The Significance of Plasma Sodium

By

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The clinical interpretation of plasma sodium concentration is based on the following premises:

1. Body fluids are constantly in osmotic equilibrium. (1,2) Important exceptions are fluids recently introduced into stomach and fluids in the interstitial spaces of the renal medulla, certain actively secreting glands, and the tubular epithelial cells of various nephron segments.

2. Osmotic equilibrium between the cells and the surrounding fluid is maintained by transfer of water. (3,4) Important exceptions are red blood cells and the cells of central nervous system which may respond to osmotic alterations in the extracellular environment by transfer of both water and solute. (5–7)

3. Change in body water content are reflected by changes in plasma sodium concentration. (8–11) In general, a significant alteration in plasma sodium concentration is an evidence of an abnormality in body water content not in body sodium content.

Plasma Sodium and Effective Body Fluid Osmolality

The qualitative differences between cellular and extracellular fluids are maintained by the transport and permeability characteristics of cell membranes. In general, cell membranes are relatively impermeable to the sodium ion, so sodium and its associated anions are functionally restricted to the extracellular water. Potassium and the anions associated with it are relatively restricted to intracellular water and account for the major fraction of intracellular milliosmols. Intracellular fluid is in osmotic equilibrium with interstitial fluid and plasma, so the osmotic characteristics of plasma may be used to describe the osmolality of most body fluids. Sodium is the most abundant ion in extracellular fluid and accounts for about 90% of the cations in plasma. Most of the anions in extracellular fluid are also univalent, therefore twice the concentration of plasma sodium is a good approximation of 90% of the total ions in plasma. (12) It is fortuitous that the osmotic coefficient of an 0.300 M sodium chloride solution is 0.93, making 90% of the total ion concentration in plasma a good approximation for effective body fluid osmolality. (13)

The major clinical value of plasma sodium is its reliability as a parameter for effective body fluid osmolality. There are two sets of conditions in which concentration of sodium in plasma may
be lower than normal when body fluid osmolarity is normal or increased. Hypo-
natremia may occur in patients with hyperproteinemia. (14) The concentra-
tion of sodium in water phase of plasma is normal if body fluid osmolarity is
normal. Plasma sodium concentration may also be reduced, in the presence of
normal or increased body fluid osmolar-
ity, when the extracellular space is
expanded by the accumulation of nonio-
nic extracellular solutes such as glucose,
or mannitol. (15–18) Excluding these
conditions, plasma sodium concentration
is a reliable parameter for effective body
fluid osmolarity.

**Total Plasma Solute Concentration by Freezing Point Depression**

The estimation of total plasma solute concentration by depression of
freezing point is now commonly used in both investigative and clinical labora-
tories. Using freezing point depression, it is necessary to distinguish between
total and effective plasma osmolality. The effective plasma osmolality reflects
the concentration of plasma solute which influences the distribution of body water.
Urea and sugar usually account for 5
to 15 milliosmols of solute per kilogram
of plasma water when total plasma solute concentration is estimated by free-
zing point depression. These solute particles generally have little influence
on the distribution of body water. Under
most circumstances the milliosmols due
to urea and glucose should be sub-
tracted from total plasma solute concen-
tration to define the physiologically
effective solute.

Observations were made on 150
pediatric patients. These children did
not have hyperlipemia, hyperprotein-
eemia, of blood sugar levels above 180
mg %, so plasma was considered a
reliable parameter for effective body
fluid osmolality. The patients ranged
in age from six days to 13 years and
had a variety of infectious diseases,
metabolic disorders, and congenital
anomalies. Dehydration due to gas-
 troenteritis was the most common diag-
osis. Plasma sodium concentrations
ranged from 133 to 207 mEq/L, with a
mean of 138 + 4 mEq/L. Total plasma
osmolality varied from 235 to 42
mOsm/Kg, with a mean of 292 ± 33,
and effective plasma osmolality from
215 to 398 mOsm/Kg, with a mean of
274 ± 27 mOsm/Kg. Plasma urea nitro-
gen concentrations varied from 3 to
268 mg % and plasma sugar from 29
to 176 mg %

Effective plasma osmolarity was
derived by subtraction from total plas-
ma solute concentration the milliosmols
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contributed by glucose and urea. When plots were made between the plasma solute concentration and plasma sodium concentration, and between the latter and effective plasma solute concentration, the correlation between the total plasma osmolarity and plasma sodium concentration is highly significant \((r=0.89, p<0.01)\). The relation between effective plasma osmolarity and plasma sodium concentration is even closer, \((r=0.95, p<0.01)\). The difference between the two correlation coefficients is a reflection of the measurement, by freezing point depression, of the physiologically ineffective milliosmols contributed by glucose and urea.

