchange during which at least two blood and dialysate samples are obtained at different dwell times. The precision of the measurement is enhanced with more data points. The MTAC is seldom used clinically; however, it is a very useful research tool.
Principles of Peritoneal Dialysis

References


