insipidus, results in dilute urine. Although renal water loss can lead to hypernatremia in patients with impaired thirst or access to water, most patients with diabetes insipidus have neither defect, and they typically have polyuria, polydipsia, and a normal serum sodium concentration at clinical presentation.

Evaluation of Polyuria and Polydipsia

Polyuria can result from osmotic diuresis or water diuresis. Water diuresis may result from inappropriate water loss, as in central or nephrogenic diabetes insipidus, or it may represent appropriate water loss, as in primary polydipsia. The clinical setting and urine osmolality help to differentiate these processes (Fig. 27-3).

Osmotic diuresis causing polyuria is often evident in the clinical setting. Poorly controlled glucose levels in a diabetic, administration of mannitol to a patient with increased intracranial pressure, and high-protein enteral feedings (i.e., urea diuresis) are examples in which polyuria is the result of osmotic diuresis. A urine osmolality value greater than 300 mOsm/L in a polyuric patient suggests a solute or osmotic diuresis.

After excluding osmotic diuresis, the clinician must discriminate between the causes of water diuresis. In patients with central diabetes insipidus, the onset of symptoms is characteristically abrupt, whereas patients with nephrogenic diabetes insipidus usually have a gradual onset of symptoms. Patients with primary polydipsia typically are vague in dating the onset of their symptoms. Nephrogenic and central forms of diabetes insipidus are characterized by severe and frequent nocturia, a feature that is typically absent in patients with primary polydipsia. Patients with central diabetes insipidus seem to have a predilection for ice water, which is not typically described in the other two conditions. A serum Na^+ concentration of less than 140 mEq/L suggests primary polydipsia because the patients tend to have a mildly positive water balance. A value greater than 140 mEq/L suggests central or nephrogenic diabetes insipidus because the patients tend to have a mildly negative water balance.

Urine osmolality increases in response to water deprivation in primary polydipsia but shows no response in diabetes insipidus.

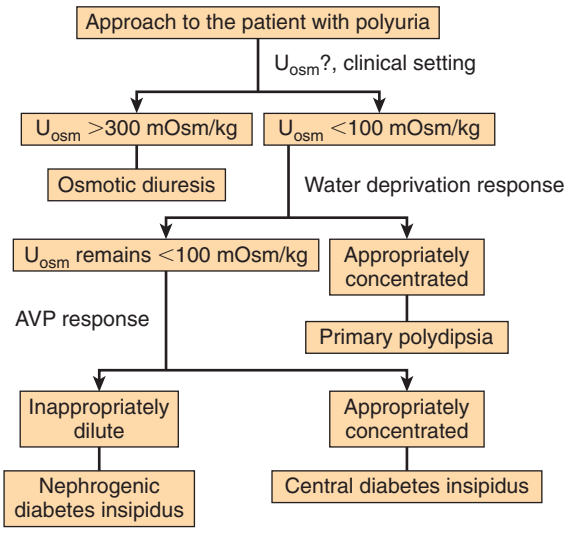

FIGURE 27-3 Approach to the patient with polyuria. AVP, Arginine vasopressin; U, urinary.

Both central and nephrogenic diabetes insipidus are distinguished by the change in urine osmolality after subcutaneous administration of AVP. It is increased in the central type but does not change in nephrogenic diabetes insipidus.

Treatment

Signs and symptoms of hypernatremia include lethargy, weakness, fasciculation, seizures, and coma. Increased ECF osmolality initially causes cell shrinkage in the brain. In response, cells generate intracellular osmoles, which balance the transmembrane osmotic gradient and pull water back into the cells, returning brain size to normal. After this adaptation, if extracellular osmolality is returned rapidly to normal, the additional intracellular osmoles pull water into the brain cells, resulting in cerebral edema. Hypernatremia should be corrected slowly by water administration at a rate that leads to one-half correction in 24 hours. The water deficit can be estimated in men from the following formula:

$$\text{Water deficit} = \text{Current body water} \left(0.6 \times \text{body weight}\right) \times \left(\frac{Na^+_{plasma}}{140} - 1\right)$$

where $[Na^+]_{plasma}$ is the sodium ion concentration in plasma. The calculation for women uses 0.5 instead of 0.6 as the multiplication factor.

Calculation of the amount of water to give must add insensible losses and ongoing losses from the urinary and gastrointestinal tracts. This formula does not include the volume of isotonic saline required in patients who may be concomitantly volume depleted. Careful monitoring of the serum Na^+ level is required to ensure the rate of correction is appropriate.

HYPOKALEMIA

Definition

Hypokalemia is a common clinical disorder. Decreases in total body potassium ions (K^+) usually result from gastrointestinal or renal losses, whereas hypokalemia in the setting of normal total body K^+ results from net movement of K^+ into cells. In most cases, the cause can be readily determined by the history, measurement of blood pressure, examination of the acid-base balance, and measurement of urinary K^+ levels.

Cellular Potassium Shift with Normal Total Body Potassium

In the absence of physical and historical evidence of gastrointestinal or renal K^+ losses, a redistribution of K^+ at the cellular level or laboratory error can account for a low serum K^+ concentration. Spurious causes of hypokalemia can be seen in leukemia patients with leukocyte counts of 100,000 to 250,000/m^3, in which the leukocytes extract K^+ from the serum.

The regulation of K^+ distribution between the intracellular and extracellular spaces is referred to as *internal K^+ balance*. Although the kidney is ultimately responsible for maintenance of total body K^+, factors that modulate internal balance are important in the disposal of acute K^+ loads. A large potassium meal, for example, could double extracellular K^+ were it not for the rapid shift of the K^+ load into cells. The kidney cannot excrete