Edelman and his associates showed good correlation between total serum solute concentration and serum sodium in 98 adult patients \((r = 0.8)\). (19) Even better correlation was evident in the relationship between effective plasma osmolarity and the concentration of sodium in plasma water. Similar results were reported by Hellerstein, et al in 38 pediatric patients. (7)

Edelman (19)

\[
Y = 175x + 10.1, \ r = 0.97 \ (No. = 98)
\]

Hellerstein

\[
Y = 186x - 2.4, \ r = 0.96 \ (No. = 38)
\]

Glucose, Urea, and other nonionic extracellular solute may affect the distribution of body water. (20)Abrupt increase in the plasma urea concentration causes a transient rise in effective osmolarity. These effects are dissipated in a few hours as the concentration of urea in cell water approaches that in extracellular water. (12) Extracellular glucose undoubtedly exerts effective osmotic activity above certain plasma glucose levels, although the specific threshold is not known. This probably varies between physiological events as well as between individuals. In the total absence of insulin activity, glucose is probably an osmotically effective solute for most cells at rather low plasma levels.

For the estimation of effective osmolarity from total plasma solute concentration, extracellular fluid glucose may be treated as if it dose not contribute effective solute at plasma concentration below 180 mg% \((10 \text{ mOsm/Kg})\), the approximate renal threshold for glucose.

The normal range for effective plasma osmolarity was \(273 \pm 5.4 \text{ mOsm/Kg}\) plasma water in a group of 77 children ranging in age from one month to fifteen years. The plasma sodium range in this group of children was \(139 \pm 2.9 \text{ mEq/L}\).

\* \([\text{mOsm}]_{\text{EFF}} = [\text{mOsm}]_{\text{FP}} - \frac{[\text{Urea Nitrogen mg%} \times 10 + \text{Sugar mg%} \times 10]}{28} + \frac{180}{28}\)

\([\text{mOsm}]_{\text{EFF}}\) is effective plasma osmolarity and \([\text{mOsm}]_{\text{FP}}\) is total plasma solute concentration by freezing point depression. The milliosmols per kilogram of plasma water contributed by sugar and urea assumed to be equal to the sum of the millimolar concentration of these solutes per liter of plasma.
Summary
In the absence of hyperlipemia, and hyperproteinemia, there is a close correlation between plasma sodium concentration and effective plasma osmolarity. In the clinical interpretation, plasma sodium concentration is a reliable parameter for effective body fluid osmolarity.

References


IMMUNOLOGY
IN THE FIELD OF OBSTETRICS & GYNECOLOGY

นายแพทย์ ม.ส. ศิวัญนฤ ศิริวงศ์*

ในการทดลอง 10 มี. ที่ส่องผ่านเนื้อเยือกของสำนักงานการแพทย์ และวิศวกรรมสิ่งแวดล้อม มีการตรวจคัดเลือก และวิเคราะห์สำนักงานการแพทย์

Immunology ซึ่งเป็นผลที่เกิดจากการใช้
ทางเชิงวิวัฒนา เพาะผักพันธุ์ต่าง ๆ และกัน
วัชรยุทธ์ หน้าที่ความสนใจแพร่
แผ่งผ่านในส่วนที่เกี่ยวกับวัชรยุทธ์-
ศาสตร์-แนววิทยาศาสตร์แห่ง

การทดสอบการตั้งครรภ์ (Pregnancy test)

เว็บไซต์ Wide และ Gemzell ในปี 2560 ได้เปิดเผยเทคนิคในการ
ตรวจหา Human Chorionic gonadotropin
(HCG)— โดยวิธี Hemagglutination Inhibition ซึ่งปรากฏการเกิดผลเล็ด, ผล
เร็ว และรวดเร็วผลดีจากการทดสอบ
การตั้งครรภ์โดยวิธีอื่น ๆ

วัสดุที่ใช้ในการทดสอบประกอบด้วย
Rabbit serum containing antibodies to
HCG (ได้จากกระต่ายซึ่งส่งติดคัดโดย Pure
HCG) และ HCG-coated red-cells (ได้
จากเม็ดโลหิตแห้งซึ่งได้ Stabilized
ด้วยเพรรมีสิน	tanned กับ	tannic acid
เพื่อ facilitate การติดเชื่อมต่อ HCG และ
ผสมกับ HCG)

การทดสอบที่มีผลบวกต่างๆจะหมายถึง
ประโยชน์ของผลต่างๆ ซึ่ง HCG แอน
ทิปส์แต่ต่างๆโดย HCG coated red cells
ที่เจาะไว้ด้วยการจับ บ้างสามารถมองเห็น
โดยตรง HCG— จะทำให้ปฏิกิริยาที่
แอนทิบอดี ในรูปรแบบหลายอย่าง เพราะ
จะนิยามให้ HCG Coated red cells เข้า
ไปจำไม่ได้การรวมตัว (agglutinate) และ
จะตกอ่อน ระดับที่เกินไปที่นุ่มตลาด
หลังแต่ยับยั้งไม่ต่างกับ บ้างและ
ของคนวิชานั้นจะไม่ได้ HCG อยู่ในและ
HCG antibodies ในรูปรแบบหลายอย่างจะ
คงอยู่เพื่อ agglutinate กับ HCG coated
red cells ชี้ปฏิกิริยาของหลอดเวลาที่
ประมาณ 2 ชั่วโมงหลังจากการทดสอบ

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