An integrated view of potassium homeostasis

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An Integrated View of Potassium Homeostasis

TO THE EDITOR: The review article by Gumz et al. (July 2 issue) on renal potassium handling focuses on the cortical collecting duct. We would emphasize the emerging recognition of the role of the distal convoluted tubule in potassium homeostasis. Dietary potassium was recently shown to rapidly (within minutes) inactivate the sodium–chloride cotransporter in the distal convoluted tubule. This induced natriuresis and kaliuresis, probably by increasing sodium delivery to potassium secretory segments. Because aldosterone does not mediate this process, it is part of the feed-forward kaliuretic reflex. In another study, potassium-induced natriuresis was preserved in a model of depletion of extracellular fluid volume (which normally results in avid sodium reabsorption); this indicates the physiologic importance of this process.

The opposite is also true — a low-potassium diet activates the sodium–chloride cotransporter. With such a diet, activity of the sodium–chloride cotransporter increases through changes in cell-membrane voltage, intracellular chloride, and kinases that regulate the sodium–chloride cotransporter. Clinically, the activation of the sodium–chloride cotransporter by a low intake of dietary potassium may explain the well-known link with salt-sensitive hypertension. In summary, the distal convoluted tubule acts as a potassium sensor and affects downstream potassium secretion by regulating sodium delivery.

In summary, our trial showed that angioplasty with a drug-coated balloon maintained vessel patency that was superior to that of angioplasty with a standard balloon, and it showed superiority for a functional end point on the Walking Impairment Questionnaire. We agree that all patients should receive maximum tolerated doses of statins and that data from larger studies are lacking to confirm the beneficial effects on quality of life and physical functioning conferred by angioplasty with a drug-coated balloon over conventional angioplasty with a standard balloon.

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To the Editor: As Gumz et al. correctly state, “the healthy kidney has a robust capacity to excrete potassium,” and most people can ingest very large quantities of potassium without clinically significant hyperkalemia. However, it is not...
widely known that excessive ingestion of potas-

sium-rich foods or drinks because of a psychiatric

disorder can cause clinically significant hyper-

ekalemia in people with healthy kidneys and

adrenal glands who do not have precipitating

factors such as diabetes or the use of potassium-

sparring medications. For example, in an adoles-

cent with anorexia nervosa, recurrent hyperkale-

mia occurred with obsessive eating of up to 20

bananas per day.1 Hyperkalemia developed in

another patient who had schizophrenia and psy-

chogenic polydipsia when she replaced the water

in her diet with orange juice.2 Finally, recurrent

hyperkalemia due to excessive ingestion of dried

fruits developed in a healthy person, possibly be-

cause of an undiagnosed eating disorder.3

Excessive consumption of potassium-rich foods

or drinks because of a mental disorder should be

considered in the differential diagnosis of un-

explained hyperkalemia in otherwise healthy

people. A careful history regarding the patient’s
dietary habits should be obtained.3

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The views expressed in this article are those of the author
and do not necessarily represent the official views of the Na-

tional Institute of Mental Health, the National Institutes of
Health, the Department of Health and Human Services, or the
U.S. government. No potential conflict of interest relevant to this letter was re-
ported.

1. Tazoe M, Narita M, Sakuta R, et al. Hyperkalemia and hyper-
dopaminemia induced by an obsessive eating of banana in an
2. Berk DR, Comti PM, Sommer BR. Orange juice-induced hyper-
3. Pavletic AJ. Hyperkalemia induced by excessive consumption of

dried fruits — manifestation of an undiagnosed eating disor-

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TO THE EDITOR: Gumz et al. propose that circa-
dian clocks within renal tubular cells are ac-
countable for the kaliuretic effect of aldosterone.
Yet, another paradoxical phenomenon also con-
tributes to the kaliuretic effects of aldosterone: during volume depletion, aldosterone increases
sodium reabsorption without increasing potas-
sium secretion. Conversely, in hyperkalemic
states, aldosterone leads to potassium secretion
without increasing sodium reabsorption. This ef-
fect is mediated through angiotensin II, which
activates the sodium–chloride cotransporter and
epithelial sodium channel (ENaC) and inhibits
the potassium channel (ROMK); this happens
with no signaling of lysine-deficient protein ki-
nase 4, so there is no increase in potassium ex-
cretion. Furthermore, hyperkalemia without
volume depletion also occurs because of low angi-
otensin II levels and aldosterone-activated sodium
reabsorption through the ENaC and potassium
secretion through ROMK.1

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ported.

