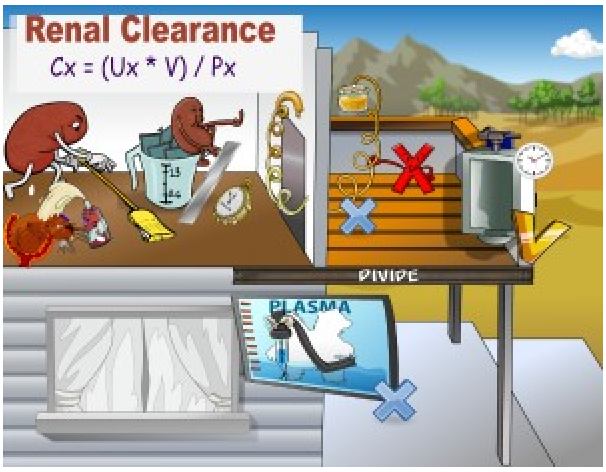
Renal Clearance

Renal clearance is a clinical index used to assess kidney function. It is expressed by the equation Clearance of X = (Urine Concentration of X) x (Urine Flow Rate)/ (Plasma Concentration of X) or Clearance = (Ux x Vx) / Px. Conceptually, it describes the volume of plasma cleared of a given substance per unit time. Clinically, this is important when estimating the glomerular filtration rate or GFR, which specifically uses the renal clearance of creatinine to provide an objective measure of kidney function. Creatinine specifically is used because it is freely filtered into Bowman's Capsule and is neither reabsorbed nor secreted actively. This fact means that the amount of creatinine filtered out of the plasma into the urine is entirely dependent on the volume that the renal nephrons are able to handle and filter.



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Characteristics

Estimates the Volume of Plasma Completely Cleared of a Substance by the Kidneys Per Unit Time

Kidney on Measuring-cup of Plasma-tv over Watch

Renal clearance tells us what volume of plasma is completely cleared of a substance in a given amount of time. For example, if I have one liter of plasma with four particles of substance and I remove all four particles in an hour, my renal clearance is one liter per hour. If, however, I clear only two particles out of four in a given hour, my renal clearance is half a liter per hour.

Creatinine Clearance Used to Estimate GFR

GFR-Gopher with Cr-eam

One specific clinical use of calculating renal clearance is in calculating creatinine clearance, which is used to estimate glomerular filtration rate, or GFR. Creatinine specifically is used because it is freely filtered at the glomerulus and is neither actively absorbed nor excreted. In other words, the urine concentration of creatinine compared to the plasma concentration is dependent only on how much volume is able to be cleared by the kidney, which is dependent on its function and ability to filter. In comparison, the concentration of other substances, for example, sodium, in the urine versus plasma is dependent on other factors such as endocrine signaling and volume status, which may lead to active excretion or absorption of sodium independent of renal function.

Equation

$C_x = (U_x * V) / P_x$

Kidney Clearing Concentrated-urine in a U-shape and Urinal over Clock with Plasma-TV Concentrate Underneath

Renal clearance (C_x) is equal to the urine concentration of substance X (U_x) multiplied by the urine flow rate (V) divided by the plasma concentration of substance X (P_x).

Variables

Urine Concentration of Substance X (U_x)

Concentrated-urine in U-shape

The urine concentration of a substance (U_x) expressed in units of concentration such as mg/dL or mmol/L must be measured in order to calculate renal clearance of a substance.

Times Urine Flow Rate (V)

Urinal with Clock

The urine flow rate is expressed as volume per unit time and reflects the volume of urine produced in a given amount of time. When trying to measure this clinically, urine is typically collected over a twenty-four-hour period and measured.

Over Plasma Concentration of Substance X (P_x)

Plasma-TV Concentrate

Finally, the product of urine flow rate and urine concentration of substance X is divided by the plasma concentration of substance X, which is typically obtained from a blood draw. You will notice that the units of concentration from dividing urine by plasma concentration will cancel out, leaving units of volume per unit time.