

THE AFIB REPORT
Your Premier Information Resource for Lone Atrial Fibrillation
Publisher: Hans R. Larsen MSc ChE

VIRTUAL LAF CONFERENCE

Proceedings of 26th Session
March 3rd, 2004 – March 24th

SUBJECT: The Aldosterone Connection – Breakthrough?

Background

Many afibbers, myself included, have noted that it feels like something is building up in the body that is eventually released by an episode. Some, again myself included, have also noticed an increase in PACs and /or PVCs in the days prior to an episode and a total lack of ectopic beats in the first few days following an episode. Yet others have noticed a distinct pattern to their episodes in that they occur more or less every week, every 12 days, every 16 days or whatever. Finally, many afibbers have noticed a distinct increase in urination frequency during the early stages of an episode. All these observations point to a hormonal connection. Something builds up in the body to set the stage for an afib episode. The episode itself gets rid of this “something” and then the cycle begins again.

In the most recent LAF Survey (LAFS V) I observed that about one third (35% adrenergic, 33% mixed and 34% of vagal afibbers) of 142 respondents reported a distinct pattern to their episodes. The average (mean) number of days between episodes was 13.

In January 2003 we discussed the possibility that aldosterone and/or cortisol might be involved in the etiology of periodic LAF (LAP occurring at regular intervals). See the following proceedings for the detailed discussions:

www.afibbers.org/conference/session1.pdf
www.afibbers.org/conference/session2.pdf

The subject was also covered in detail in the March 2003 issue of *The AFIB Report*.

Basically, the idea is that a malfunctioning adrenal gland (adenoma or hyperplasia) produces an inappropriate amount of aldosterone and/or cortisol, which eventually leads to an intracellular electrolyte imbalance, more specifically an increase in Na and a decrease in K and Mg. This, in turn, sets off an AF episode. During the episode copious amounts of natriuretic peptides (ANP and BNP) are released by the fibrillating heart. Both ANP and BNP are strong diuretics and markedly reduce Na concentration while suppressing the formation of aldosterone and, in the case of ANP, also inhibits cortisol synthesis. This would favour termination of the episode. In other words, LAF may be the result of a dysfunction in the constant “tug-of-war” between the RAAS (renin-angiotensin-aldosterone system), specifically aldosterone and the natriuretic peptides.

The Breakthrough?

After much pleading and cajoling I finally managed to get to see a competent kidney specialist who showed an interest in investigating the LAF/aldosterone hypothesis. He ordered a comprehensive set of tests including both blood and 24-

hour urine samples. I was to provide the samples 2 days after an episode, 6 days after an episode, and 1-2 days before the next episode, which would usually be 11-12 days after the previous one.

The analyses have now been done and prove, beyond any reasonable doubt, that I do indeed have hyperaldosteronism. The results can be found at

www.afibbers.org/results.pdf

The abnormally low renin level, elevated aldosterone level, metabolic alkalosis (high bicarbonate level), and renal wasting of K and Mg are all as predicted by the hypothesis.

PC has kindly suggested a link that explains hyperaldosteronism in great detail.

<http://www.endotext.org/adrenal/adrenal23/adrenal23.htm>

My next step is a CT scan to determine the nature of the abnormality in my adrenal glands.

To make a long story short, the hypothesis discussed in January 2003 has now been verified – at least in my case. The presence of hyperaldosteronism has been clearly associated with cardiac arrhythmias and I am now convinced that it is the underlying cause of my own afib.

The next question of course is: “How many more “periodic” afibbers have hyperaldosteronism?” I think we ought to find out, so I propose that we do a survey. This would involve afibbers who have periodic episodes and are able to pretty well predict when their next episode will occur. What I propose is that these afibbers arrange to have a blood sample drawn one or two days prior to their next expected episode. The sample should be analyzed for bicarbonate and plasma renin level and should, for the purpose of standardization be taken in the sitting position around 9 AM local time.

Non-periodic afibbers would of course also be welcome to take the test for comparison purposes, but the interpretation of their results would be a little more challenging.

The results would be submitted to me for compilation and analysis along with the following information:

- Age
- Gender
- Type of afib (adrenergic, mixed or vagal)
- Date sample taken
- Number of days between sample date and the end of the preceding episode
- Duration of preceding episode (hrs)
- Number of days between sample date and the start of the following episode
- Duration of the “following” episode
- Normal interval between episodes (days)
- Normal blood pressure and pulse rate
- Presence of hypertension and whether it is treated or not
- List of all pharmaceutical drugs used including those used on demand

What I would like to do now is to open up the Conference Room to the discussion of two subjects:

The ramifications of the likely connection between LAF and hyperaldosteronism in periodic afibbers.

Proposed test protocol

The plan would be to proceed with full-scale 24-hour urine and blood tests for all afibbers with an abnormally low renin level and an elevated bicarbonate level.

I do feel that it is quite exciting that for the first time, to my knowledge, we have, through our joint efforts, been able to

link a clinically observed abnormality (in adrenal secretion) to the presence of afib. Your comments please!!!!

Hans

Hans,

That is incredible news!!!!!!! :-))) That is certainly a major breakthrough. Did the specialist offer any solutions and causes, to hyperaldosteronism? I would be very interested to know any light the doctor may have shed on this situation.

Richard

Great news, Hans. Now, what do we do about it?

And the odds of getting my physician to agree to any of this are somewhere close to 0.

John

Hans,

One real quick question. Do you know if your hair analysis revealed low or high tin levels. My intracellular test was very high, and my hair was somewhat high. Tin is associated with adrenal function and the left side of the heart, and if low, one could possibly have low adrenal function, but it didn't say what happened if high.

Richard

Hans, are you drinking Waller water? Do you think there may be a link between the bicarbonate in it and high results?

I still haven't got my head around why ANP waits for AF to start if there is a Na imbalance - surely there would be a rise in blood pressure and a release of ANP before the event? I know this has been discussed before so I'll have a search and re-read to see if I can persuade my brain to change sides :)

--

James D

Most interesting. A couple of comments:

1. Hyperaldosteronism causes fibrosis which, if I remember PC's opinions correctly, is implicated far more in AMAF than in VMAF. But accelerated fibrosis could only contribute to the plight of VMAFr's also. Although I am a NON-periodic VMAFr, I certainly HAVE noticed an increase in ectopy prior to an episode and a lack of ectopy immediately after an episode. I'm assuming that any breakthrough for AMAFr's would also have important ramifications for VMAFr's?
2. As I've often said, I was seriously stressed as a child and adolescent that I've long considered that I suffered adrenal burn-out at that time. I have accordingly postulated that my current problems are more than a little connected as a result of the stress of my formative years. I did not go through puberty until I was almost 17 years of age, and my family GP attributed this at the time to the traumatic environment in which I was 'growing up'. At the age of 18-19 I most notably went through a phase of excessive sweating under my arms - huge damp patches (fortunately no smell!) with big (10-14" dia salt marks on outside of jackets - including a black leather one which I remember constantly washing the salt marks off year-round. The aforementioned must be connected with adrenal function and aldosterone output. I am left wondering where I stand now as regards to my aldosterone levels: I had a 24hr urine adrenalin test (to check

for a benign renal tumour producing an excess of adrenalin - my doc at that time only did the test further to my nagging as I thought at that time that excess adrenalin could be causing my ectopics) about 6 years ago (before AF) which came back within normal range.... does it follow that aldosterone levels would also be normal or is this a totally different 'kettle of fish'??

Mike F.

Hans - this is a great breakthrough, indeed. I'm very impressed that you found a doctor who is willing to do some experimenting with you.

I almost wish I was one of the people who had those predictable events so I could be participating. It seems as if it will definitely be an answer for some afibbers. Good work Hans.

I'll be reading the web sites provided just so I can try to understand the whole process.

Congratulations!

Jackie

Thank you all for your comments. Following are some of the answers I hope! :-)

Richard,

Please check out the link provided by PC for causes and remedial action regarding hyperaldosteronism. This explains it far better than I ever could. The solution to the problem is either unilateral adrenalectomy or medications such as ephlerenone depending on what the CT scan shows.