1. Arroyo JP, Ronzaud C, Lagnaz D, Staub O, Gamba G. Aldos-
terone paradox: differential regulation of ion transport in distal
nephron. Physiology (Bethesda) 2011;26:115-23.

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THE AUTHORS REPLY: We agree with Hoorn and

colleagues that the late distal convoluted neph-
ron participates in potassium homeostasis. This

is shown in Figure 2 of our article.

Hoorn et al. cite a study by Sorensen et al.1

that examined the effect of the administration of

a large potassium load by means of gastric lavage

that increased the plasma level to approximately

9 to 11 mmol per liter in sodium–chloride co-

transporter–null and control mice. Sorensen and

colleagues proposed that this maneuver inhibited

activity of the sodium–chloride cotransporter in

the early distal convoluted tubule and en-

hanced delivery of sodium to the late distal

convoluted tubule, the connecting tubule, and

collecting duct. According to this model, potas-
sium secretion in these latter segments is limited
by sodium delivery, and the shift of sodium
absorption from the early distal convoluted tubu-
le to these downstream segments explains the
observed kaliuresis. However, even modest in-
creases in the plasma potassium level that are
less than the values observed by Sorensen et al.

have been shown in in vivo microperfusion stud-
ies to directly increase potassium secretion by
cells in the distal nephron when the luminal
perfusion rate and sodium delivery are held con-
stant2; thus, an alternative explanation of the
results of Sorensen et al. merits consideration.

In addition, because the kaliuretic response oc-
curred before a change in plasma aldosterone,
Hoorn et al. propose that this hypothesized kaliuretic mechanism is a component of the feedforward kaliuretic reflex. According to our current understanding, however, a feedforward system requires neither a change in the plasma aldosterone level nor a change in the plasma potassium level.

Pavletic calls attention to an uncommon cause of hyperkalemia. The clinician should be able to identify it from a careful history.

Ardalan and Golzari interpret our article to mean that the circadian clock is responsible for a kaliuretic effect of aldosterone. To clarify this point, the primary and consistent effect of aldosterone on external sodium and potassium balance is to promote sodium retention, which is observed regardless of the time of day when aldosterone is administered. Aldosterone has important effects on internal potassium homeostasis by stimulating plasma membrane pump-leak kinetics and by its action to preserve sodium balance and blood pressure. Long-term mineralocorticoid stimulation reduces the level of plasma potassium in the absence of discernible changes in the level of total-body potassium. Conversely, the study of Todkar and coworkers involving aldosterone synthase-null mice shows that appropriate excretion of potassium occurred in the complete absence of aldosterone. These mice excreted a high physiologic, but not supraphysiologic, level of potassium as long as other compensatory systems were preserved.

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Since publication of their article, the authors report no further potential conflict of interest.


Nitroglycerin and Nitric Oxide — A Rondo of Themes in Cardiovascular Therapeutics

TO THE EDITOR: Steinhorn et al. (July 16 issue) note “anecdotal evidence” of “Sunday heart attacks” caused by withdrawal from nitroglycerin in an occupational setting. In reality, since 1882, considerable research involving people who worked with dynamite has validated such withdrawal syndromes (e.g., headaches, angina, and heart attacks). The authors further note that sildenafil was originally designed as an antiangiinal drug and then was shown to be an effective treatment for erectile dysfunction. However, they did not voice any concerns about similar effects of withdrawal associated with the use of phosphodiesterase type 5 inhibitors.

The exponential worldwide sales of longer-acting cyclic guanosine monophosphate phosphodiesterase inhibitors for daily use and the obvious marketing to younger populations suggest that a large proportion of the male population may be at risk for withdrawal syndromes that were previously noted only in workers with long-term exposure to nitroglycerin. Perhaps a more appropriate theme for this drug discovery may be “bench to bedside to bedroom to grave.”

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