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NEPHROLOGY - LETTER TO THE EDITOR

Solute-free water excretion and electrolyte-free water excretion are better terms than solute-free water clearance and electrolyte-free water clearance

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Editor,

Renal solute and water excretion determines the direction and magnitude of the change in serum sodium concentration resulting from renal losses [1–8]. The rates of renal solute and water excretion are expressed as osmolal clearance (C_{Osm}), solute-free water clearance (C_{H2O}), electrolyte (monovalent cation) clearance ($C_{(e)}$), and electrolyte-free water clearance ($C_{H2O(e)}$). These clearances consider that the volume of the urine consists of two virtual parts: C_{Osm} and $C_{(e)}$ have osmolality or sodium plus potassium concentrations equal to those of plasma, respectively; C_{H2O} is solute-free (pure water) water clearance; $C_{H2O(e)}$ is electrolyte-free (sodium plus potassium-free) water clearance. Table 1 shows the formulas for these clearances [6, 7].

The main components of urine solute are sodium and potassium salts and urea. $C_{(e)}$ and $C_{H_2O(e)}$ are expressions of the relationship between urine volume, urine sodium concentration (U_{Na}), urine potassium concentration (U_K) and plasma sodium concentration (P_{Na}), but not urea. $C_{(e)}$ is defined as the virtual volume of plasma completely cleared of sodium and potassium by the kidney per unit time (e.g., a minute). $C_{H_2O(e)}$ is defined as the volume of pure water to be subtracted from or added to a urine volume to produce a concentration of sodium and potassium in this modified urine equal to plasma concentrations of either sodium or sodium plus potassium. With this definition of $C_{H_2O(e)}$, it should be noted that the volume of plasma needed to provide the amount of electrolyte-free water to the urine is slightly higher than the volume of electrolyte-free water obtained. Thus, 100 mL of plasma can generate maximally only 93 mL of electrolyte-free water to the urine due to the presence of 7 g of proteins in 100 mL of plasma. These plasma proteins cannot be filtered into the urine under normal protein handling by the kidney.

If $U_{Na} + U_K < P_{Na}$, then $C_{H_2O(e)}$ is positive, a process that will increase plasma sodium level. If $U_{Na} + U_K > P_{Na}$, then $C_{H_2O(e)}$ is negative, a process that tends to reduce plasma sodium level [9]. $C_{(e)}$ and $CC_{H_2O(e)}$ were introduced in medical practice because they provide an accurate characterization of the pathophysiology of dysnatremias produced by various diuretic states, while C_{Osm} and $C_{H_2O(e)}$ do not [1–8].

C_{Osm} and $C_{(e)}$ are computed by the general formula expressing steady-state renal clearances of solutes, UV/P, where U and P are urine and plasma concentrations of the solute studied, respectively, and V is urine volume formed per unit time. The word "clearance" in solute-free or electrolyte-free water clearance does not correspond with the conventionally recognized nephrological meaning of "clearance" (expressed as a formula "UV/P" or narratively, "the volume of plasma from which a substance is entirely removed by the kidney per unit time"). Therefore, we propose that the term solute-free water clearance is replaced by "solute-free water excretion" abbreviated as E_{H_2O} and the term electrolyte-free water clearance excretion be replaced by "electrolyte-free water excretion" abbreviated as $E_{H_2O(e)}$ [10].

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Table 1 Clearance formulas expressing the relation between the rates of urinary solute and water excretion

Clearance	Formula
Osmolal clearance	$C_{Osm} = V \times \frac{U_{Osm}}{P_{Osm}}$
Solute-free water clearance	$C_{H2O} = V - C_{Osm} = V \times (1 - \frac{U_{Osm}}{P_{Osm}})$
Electrolyte clearance*	$C_{(e)} = V \times \frac{U_{Na}+U_K}{P_{Na}}$
Electrolyte-free water clearance*	$C_{H20(e)} = V - C_{(e)} = V \times (1 - \frac{U_{Na}+U_K}{P_{Na}})$

V urine volume per unit time, U_{Osm} urine osmolality, U_{Na} urinary sodium concentration, U_K urinary potassium concentration, P_{Na} plasma sodium concentration

*Plasma potassium concentration (P_K) was not included in the formulas of electrolyte clearance and electrolyte-free water clearance because its magnitude is small compared to P_{Na}. However, some authors include P_K in these formulas, which results in $C_{(e)} = V \times (U_{Na} + U_K) / (P_{Na} + P_K)$, and $C_{H2O(e)} = V \times (1 - (U_{Na} + U_K)/(P_{Na} + P_K)$ [2, 8]

Author contributions All the authors meet the follow criteria: substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Compliance with ethical standards

Conflict of interest The authors declare that there is no conflicts of interest or competing interests.

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