Sorry, my 1998 hair analysis did not include tin levels.

John

If you have periodic afib episodes I would track down a doctor who will order the 2 tests - plasma renin and bicarbonate. They are simple and relatively inexpensive.

James D,

No, I am not drinking Waller water and have not been doing so for at least 6 months.

ANP is only released as a result of non-laminar, ie. chaotic flow so would not be released in appreciable amounts when the heart is beating normally. The nephrologist whom I am working with, and I respect him highly, agrees that the periodic release of ANP may indeed help ward off hypertension. He did research on ANP early in his medical career.

Mike F,

The initiation of an afib episode requires 3 conditions to be met:

- * An oversensitive heart tissue;
- * A dysfunctional autonomic nervous system;
- * A trigger.

I believe the oversensitive heart tissue could be caused by an aldosterone and/or cortisol excess in any afibber whether vagal or adrenergic.

Adrenalin (epinephrine) is made in the inner part of the adrenal gland (medulla) whereas aldosterone and cortisol are

made in the other part (cortex). Having a normal adrenalin level would have no bearing regarding the normality or otherwise of your aldosterone/cortisol production.

Fellow afibbers,

In conclusion, if I experienced periodic episodes (which I do) I would run, not walk, to the nearest doctor who would order the plasma renin and bicarbonate tests.

Hans

ANP is only released as a result of non-laminar flow so would not be released in appreciable amounts when the heart is beating normally.

Hi Hans, that's not my understanding, ANPs primary aim is to defend against excess Na/water retention. The primary trigger is atrial stretch due to increased blood volume. I don't believe it's evolution has anything to do with irregular rhythms.

Would you have expected a lower reading of Na on day 2 if the ANP released in AF was ditching significant quantities of Na? (or would another test on the day of AF be required to see this drop?)

Have you done much research into how you go about fixing hyperaldosteronism? I hope you've moved the goal posts to an easier playing field :)

All the best

--

James D

James,

I guess I could have expressed it better. What I meant is that the amount of ANP released in the normal "tug-of-war" with aldosterone in the control of blood pressure under normal conditions is insignificant compared to the amounts released during an afib episode; witness the frequent trips to the toilet during the early stage of an episode :-)

I think you would need to do several tests on the actual day of the episode to follow the Na excretion accurately and I don't think the medical system here would have been too keen on supporting a research project of this nature.

Hyperaldosteronism (aldosteronism, Conn's syndrome) is usually associated with a benign tumor on one of the adrenal glands, an enlargement of one adrenal gland (unilateral hyperplasia) or enlargement of both adrenal glands (bilateral hyperplasia). Hyperplasia is usually related to long term stress. The usual treatment involves surgical removal of the gland with the tumor or medication in the case of hyperplasia.

I do believe that aldosteronism is easier and less dangerous to cure than is atrial fibrillation as such and what is more, dealing with the aldosteronism deals with the cause not the symptom. I would find it very hard to justify an ablation now that I know that the problem lies with my adrenal glands. That is why I urge everyone with periodic afib to have two simple blood test - bicarbonate and plasma renin. It just does not make sense to have a PVI, which may or may not be successful, if the real problem lies elsewhere and is likely to show up in some other way even if the PVI is successful.

Hans

Hans,

I'm VMAF my episodes tend to be very periodic, around 2 weeks. And yes I can tell they're approaching and feel momentarily cleansed after an episode. Two years ago when I was diagnosed with AF I was taking 200mg. Toprol &

80 mg. Accupril a day for high blood pressure. At the time I was diagnosed, my blood pressure readings were beginning a steady decline. I've been off blood pressure meds for over 1 year now & it's not uncommon for me to have readings as low as 95/55 I used to be 130-135/85-95 while on medication. I attribute my lower blood pressure to supplements for AF. CoQ10, magnesium, taurine, L-carnitine and fish oil. (But I sometimes wonder if something else is going on with my BP) Do you think hyperaldosteronism is something I should check into considering my low blood pressure readings?

Wayne

This is the first time I have posted on this site, but I have dipped into it from time to time and found it very helpful. I am posting now because my experience seems relevant to this topic.

I was diagnosed with AF some 2.5 years ago at the age of 50 and was cardioverted after 7 days in AF, which restored me to SR. 3 months later I had a recurrence and was put on Sotalol and warfarin. Initial tests did not show underlying heart problems or high blood pressure. I remained in SR for 6 months but then had another episode of AF, which converted spontaneously after about 4 hours. Thereafter I had recurrences at 3 monthly intervals, which woke me from sleep at around 3am and which converted in about 4 hours. There was no obvious trigger to any of these episodes.

Meanwhile I was having occasional episodes of high urine production and faster heart rate for a few hours, which were not associated with AF. My GP referred me for an ultrasound scan, which showed a kidney growth. A subsequent CT scan also showed an adrenal adenoma. As I have private medical insurance I was referred to an endocrinologist (Professor Monson, Barts hospital) who arranged a series of tests which required me to be a hospital in-patient for three days. These included urine collection, blood tests at all hours of the day and night and ultimately taking a low dose steroid for 48 hours to find out if my cortisol levels could be depressed, and thus be produced normally rather than by the adenoma. These tests all proved negative and I was told that my adrenal adenoma was not producing any hormones.

Interestingly 36 hours after taking my last steroid tablet I had an AF episode, one month early, which did not spontaneously convert after a few hours. I went to A&E after 36 hours and was converted by means of intravenous Flecainide, although my heart rate stayed high at around 100bpm (it had been around 150 in AF and is normally around 60 bpm). It returned to normal once my (private) cardiologist took me off oral flecainide later that week and I reverted to taking Sotalol (80mg twice daily). On reflection, I wonder whether this episode was some kind of rebound effect, with my cortisol perhaps overshooting normal levels?

Since then I have had just over a year free of AF, although I cannot explain why this should be. I started Mg supplementation just before the hormone tests, and have been taking Irbesartan for nearly 2 years, as I had been shown to have a slight enlargement of the left ventricle. Perhaps one or the other has had some effect - who can tell?

Carolyn

London, UK

That is great news Hans!

To have test for Bicarbonate and Plasma Renin, is there certain day of the month test should be done? If so, could you please give us details what day of the month is good to have it done.

Since PVA, I do not have afib but I do have premature beats and would love to have the test done. Now I have to convince my Dr to agree which will be challenging.

Thanks for sharing your finding with us!

Mira

Mira,

I really don't know if the tests would be meaningful if you do no longer have periodic afib episodes my guess would be that they probably would not. However, if you want to have them I would suggest you have them when your PACs are particularly bad. Preferably around 9 am.

Hans

Anyone subscribe to *The Lancet*?... This came up in a search but there's little detail...

Correspondence - Conn's syndrome and atrial fibrillation
M. Porodko, J. Auer and B. Eber

http://www.sciencedirect.com/science?_ob=GatewayURL&_method=citationSearch&_uoikey=B6T1B-438KFM9-1T&_origin=EMFR&_version=1&md5=26b2be125d9bf1cfe26f255f3119d981

(<http://tinyurl.com/2wtap>)

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James D

James,

I have read the article on Conn's syndrome and afib in *The Lancet*. I have scanned a copy of it and have sent it to you by e-mail. I have also sent you a copy of an abstract of an article by Slovak researchers on the same subject. The names of the attachments are:

Conn'spage1.pdf
Conn'spage2.pdf
Conn'sSlovak.pdf

The Austrian researchers found a connection between paroxysmal atrial fibrillation and Conn's Syndrome (hyperaldosteronism). The atrial fibrillation episodes ceased after unilateral adrenalectomy.

The Slovak researchers describe an association between Conn's Syndrome and lone atrial fibrillation.

Hans

Hello All,

This was quite an interesting case study of a man with AF and a very small benign tumor of the adrenals. You might want to read.

