AJKDblog

Test Your Knowledge: The Role of the Kidney in Disorders of Volume

A recent AJKD Core Curriculum by Danziger and Hoenig reviewed the role of the kidney in volume regulation. Test your knowledge on this important topic.

1. Which of the following Starling forces is *not as strong* as previously thought?
    A. Inward oncotic pressure
    B. Outward oncotic pressure
    C. Capillary hydrostatic pressure
    D. Interstitial hydrostatic pressure

2. Stimulation of the sympathetic nervous system has three effects on the kidney. Which of the following is **not** one of them?
    A. Afferent arteriole vasodilation
    B. Efferent arteriole vasoconstriction
    C. Release of renin from the juxtaglomerular cells
    D. Direct activation of sodium resorption in the proximal tubule, thick ascending limb of the loop of Henle, and distal tubule

3. Which of the following is true about the macula densa?
    A. Detects tubular flow in the distal convoluted tubule
    B. Detects tubular flow by measuring tubular sodium
    C. Uses the furosemide-sensitive Na-K-2Cl channels to detect tubular flow
    D. In response to a drop in tubular flow, the macula densa suppresses renin release

4. Regarding nephrotic syndrome, which of the following statement is true?
    A. The underfill hypothesis of edema in nephrotic syndrome requires activation of ADH
    B. In experimental models with unilateral proteinuria, sodium retention is seen in both kidneys
    C. The proteinuria in nephrotic syndrome activates eNaC sodium reabsorption regardless of RAAS activity in cell culture
    D. The overfill theory of nephrotic syndrome states that low albumin leads to osmotic movement of fluid to the interstitium resulting in hypovolemia and edema

5. All of the following regarding angiotensin 2 is true **except:**
    A. Angiotensin 2 is a potent vasoconstrictor
    B. Angiotensin 2 helps correct metabolic alkalosis by stimulating the reabsorption of hydrogen ions in the proximal tubule
    C. Angiotensin 2 increases sodium reabsorption in the proximal tubule
    D. Angiotensin stimulate potassium secretion in the distal nephron by stimulating the release of aldosterone

6. Chloride is increasingly being recognized as an important mediator of intravascular volume. Evidence for this includes all of the following **except:**
    A. In rat models of salt-sensitive hypertension, chloride loading with non-sodium salts lowers blood pressure
    B. Use of sodium bicarbonate for the treatment of metabolic acidosis in CKD does not increase blood pressure or edema
    C. The chemoreceptors of the JGA detector luminal chloride, not sodium
    D. Mutations of the chloride bicarbonate anti-porter in type B intercalated cells limit chloride reabsorption and seem to provide resistance to hypertension

7. Which of the following is not consistent with a patient with volume depletion?
    A. Fractional excretion of sodium < 1%
    B. A urinary sodium above 20 in a urine with an osmolality of 1000 mOsm/kg H_2O
    C. Urine creatinine of 60 mg/dL with a serum creatinine of 2.5 mg/dL
    D. A urine sodium of 15 mEq/L and a urine potassium of 38 mEq/L

Quiz prepared by Dr. Joel Topf, AJKD Blog Advisory Board Member

Based on The Role of the Kidney in Disorders of Volume: Core Curriculum 2016 by Danziger & Hoenig

Solutions to *AJKD* Blog's Test Your Knowledge: The Role of the Kidney in Disorders of Volume

1. **A. Inward oncotic pressure**

   New research suggests that the classic Staling's Law may be an oversimplification. One weakness of the theory regards the movement of fluid back into the capillary at the venous end of the capillary bed. Inward oncotic pressure does not appear to be as strong as previously thought, resulting in more fluid movement to the interstitium which is recovered via the lymphatic system. This is important because it provides a scientific rational for the empiric failure of albumin to improve volume resuscitation in multiple large trials.

2. **A. Afferent arteriole vasodilation**

   Sympathetic stimulation causes increases in the vascular tone, and vasoconstriction of both the afferent and efferent arterioles. Prostaglandins are responsible for afferent arteriole vasodilation, countering the effect of the sympathetic nervous system.

3. **C. Uses the furosemide-sensitive Na-K-2Cl channels to detect tubular flow**

   The macula densa is responsible for tubuloglomerular feedback so that glomerular filtration is balanced with tubular reabsorption. If GFR begins to exceed reabsorption, there will be increased chloride delivery to the thick ascending limb of the loop of Henle. This increased chloride delivery is detected by the NaK2Cl transporter of the macula densa, which suppress renin secretion and lowers GFR. In addition to lowering renin, there is also an increased release of adenosine that reduces GFR to match tubular reabsorption.

4. **C. The proteinuria in nephrotic syndrome activates eNaC sodium reabsorption regardless of RAAS activity in cell culture**

   The article provides evidence for the overfill theory of edema formation in nephrotic syndrome. This theory is in opposition to the underfill theory that states that the low albumin found in nephrotic syndrome results in movement of fluid into the interstitial space and edema. This causes a secondary increase in renal sodium avidity through activation of the RAAS from intravascular volume depletion. The overfill theory states glomerular diseases can also directly stimulate renal sodium retention, resulting in increased total body sodium and edema. One possible mechanism for

this renal retention of sodium is stimulation of the eNaC channel in the distal nephron from tubular protein.

5. **B. Angiotensin 2 helps correct metabolic alkalosis by stimulating the reabsorption of hydrogen ions in the proximal tubule**

   Angiotensin 2 stimulate NHE3, which increases hydrogen secretion in the proximal tubule. This can generate and perpetuate metabolic alkalosis in the presence of volume depletion by increasing reabsorption of filtered bicarbonate even when it appears maladaptive.

6. **A. In rat models of salt-sensitive hypertension, chloride loading with non-sodium salts lowers the blood pressure**

   One of the lines of evidence that demonstrates the importance of chloride balance in disorders of volume and blood pressure is seen in rat models of salt-sensitive hypertension where non-chloride containing sodium salts do not cause hypertension. This provides evidence that it is not sodium in these salt-sensitive rodents that drives the hypertension.

7. **D. A urine sodium of 15 mEq/L and a urine potassium of 38 mEq/L.**

   There are a number of indices that can be used to determine if a patient's kidneys are behaving as if the patient is volume depleted. One of these is the urinary sodium-potassium ratio. A fall in this ratio (more urinary potassium compared to urinary sodium) is evidence for plasma aldosterone activity. A urinary sodium-to-potassium ratio of more than 1:4 is consistent volume depletion.