<http://www.tarka.ch/dt/science/casestudies/case011.html>

Richard

Hans,

Prior to a bad episode, (all episodes are bad), I mean the frequent urination producing ones, I too feel like something building up inside and it's a really bad feeling. These I refer to as 'full blown' afib attacks. The ones that takes me down. Not just the light headed kind. Other times I am in afib although quite uncomfortable and feels bad too, but not as bad

like the attacks that start with 'something building up inside me' attacks feel.

So it's sometimes I have that terrible feeling and other times it's just a bad feeling with afib. What I'm trying to say is the 'building up' feeling leads to the most devastating, lack of a better word, feeling attacks. Not just a light headed feeling but feel like I'm going to pass out in spite of or regardless, shortness of breath, etc.. There's no getting up and walking around. I'm down for the duration. It's urinal time instead of walking to the bathroom in the adjoining bathroom.

However, I never can predict how often I will have an attack. The attacks I have always had are indiscriminate, happen anytime and anywhere without prior warnings.

I have thought over the years that the attacks were adrenaline related. Only recently, February 20, a visit with my EP, he said the word 'adrenergic'. I had never heard him or any other cardiologist or EP say the word adrenergic.

Glenn Camp

James,

This may be the same link that Hans has emailed to you, but I found this link, where you have to register, but it's free.

<http://www.thelancet.com/journal/vol357/iss9264/full/lan.357.9264.correspondence.15928.1>

Richard

Glenn,

I would think that before you have a PVI, that you get these tests done, that Hans recommends. It certainly can't hurt. Also tell them you want a scan of your kidneys. Really force the issue, even if you have to pay out of pocket.

Richard

Thanks for the email Hans (and thanks for the link Richard- *The Lancet* site says it's having difficulties at the moment but it's useful info).

Is there a persuasive argument to take the test even if you don't have hypertension (even mild hypertension) or hypokalaemia?

--

James D

James,

I had similar questions, with a few extra ones thrown in. Normally my BP is normal, but on occasions, it has been elevated to the 140/90 area. (Last test at the EP's office was 90/60, but was on Toprol at the time). My saliva cortisol test indicated elevated cortisol at noon and midnight. My intracellular K level was normal, with a result of 90 and ref range of 75.6-95, but would flecainide distort such readings??? The hospital tests I had for serum K levels, on several consecutive days indicated to the low side. Ex. ref range 3.7-5.2, results 4.0, 3.7, 3.8, 4.2. I was not on flec at this time.

My questions. Hans, did you have elevated BP or did it fluctuate, if known? Does anyone else have the occasional bout of elevated BP or hypertension? Has anyone had their cortisol levels checked, and if so what did they indicate? Should it have been normal prodical to have the tests you recommended, Hans, or would these tests only be given if K levels were below normal? Would it be advisable to go to an endocrinologist?

This is all very fascinating, and I do indeed plan on taking the avenue of getting these tests done. Thank you, Hans and PC, for all you have both done in making us aware of this issue!!! :-)))))) This may not be a problem with me, but it will certainly answer more unanswered questions. I have had a scan of my head, so why not the kidneys? Shoot, why not the whole body?????

Richard

Hans,

Your continued dogged determination in pursuit of the cause of LAF is most admirable. I think that sentiment is absolutely universal amongst those who visit the BB and the CR.

Given the stated hypokalemia connection in the article on Conn's Syndrome and LAF (thank you Richard for the link), I think the inflammation connection in true LAF is less persuasive. I found it interesting that "interval potassium concentrations were within the normal range" in their patient. Indeed the ANP secreted during the episode probably rapidly rectifies this hypokalemia, making it even more difficult to establish the hypokalemia connection. The adrenal cortical tumor or hyperplastic cortical tissue must pulse out aldosterone and cortisol, i.e., secretion is not steady state. What better stimulus for this than periodic stress.

I personally feel that this accelerating association makes prolonged increased aldosterone secretion in poorly hydrated endurance athletes with VMAF a more significant suspect. In fact I would love to hear from any VMAFers out there that pursued endurance sports for years that can unabashedly state that they always drank eight 8 oz glasses of water everyday and much more on days of such activity.

This aldosterone/cortisol connection with LAF and its apparent hypokalemia mechanism further underscore the importance of magnesium, which is absolutely vital in maintaining intracellular levels of potassium. The gradient between K⁺ within the cell and that outside the cell is 40:1, for Na⁺ it is 1:13, for Mg⁺⁺ it is 3:1 and for Ca⁺⁺ it is 1:25,000. Mg is required to maintain all of this.

PC

Richard and James,

Aldosteronism is most often, but by no means always, associated with hypertension. It is not likely that it would be tested for unless you have high blood pressure and a very competent and caring nephrologist handling your case. However, if the hypothesis (The Play) is correct then periodic afib episodes is precisely what would prevent the development of permanent hypertension.

My blood pressure does vary from day to day but I do not have, even periodic, hypertension and only had the tests because I finally found a competent nephrologist who was interested in the possibility of an association between aldosteronism and LAF.

Please review my test results carefully if you have not already done so. They can be found at:

www.afibbers.org/results.pdf

For your information my mid-morning blood pressure on the three testing days was 129/77, 120/80 and 130/84.

You'll see from my results that my cortisol and aldosterone levels were abnormally high just before the episode while plasma renin decreased throughout the afib-free interval and was 0.00 the day before the episode. You can't get much lower than that :~)

If you have afib episodes at regular intervals I again urge you to have the two simple, preliminary blood tests done (plasma renin and bicarbonate). There is much to gain and absolutely nothing to lose. An endocrinologist or a nephrologist would be preferable, but I am sure your family physician could order the tests as they are quite routine.

Hans

Richard

I have already degenerated past the point of continuing to try new approaches. Time is a factor now and I am already 68. I would recommend anyone that is still in good enough physical condition to do that. There has to be a cause for afib. I have yet to read of a complete cure through ablation. A few have claimed complete cures of all arrhythmias through maze surgery. All I read about those who have had ablations are still having some different types of beats, ie ectopic beats, afib cured but now pac's, etc.. I don't know how dr's claim high rates of 'complete' cures. Maybe the success stories are not posted as much as the ones who still suffer have posted.

Oh btw, I have CT scan's of kidneys and urinary tract done once a year because of tumors in the past.

Glenn

If one has episodes every 2-3 days like I do, would that make me a good candidate for testing due the increased number of afib events, or a bad candidate because their is virtually no period of relative calm? Or does it even matter, Evaluate the tests on an individual basis??

Man I've got to get a new doctor. It was hard enough getting tests for CRP homocysteine and ferritin out of him. You'd think he was paying for them himself.

Would a permanent afibber be in a perpetual state of hyperaldosteronism?

Adrian

I'll try reposting this again - IF I can remember the gist of it!!

My BP ranges 120/70 - 150/90, so I'm periodically hypertensive, and my serum K is mid-range. I'm assuming that I could still have a significant degree of hyperaldosteronism??

Hans, how have your own serum K values been recently? Can an excess of aldosterone and too little renin lead to hyperaldosteronism even WITH normal serum K values??

Lastly, I do find it hard to believe that many AFrs will have significant enlargement and/or albeit small benign tumours/growths. I'm accordingly assuming that it is possible to have adrenal glands which scan as normal and still have a degree of hyperaldosteronism to precipitate AF?

TIA,

Mike F.

Hi Mike,

Just a small point. As I understand it, aldosterone's job is to keep hold of Na and water (and it will ditch K) - so I think with too much aldosterone you'd become hypokalaemic - not hyper (i.e. low potassium). I believe this hoarding of Na and water would also produce this blood pressure rise I keep on asking about :) Aldosterone's counterpart would be

ANP (which ditches Na and water) - which is why he thinks the ANP release is beneficial in restoring the Na/K balance once AF starts.

I'm assuming that Hans thinks it's this low potassium rather than aldosterone levels that is what's causing the heart problem?? i.e. even though the low potassium is a secondary problem because of the hyperaldosteronism it's this secondary problem which is causing the AF.

If you look at Hans' results.pdf I think his potassium levels would be classed as low-normal (not even sure it would be classed as hypokalaemia??)

Hans, am I correct in thinking you believe your low normal K and high normal Na is what's causing your heart trouble (plus a predisposition to be sensitive to the balance of Na and K) and that fixing hyperaldosteronism would raise the K a little and drop the Na a little bringing them more into balance and making AF less likely?

James D

James,

I know we've had this discussion before, but it's my understanding that the secretion of ANP, unlike that of aldosterone, is not directly related to Na⁺, except insofar as stretch receptors in the atria are stimulated by hypervolemia (increased blood volume). Fibrillating atria that can't push blood through to the ventricles become slightly enlarged and the resulting stretch of atrial myocytes triggers these receptors.

PC

Hi PC,

Yes, I agree ANP release comes about because of atrial stretch. I think Hans's argument though would be that this has a beneficial effect of Na loss which, to some extent, compensates for the K loss from the aldosterone (It's the counter part to aldosterone in Hans's play rather than physiologically speaking?). I'm sure Hans will speak up if I'm putting words into his mouth :)

In AF's case I don't believe the ANP release is necessarily due to hypervolemia but rather the poor haemodynamics of the heart cause atrial stretching and trigger the release of ANP under false pretences.

Personally, I still believe the ANP released during AF is a red herring and is throwing us off track. I'm still unable to suggest another track though :)

--

James D

James,

100% agree.

PC

PC

What do you mean by "periodic stress?"

Carol

Wayne,

Yes, I think it may be worthwhile to check your renin and bicarbonate levels seeing that your episodes occur at regular intervals. Not all patients with hyperaldosteronism have high blood pressure.

Hans

Carolyn,

Thank you for sharing your afib journey. It is hard to say whether it is the magnesium or the irbesartan that has helped. If you were magnesium-deficient then the Mg may certainly have helped but it is also quite possible that the irbesartan (Avapro) could have helped keep you in sinus rhythm longer. Particularly since you may have some RAAS (renin-angiotensin-aldosterone-system) issues. As you say - who can tell :-)

Hans

James,

There is ample evidence that ANP levels in the heart during afib is higher than during normal sinus rhythm. Researchers at the Mayo Clinic found that afibbers had a 60% higher level of ANP when in afib as compared to when in NSR.

Italian researchers measured the actual ANP production in the heart during afib and found that the more ANP was produced during the episode the quicker it terminated.

I don't think there is any doubt that ANP plays an important role in terminating afib episodes and that more is produced when the heart is fibrillating.

Hans

James,

I believe a high aldosterone/cortisol level is detrimental for several reasons.

It causes inflammation and fibrosis of the heart; it disturbs the ANS balance; it increases the production of reactive oxygen species; it decreases NO production and causes loss of potassium and magnesium. A very bad actor indeed.

So, I believe that excessive exposure to aldosterone makes the heart tissue more irritable and sensitive and thus a much easier target for a hypokalemia-induced afib episode.

I think fixing the aldosteronism would achieve two things:

Eliminating the above-mentioned bad effects of aldosterone and thus make the heart less sensitive to triggers, oxidative stress and electrolyte imbalances.

Bringing the K/Na ratio back to a more desirable level and thus as you say, make an afib episode associated with electrolyte imbalance less likely.

Hans

Adrian,

I really, really need to emphasize that I do not for one moment believe that aldosteronism is the only underlying cause of LAF. I am by now convinced that there is no single cause of LAF, in other words, no "holy grail". Lack of magnesium, hyper- and hypothyroidism, pheochromocytoma, electrolyte imbalances, binge-drinking, glutamate sensitivity, pesticide exposure, et., etc. are

all either clinically proven or highly likely underlying causes of LAF. I think what it boils down to is that we each need to find our own specific underlying cause and deal with it.

What I do believe is that afibbers who have episodes at such regular intervals that they can pretty well predict when they are going to happen may have a problem with a gradual build-up of aldosterone and/or cortisol. This would eventually result in hypokalemia and an afib episode. I don't know whether aldosteronism may also be the underlying cause of non-regular, non-predictable episodes or indeed of permanent afib. If I had to guess, my guess would be "probably not".

Hans

Mike,

Please see my answer to Adrian. I do not believe for one moment that aldosteronism is the underlying cause of ALL afib, but I do believe that it may be for afibbers who have episodes at such regular intervals that they can pretty well predict when the next one is going to hit.

Neither high blood pressure nor an abnormally low serum potassium level are required for aldosteronism to be present. At least 20% of patients with aldosteronism have low normal levels of potassium. My own level usually runs at 3.5-3.7 vs the normal range of 3.5-5.0 mmol/L ie. low normal.

The most important marker of aldosteronism would seem to be an abnormally low renin level combined with a normal or elevated aldosterone level. Potassium levels can be normal.

Do a significant number of afibbers have enlarged adrenal glands or a small tumour on one gland? Good question! LAF is usually treated by cardiologists not by endocrinologists or nephrologists. I am quite sure that if we did a survey for the purpose of finding out how many cardiologists or EPs had ordered a renin/aldosterone test for their patients before resorting to medications or ablations we would find that none, zero, zilch, nada had done so :~)

I don't know just how enlarged or "tumourized" the adrenal glands would have to be for the abnormality to precipitate LAF, but I fully expect that someone will determine this within the next 10 years or so.

Hans

http://merck.praxis.md/index.asp?page=bpm_brief&article_id=CPM02EN315

(Merck Medicus, a website of Merck & Co.)

"Management Highlights":

- Primary aldosteronism (PA) is characterized by spontaneous hypokalemia on a normal sodium diet or severe diuretic-induced hypokalemia.
- The differential diagnosis of PA includes adenoma (60%), hyperplasia (40%), and glucocorticoid-remediable aldosteronism (GRA).
- GRA is characterized by autosomal dominant inheritance and hypertension diagnosed in the first two decades of life.
- The mutation causing GRA has been discovered, allowing for direct genetic screening for this disorder.

Also, in the column on the left side, select the full article "Primary Aldosteronism":

"Primary aldosteronism occurs in approximately 1% of unselected hypertensive patients. Because of the escape phenomenon (the absence of continued sodium retention with prolonged mineralocorticoid administration), these patients seldom have edema, but most have signs and symptoms of hypokalemia, their most common distinguishing feature....."

Erling

Erling has pointed out a very important piece of information wrt chronic hyperaldosteronism. His reference hyperlink mentions: "the escape phenomenon = the absence of continued sodium retention with prolonged mineralocorticoid administration" Could this also happen in those with poor hydration habits?

The escape phenomenon suggests that some kind of refractory state develops, a kind of aldosterone resistance. Higher levels of aldosterone are required to maintain proper Na balance. So just how does this work?

Na⁺ and K⁺ are exchanged 1:1. If Na⁺ isn't increased, i.e., no edema, then K⁺ cannot be decreased. What then is the mechanism? I believe the following article might lend some insight into this. The link from which it was lifted (www.barttersite.com) appears to be no longer operational.

Magnesium and potassium-sparing diuretics.

Ryan MP

One of the most common and serious side effects of diuretic therapy is increased urinary loss of K. Another, although less well publicized, side effect of diuretic therapy is excessive urinary loss of Mg. In examining the effects of diuretics on Mg and K metabolism, the following factors should be taken into account: site of action and duration of action of diuretics, duration of treatment and dosage used, concurrent drug therapy, underlying disease conditions and dietary intake of Mg. Diuretics acting in the proximal tubule tend to have only minor effects on Mg excretion. Loop-blocking diuretics, however, cause major urinary losses of Mg. The Mg-wasting effects of loop-blocking diuretics have been demonstrated in large numbers of experimental and clinical studies, and the findings are consistent with micropuncture studies in laboratory animals which indicate the loop of Henle as the major site of Mg reabsorption. The effects of thiazide diuretics on Mg excretion are less well established than those of loop-blocking diuretics. Experimental studies demonstrate that thiazides have little or no direct effect on Mg transport in the nephron. However, some clinical studies indicate that thiazide treatment may induce Mg loss. This may be secondary to alterations in the renin-angiotensin-aldosterone system and in the calcium and parathyroid hormone and may be contributed to by concurrent drug treatment and the underlying disease conditions. K-sparing diuretics are usually administered concomitantly with more potent diuretics to counteract diuretic-induced K depletion. These agents act in the late distal tubule and collecting duct. Evidence has accumulated in recent years indicating that these drugs may also exert some Mg-sparing properties. Experimental and clinical investigations from our own laboratories and from other investigators will be reviewed. In animal studies, a dose-response relationship has been established for the actions of amiloride in reducing fractional excretion of Mg and K during furosemide-induced diuresis. The effects of amiloride on Mg excretion are less than those on K excretion, and this is compatible with the different handling of K and Mg in the distal tubule and collecting duct. The effects of aldosterone antagonists on Mg excretion are less well established than those of amiloride. Some recent studies indicate that converting-enzyme inhibitors may also influence Mg and K metabolism. The Mg-sparing actions of drugs may have important therapeutic implications.

Magnesium 1986;5(5-6):282-92

This is all a bit complex, but there appears to be some connection between Na⁺ reabsorption and Mg⁺⁺ secretion/excretion independent of K⁺, blocked by some K sparing diuretics. Hans has pointed out that elevated bicarbonate levels are one feature of hyperaldosteronism. We know that in order to maintain electrical neutrality bicarbonate secretion/excretion in the urine to lower bicarbonate blood levels is accompanied by K⁺ and/or Mg⁺⁺ secretion/excretion in the urine. And if Mg⁺⁺ levels are low/low normal than so will be K⁺ levels.

I've always felt that Hans was right on the money with the aldosterone/cortisol association with LAF. It's just that I've felt that the electrolyte connection was much more significant in its genesis than the inflammation connection. The latter is just too broad an assault on the heart to be implicated in something as specific and delicate as LAF.

Also, for those of you interested in the pesticide connection the following article might provide some interest.

Magnesium Deficiency In Patients With Chemical Sensitivity

<http://www.aehf.com/articles/A27.htm>

Please note the association with low back pain, of which there seems to be an epidemic. My low back present for at least two decades, requiring complete withdrawal from running for ten years, has been slowly but completely eliminated over the past 6 months to a year. My really bad plantar fasciitis is completely gone, despite running 30 miles a week times many months. I have no idea whether this is due to Mg supplementation or something else, e.g., Vitamin B6. The latter is strongly associated with carpal tunnel syndrome, another kind of fasciitis.

PC

For anyone really interested in the deep background on hyperaldosteronism I can highly recommend the link suggested by PC:

<http://www.endotext.org/adrenal/adrenal23/adrenal23.htm>

Hans

Thanks for the comments Hans - it does sound like aldosterone is a multi headed beast!

I've no doubt at all that ANP is produced during AF (and produced in abundance). My doubt is whether it's being produced for the purpose it was designed.

I accept that in the scenario you describe ANP production may even be beneficial but I put this down to happy coincidence rather than grand design.

Like you, I also believe there is no single cause of LAF. It's not inconceivable that some folk out there have LAF that is caused by low Na levels. I still think ANP will be produced during their AF episodes but the outcome may not be quite so helpful.

I think ANP is being produced secondary to the AF rather than in an attempt to restore sinus rhythm.

So I believe our difference of opinion is to whether ANP plays an important role in terminating afib rather than whether it's produced during AF.

--

James D

Thank you PC, for that info, and for sharing the chemical sensitivity site. I found this portion of interest:

Some interesting facts came to the forefront as we further considered this group of patients. It appeared that serum and red blood cell measurements of magnesium may not reflect a true state of magnesium depletion unless it is extremely low. Further, if serum levels fell within the "normal" range, a depleted state may still be a possibility. This was in agreement with the World Conference on Magnesium (1985) consensus that the best way to define deficiency was by magnesium challenge.³¹

Maybe a Mg challenge test is in order, so I can truly get to the bottom of this.

I'd like to share some recent observations about myself. I was taking 500mg of taurine, before Jackie's post, and upped that to 1000mg per day. I changed from Mg glycinate to taurate, but am only taking 1 cap per day, which gives me 125mg of Mg. I added Concentrace trace mineral drops, to cover all the trace minerals, and this includes 1.5 mg of lithium and 250mg of additional Mg per day. I started feeling as if something changed, that's really hard to put into words, but my heart started beating more steadily throughout the day and night. I hardly notice any skipped beats or whatever it was that my heart was doing before. I went out of rhythm for 10 mins. only when I took 500mg of arginine, so I ceased that after the first day. I might add here, that my amino recommendation from Great Smokies did not include arginine. In the last week, my eating habits have left a bit to be desired. For matter of convenience, a birthday celebration, and my schedule, I found myself eating out more often. That included a couple of hamburgers, some fried fish, a subway sandwich, with a few good meals thrown in, between. I have not noticed any problems whatsoever, which is highly unusual. I've even had a few desserts. I might add, that I've upped my digestive enzymes, which includes Metagest from Metagenics, (betaine HCl, pepsin (porcine), genetical root), Azeo Pangen Extra Strength from Metagenics (protease, lipase, and amylase - high amts) and DigestZyme from Transformation (amylase, protease, lipase, cellulase, invertase, malt diastase, lactase, w/probiotics). I was taking enzymes before, but started including all three with each meal. I do try to eat a handful of nuts per day for more Mg, but was doing this all along.

Anyway, I'm not for one minute beginning to believe that I can go back to my old ways of eating, but I do find it of interest, that a few bad meals thrown in from time to time, are not affecting me presently. Because I have done higher doses of taurine and digestive enzymes before, I have to say, by a gut feeling, that is has to do with the ConcenTrace minerals, but it's hard to know for sure. I'm still on flec., but I'm feeling great.

I've also got a call into my EP, to get the biocarbonate and renin test, as well as a CT scan. We'll see.

Thanks, PC.

Richard

Richard,

I have suspected for some time now that true LAFers' overall problem with magnesium deficiency is only partly due to low intake. I believe the aldosterone connection may be causing us to not only lose K⁺ but also Mg⁺⁺. We're urinary magnesium wasters because of the aldosterone induced elevated blood bicarbonate. Our serum K⁺ hovers near the lower limits of normal and we have a problem maintaining intracellular homeostasis, especially at times which further compromise this, e.g., postprandial alkaline tide, hypoglycemia, stress,.... Despite 800+ mg of elemental Mg⁺⁺ for well over a year, my intracellular Mg⁺⁺ has hardly improved and remains right at the lower limit or normal. I have to be wasting it in my urine.

So, Richard I'd stick with that gut feeling on the minerals.

PC

PC,

I think you are right on with the urinary K and Mg wasting. Right after an episode my urinary excretion of K was 2.4 g/day and that of magnesium 178 mg/day. However, 11 days after the end of an episode (1 day before the next episode) my daily K excretion was 3.7 g and the Mg excretion was 230 mg. Over the same period my blood level of Mg went from 0.94 mmol/L to 0.87 mmol/L while my blood level of K fell from 3.6 mmol/L to 3.5 mmol/L. I guess that it is possible that the intracellular levels were similarly affected.

Hans

Hans,

That's most fascinating.

There was urinary K⁺ and Mg⁺⁺ wasting despite dropping blood levels of both. Low blood Mg⁺⁺ and K⁺ have no dedicated hormone to watch over them at such times, unlike Ca⁺⁺, which has parathormone, and Na⁺, which has aldosterone.

According to Dr. Durlach

"Vitamins B6 and D, insulin (either directly as an ionophoric hormone or indirectly as a hormone that stimulates hepatic and renal hydroxylations that activate vitamin D) and perhaps taurine are capable of increasing the cellular level of magnesium. These hormones and vitamins moreover represent at present the only "magnesium fixing" agents that are available to us. In the opposite manner, adrenalin, perhaps by beta stimulation, reduces the level of magnesium in the cell."

He also states that PTH and insulin also play a role in Mg homeostasis by increasing cellular uptake.

Perhaps there is some yet to be fully delineated relationship between insulin and magnesium that might explain the absence of diabetes and the prevalence of hypoglycemia in LAFers.

As you know, I was initially reluctant to take Vitamin D, because I was concerned that it might increase Ca⁺⁺ absorption more than Mg⁺⁺ absorption. But for the last three or four months I've been taking 400 IUs of Vitamin D (as D3). According to Mercola and many other experts, Vitamin D is the most commonly deficient vitamin.

PC

Hi Richard,

While you are having your vein punctured anyway why not get a test of your DHEA or DHEAS level. I have a feeling the results could be most instructive.

Hans

Hans,

I'll do that, and if there are any other tests you can think of, pls. let me know.

Thank you,

Richard

Richard,

The "Cadillac" of course, would be to have all the tests I had; but that may be a bit premature. You could also just add blood cortisol and aldosterone (at 9 am), but these tests are fairly inaccurate compared to the 24-hour urine samples.

Hans

Here's a study on dogs and the RAAS system that may be of interest.

http://www.vspn.net/Library/Journals/VSPN_AbstractOWeek080902.htm

Richard

Very interesting, Richard. I saved it and will study it more closely but right now it has left me with an uncomfortable feeling.

John S.

Just to contribute to the excellent current debate - albeit in a small way, my last blood work (Nov 03) showed serum K of 4.3 (low-mid-range) and, perhaps more significantly, serum bicarbonate of 28 (almost top of range).

Mike F.

Hi PC,

You mention that Ca++ has parathormone to "watch over it". Well, my parathormone clearly is not that great a watcher; my blood level of calcium was 2.14 mmol/L right after the episode and 2.02 mmol/L just before the next episode - both below the normal lower level of 2.15. As a matter of fact, my calcium levels are generally below normal. Also, my phosphorous at 0.74 mmol/L was below the normal lower limit of 0.80 on the day before the episode. Are these further clues?

Hans

Hans,

My testings in the hospital indicated below range Ca, as well as somewhat low Pho, too, back in Jan 03. This was my last time in the hospital. The Dr. Gonzalez article stated this meant the sympathetic nervous system was suppressed, FWIW.

Richard

Hi Hans,

I lifted the below from the exatest website at

<http://www.exatest.com/PDF%20Files/19.%20INTERPRETAION%20GUIDE%202001.PDF>

LOW CALCIUM

Deficiency of cellular calcium may be expressed with symptoms of peripheral numbness, brittle fingernails, fragile bones, cardiac palpitations, hypertension, insomnia, CNS irritability leg and muscle cramps, osteomalacia, osteoporosis, and periodontal disease.

There is evidence that low tissue calcium contributes to PMS, and muscle flaccidity. Cardiomyopathic heart tissue appears to have diminished concentrations of calcium.

True decrease in the physiologically active Ca⁺⁺ occurs in many situations, including hypoparathyroidism, vitamin D deficiency, chronic renal failure, MAGNESIUM DEFICIENCY, prolonged anticonvulsant therapy, acute pancreatitis, massive transfusion, and alcoholism.

LOW PHOSPHOROUS

Low levels of cellular phosphorous may be caused by low dietary intake, malabsorption, and hypoparathyroidism. The malnutrition effects seen in alcoholics may occur following 2-4 day of hospitalization due to decreased levels of ATP in red cells, causing less oxygen to the vital tissues. Diarrhea, vomiting, MAGNESIUM DEFICIENCY or use of aluminum-containing antacids may deplete phosphorous. Anorexia, dizziness, bone pain, muscle weakness and waddling gait along with rises in serum creatinine kinase might indicate muscle injury along with myopathy.

Hypophosphatemia can also be seen in a variety of biochemical derangements, including, sepsis, HYPOKALEMIA, malabsorption syndromes, and hyperinsulinism.

Hans, my intracellular P was also very low, right at the lower limit, on two intracellular measurements. I think it all fits in very nicely with your hyperaldosteronism explanation secondary to low K and Mg, presumably wasted in the urine.

This is double trouble, since hypokalemia is notoriously difficult to correct in the face of magnesium deficiency. Until both are corrected, phosphorus can't be.

My advice is to continue with Vitamin D and stay away from the bottle.

PC

Just to contribute to the excellent current debate - albeit in a small way, my last blood work (Nov 03) showed serum K of 4.3 (low-mid-range) and, perhaps more significantly, serum bicarbonate of 28 (almost top of range).

My intracellular Ca (RBC) was right at bottom of normal range when tested one year ago (along with Mg). Adding this to my high serum bicarbonate (almost top of range 11/03)..... maybe something of a picture is starting to emerge. And it's looking like more than a few of us might well be lacking Vit D. Great stuff guys.

Mike F.

Mike,

Regarding human vitamin deficiencies, Vitamin D outranks them all.

My comment about "staying away from the bottle" was a joke.

PC

I think this is quite brilliant. Although I have been free of afib for 15 months, since maintaining a regime of Mg and K supplementation, I do have regular periods, roughly 3 weeks apart, in which I notice an increase in PACs. This increase lasts for a period of several days, less than a week I think, before I once again become nearly PAC-free. I also have an elevated stress response, a low startle threshold, and so forth, which, I am convinced, are the result of a childhood trauma (which, often diagnosed as post traumatic stress disorder, produces this symptomology). In other words, I fit this picture pretty well, too. This explanation also fits well with the common medical observation that afib is precipitated by stress.

Michael in SF

Hans or PC,

Is this excerpt correct?

Aldosterone regulates the blood pressure, at the request of the kidneys, and maintains the sodium/potassium ratio by releasing excessive potassium. If the kidneys can't recruit enough aldosterone to maintain the blood pressure they need for optimal function, the pressure drops, and potassium accumulates. On the other hand, if the adrenals are experiencing high stress, they will send out too much aldosterone along with the excessive cortisol, and this raises the blood pressure and eventually causes potassium depletion, resulting in edema.

<http://www.balancingcenter.com/articles/allergies3.html>

Thank you,

Richard

Richard,

Sounds more or less correct to me as long as it is understood that the blood pressure does not necessarily reach the hypertensive region and that edema does not necessarily show up as visible fluid accumulation. In other words in the case of the aldosterone hypothesis and LAF we are talking about changes that would probably be considered subclinical.

Hans

Thank you Hans. I still am awaiting a call from my EP, so I'm giving up and calling an endo. myself. For insurance purposes, I'm really feeling a pain in my kidney here lately.

I'm still trying to find out and understand what the ion gap test is. I just realized that my renal/hepatic test done in Dec.

03 showed below ref range, like in Jan 03. Does anyone know if the anion test is the same as the ion test?

Thank you,

Richard

Richard,

The only "ion" gap with which I'm familiar is the anion gap. It's not really a test, but a calculation based on test results. When I was in medical school, it was defined as

Anion gap = (Na + K) - (Cl + bicarbonate) (all units mmol/L)

The following websites may provide more detail on this.

<http://www.fpnotebook.com/REN56.htm>

http://www.qldanaesthesia.com/AcidBaseBook/AB3_2.htm

PC

PC and Richard,

My anion gap, based on my recent test results was 8.6 right after an episode and 12.5 just before the next episode - whatever that means. :~)

Hans

Hans,

Looking at your anion gap, the difference is due essentially to a lower HCO₃⁻ just before the next episode.

Hyperaldosteronism is supposed to cause metabolic alkalosis because H⁺ ions are secreted/excreted by the renal tubules. Blood bicarbonate (alkalosis) is increased as a result of this.

If elevated levels of aldosterone between episodes were causing a metabolic alkalosis, then it seems to me that HCO₃⁻ should be gradually increasing as one approaches the next episode. This should result in a decreasing anion gap (increasing HCO₃⁻) and not an increasing one as described.

But what do I know? I don't know why aldosterone causes excretion of H⁺.

PC

My hospital records show it being called an ion gap, but I'll assume it's the same as the anion, until I can converse with my EP. Anyway, my results back in Jan 03, when admitted to the hospital out of rhythm were 12 upon admission, dropped to 4 on the second day, (that's a big drop) but I was cardioconverted the day before, and then went to 5 on the day of release. In May 03, when going to visit the EP to be put on heparin and coumadin, after returning to NSR after 1.5 mths., using flec. myself to convert, was 7. I had been in NSR for 2 days prior. Then in Dec 03, on a regular visit, with no problems, my test was 4. The ref. range is 5-15. Going further back in my records during May 02, I showed a result of 7, Dec 01 was 9, Nov 01 was 14. There seems to be big fluctuations between 4 and 14.

Richard

PC - after reading this post, I've been mulling around an occurrence I experienced a number of years ago regarding a low phosphorous result in lab tests.

I was being treated for hypothyroidism at the time and this low phosphorous number was flagged as being below normal. My internist at the time was familiar with hypophosphatemia and began a course of supplemental intake with frequent labs to monitor. It was extremely difficult to reach numbers that were satisfactory to him.

Eventually, and over another issue unrelated to phosphorous, I decided to change doctors, but at the same time, I went to a nephrologist to have my kidney's evaluated because of the low phosphorous issue. As I recall, I did a urine collection which was the basis of the evaluation. I was told that some people just have a lower number and that it would be virtually impossible to increase and maintain the number through supplementation and that there was nothing wrong with kidney function. Therefore, I stopped the supplement.

My main concern was kidney function since as a child, I had glomerulonephritis. I was told I had fully recovered but never to eat heavily salted foods and to comment about the nephritis problem.
if and when I became pregnant

Now I'm curious if this was an initial warning of malfunction.... my afib started a few years after that go-around over the phosphorous levels.

Does my scenario set off any bells when you read it?

My obvious concern now is that even though I've had the ablation, I did have afib after the 3 month date and am now watching to see if more occur which would indicate the need for a touch-up ablation.

So, then, reading this topic...my immediate concern is if, for me, is my situation possibly related to kidney/aldosterone/Mg and K wasting. If so, it would not seem it would be in my best interests to have a touchup until I was sure I really needed it based on the substance of this CR topic.

I'm not putting you on the "medical spot" here - just looking for some reasonable speculation regarding a possibility that the source of my problem could be ongoing in spite of ablation.

Thanks for any comments you care to offer.

Jackie

Jackie,

Hans has previously written something like LAF does not exist because of the absence of some precisely located atrial scar tissue (he was much more eloquent than this).

And earlier on this thread he wrote:

"It just does not make sense to have a PVI, which may or may not be successful, if the real problem lies elsewhere and is likely to show up in some other way even if the PVI is successful."

Unless Dr. Natale has good reasons otherwise, I think it would be most prudent to delay any possible touchup and pursue any and all nonsurgical approaches to stopping the AF. This assumes that your quality of life is not unduly compromised during this search.

Phosphorus in blood is only present as phosphate, as far as I know. Unlike HCO₃⁻ and Cl⁻, PO₄⁻⁻ is not an anion that is often evaluated in blood. It doesn't even enter into the anion gap calculation. Like K⁺ and Mg⁺⁺, PO₄⁻⁻ is predominantly intracellular.

Low levels are unusual and not really associated with clinical disease other than malnutrition, i.e., it's more of a biochemical oddity. Elevated phosphate is seen in renal failure. Blood phosphate binds with blood calcium, causing blood levels of calcium to drop, thereby mobilizing PTH.

The advice wrt salt was/is standard for mainstream medicine to anyone and the inclination toward nephritis could become a problem during pregnancy for anyone, e.g., nephrotic syndrome, pre-eclampsia, etc.

So, I personally would not associate your earlier biochemical anomalies with LAF.

PC

Richard,

About the only difference between an ion gap and the anion gap is an extra spacebar keystroke in the former.

I don't think the anion gap is as popular as it once was. There are more sophisticated tests to measure the problem these days. I suspect that part of it may be the wide fluctuations to which you allude. But I don't really know for sure.

PC

I wanted to post some hospital test results from the past, in case it gives any pertinent info. I'm trying to find time to study, on what some of this represents. In the meantime, maybe something will strike a chord with someone here.

Date CI CO2 ION N+ K Ca Na Mg
98-108 22-32 5-15 8-21 3.7-5.2 8.9-10.2 136-145 1.8-2.4

11/01 97* 32 14 10 4.2 10.1 143 ?

12/01 101 28 9 15 3.8 9.3 138 2.4

5/02 102 31 7 10 4.2 9.8 140 ?

I know I was in flutter on the following day:

1/29/3 101 24 12 14 4 9 137 2.2

Back in NSR on the following day:

1/30/3 109* 25 4* 7* 3.7 8.4* 138 ?

1/31/3 110 25 5 9 4 9 140 ?

Incomplete record, but had gone back to NSR two days prior:

5/03 107 27 7 11 3.8 ? 141 ?

Regular checkup:

12/03 103 31 4* 16 4.8 9.4 138 ?

It would appear on the last normal check up that my Na was low and K was a bit higher.

Here's something of interest:

Renal effects of aldosterone in the sodium bicarbonate infused rat.

Musabayane CT, Balment RJ.

Department of Physiology, University of Zimbabwe.

The present study investigated the renal function in male Sprague-Dawley rats receiving continuous NaHCO₃ (0.077 M) infusion. The renal effects of aldosterone administration in this preparation were also examined. Continuous NaHCO₃ infusion significantly (p less than 0.01) depressed plasma aldosterone concentration to 2.36 +/- 1.22 nmol (n = 8) when compared to saline infused rats (4.36 +/- 0.72 nmol, n = 7). The low plasma aldosterone levels in HCO₃-infused rats was associated with renal loss of large amounts of K⁺ and hypokalaemia. Aldosterone administration (42 pmol/min) for 2 h significantly (p less than 0.01) reduced the Na⁺ excretion rate in bicarbonate infused rats from a mean peak of 9.82 +/- 1.16 to 5.16 +/- 1.20 mmol/min (n = 8). Aldosterone administration did not alter renal excretion in saline-infused rats. It is concluded that NaHCO₃ loading depressed endogenous aldosterone secretion, and that this lowered endogenous plasma aldosterone level allows the mineralocorticoid effect of exogenous aldosterone to be observed.

http://www.sodbrennen-welt.de/science/1991/1991_1659727.htm

OBJECTIVE: To describe changes in renal function of horses after oral and i.v. administration of sodium bicarbonate (NaHCO₃) and to determine whether changes are dose dependent. ANIMALS: 6 Standardbred mares. PROCEDURE: Blood and urine samples for determination of renal function were collected immediately before and at hourly intervals for 12 hours after administration of each of 3 oral doses (1,500, 1,000 and 250 mg/kg of body weight, in 3 L of water) and 1 i.v. dose (250 mg/kg, 5% solution) of NaHCO₃, or water (3 L orally). RESULTS: NaHCO₃ induced increases in urine flow; electrolyte-free water reabsorption; urine concentrations of sodium and bicarbonate; fractional excretion of sodium, potassium, chloride, and bicarbonate; urinary excretion and clearance of sodium and bicarbonate; urine pH and anion gap; and mean plasma concentration of antidiuretic hormone. NaHCO₃ induced attenuation in reduction with time of urine excretion and clearance of potassium, chloride, and osmoles, and induced reduction in urine osmolality. Plasma aldosterone and atrial natriuretic peptide concentrations and glomerular filtration rate were not modified. CONCLUSIONS: Renal responses to NaHCO₃ load emphasize conservation of plasma volume and reestablishment of acid-base balance over control of hyperosmolality by diuresis, natriuresis, and increased bicarbonaturia. These responses imply a large fluid shift from the extravascular space to the vascular compartment, which was eliminated via diuresis, thus preventing hypervolemia.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9185977&dopt=Abstract

Here's a pdf. link/slide explanation concentration of hydrogen/potassium secretion:

<http://www.phys.mcw.edu/medphy/slides/Lecture48.pdf>

I need to further study this, to understand.

Richard

Sorry, I had all my numbers aligned, but once posted, they closed in to each other. Hope it makes sense.

Richard

I think you all might find this site very interesting, as it pertains to metabolic acidosis and alkalosis. It's not too long, either.

It speaks of hypochloremia and hyperbicarbonatemia, of which my results of 11/01 showed this, and states that by taking Na and K chloride during the correction phase, repairs the electrolyte deficits. Excretion of K might cause bicarbonate to give up its hydrogen, leaving it acidifying rather than buffering.

I don't know if any of you have heard of Milk Alkali Syndrome, but this can cause metabolic alkalosis, and Angus had quit drinking milk, to become AF free. I have to do more reading on this.

http://cnserv00.nkf.med.ualberta.ca/cn/Schrier/Volume1/chap6/ADK1_06_19-21.pdf

Interesting stuff!!!

Richard

And there's a bit more.

Deficiency of chloride alone leads to contraction of extracellular fluid volume and metabolic alkalosis which, in turn, leads to a deficiency of potassium by increasing urinary excretion of potassium.

With few exceptions (e.g., monosodium glutamate and sodium bicarbonate) sodium and chloride are most often consumed as sodium chloride (salt).

Recent research: The potential of sodium chloride to increase blood pressure is dependent on concomitant high dietary intake of both sodium and chloride. Blood pressure is not increased by selective sodium (without chloride) loading. <http://www.nutrition.org/nutinfo/content/chlo.shtml>

Could the MSG, without balance with chloride, be the cause of arrhythmias? Could the reason Hans does not have hypertension, is because he is low in chloride?

Why did my chloride level jump 8 pts. after cardioversion in the hospital in Jan. 03? Maybe Cl was in my IV. I don't know. Why was my Cl level at 97, which was 1 pt. below ref. range, but my Na and K were at normal levels in Nov, 01?

Richard

Looking over Hans' test results again, I see his Cl levels were normal. So much for that thought.

Richard

Hans,

This is absolutely brilliant news. I am away from home but have been following it with much interest and it has stimulated me to do some further research.

I am working and thinking out loud now, as I feel that somehow this is implicated in my own AF, even though it took avoidance of free glutamate to bring it under control. I also know that more hydration on my part has played a key part. Everyone please jump in if I am off on a tangent.

James says: Aldosterone's counterpart would be ANP (which ditches Na and water) - which is why he thinks the ANP release is beneficial in restoring the Na/K balance once AF starts.

I am asking would it not be arginine vasopressin or ADH that is the counterpart to aldosterone?

<http://www.sparknotes.com/nutrition/minerals/major/section1.html>

On a broader, less localized level, the kidney is primarily responsible for maintaining water and electrolyte balance in the body. The kidney is alternately triggered to action by the hormones vasopressin and aldosterone. Vasopressin, also called antidiuretic hormone (ADH), is secreted by the pituitary gland and stimulates the reabsorption of water. ADH secretion can be stimulated by a loss of body water, whether it is an actual loss or the result of a shift of water from plasma to interstitial ECF spaces as occurs in congestive heart failure. Aldosterone, secreted by the adrenal gland, acts primarily to conserve sodium, but in doing so has the affect of controlling water loss."

Now it seems to me that if Hans is Adrenergic and that high levels of aldosterone are responsible for his type of AF. Where as I am vagal and am suspecting high levels of vasopressin. I also noticed when stopping AF through diet that I did have water retention - not obvious though. Only in the fact that socks would leave a pressure mark round my legs, plus very tender breasts etc. and this doesn't happen anymore.

If this statement is true "We have demonstrated that the activation of glutamatergic neurons in the PAG area increased sympathetic tone and the release of vasopressin" from <http://hyper.ahajournals.org/cgi/content/full/25/4/507>

then would it not make sense that for some of us it is the effects of an imbalance of aldosterone and vasopressin that causes AF? I am jumping to the conclusion that high levels of free glutamate will ultimately upset the balance of aldosterone and vasopressin.

A cause of excess ADH is called SIADH, syndrome of inappropriate secretion of ADH. Amongst other things it can be brought on by SSRI drugs. I am wondering if this SIADH is just the other side of the coin in lone AF?

Fran

Mike F this is for you.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Abstract&list_uids=12503252

Department of Geriatric Medicine, Canberra Hospital, Woden, Canberra, ACT, Australia.

Numerous case reports of hyponatraemia followed increasing use of selective serotonin re-uptake inhibitors (SSRIs) but this adverse effect was only rarely observed in relation to citalopram. We report a case of severe hyponatraemia associated with deep coma, seizure, atrial fibrillation and muscle damage in a 92-year-old woman after only two doses of citalopram, and review 14 cases previously published in the literature and 28 cases spontaneously reported to Australian Drug Reaction Advisory Committee (ADRAC). The data presented suggest that citalopram, as well as SSRIs may cause hyponatraemia secondary to syndrome of inappropriate secretion of antidiuretic hormone (SIADH). The majority of symptomatic cases occurred in elderly patients (79% were older than 70 years) and in women (74%). Polymedication and concomitant use of another psychotropic drug or thiazide diuretic may precipitate and/or augment the development of hyponatraemia/SIADH. In 84% of cases, the hyponatraemia associated with citalopram was detected during the first month of treatment. High level of suspicion, close and careful monitoring of serum sodium concentration particularly in elderly patients and especially in the first month of therapy with citalopram may reduce the incidence of this serious and likely not rare adverse effect.

Fran

Could night time hydration be part of the answer here?

The last couple of days I have been posting on the board about not having afib for a year. From the response of Fran, Richard and Jackie it seems that one of the biggest changes I have made in the last year is to drink 2 or 3 large glasses of water throughout the night.

Most of us are now working longer hours and our evening meals (the largest meal of the day) is now eaten around 7 or 8pm. We then watch a bit of tele and go to bed about 10pm. We are then asleep (with a bit of luck!).

Think about what our bodies must be going through. Our digestive system is still trying to digest our large evening meal full of modern day chemicals but we are now asleep and in a horizontal position so the digestive system can't use gravity to help it. Most of us don't want to be up all night weeing so our last fluid intake was probably just after dinner. So around 2am the digestive system must be craving for water to help break down the evening meal. The cells in our bodies must be terribly dehydrated by now but our bodies are not going to have any relief until we wake up around 6am and start pumping the fruit juice, milk and coffee into us.

This night time dehydration must be playing havoc with the mg, k and na in the cells.

Dean

I'm bringing this up again in case it gets missed.

Any thoughts on vasopressin (ADH), the opposing hormone to aldosterone I spoke of in my last post? And the syndrome known as SIADH, syndrome of inappropriate secretion of ADH?

Vasopressin, also called antidiuretic hormone (ADH), is secreted by the pituitary gland and stimulates the reabsorption of water. ADH secretion can be stimulated by a loss of body water, whether it is an actual loss or the result of a shift of water from plasma to interstitial ECF spaces as occurs in congestive heart failure. Aldosterone, secreted by the adrenal gland, acts primarily to conserve sodium, but in doing so has the affect of controlling water loss."

It seems to me that adrenergic AF may be a problem caused by excessive aldosterone. And vagal AF may be its counterpart - caused by excess ADH brought in on some by long term dehydration and dietary things such as MSG which stimulate ADH to produce.

Fran

Fran,

Happy to see you're constantly thinking about the how and the why of LAF.

The kidney has two functions;

- 1) filtration performed by the glomeruli (renal cortex)
- 2) selective reabsorption of the filtrate performed by the renal tubules and collecting ducts (renal medulla)

The former prevents loss of the bigger molecules in the blood, e.g., albumin, rbcs, wbcs, and the latter help maintain proper pH and electrolyte/water balance. This is done through specific ion channels and pumps in renal tubular/collecting duct cells, controlled by aldosterone, ADH and other hormones and receptors. The juxtaglomerular apparatus (JGA) is a stretch receptor that starts the RAAS cascade leading to secretion of aldosterone.

Function # 2 is at the heart of LAF. Abnormalities in function #1, e.g., "nephritis" or nephrotic syndrome (protein in the urine) or nephritic syndrome (blood in the urine) are unrelated to LAF. Many of these latter conditions are seen during pregnancy.

Aldosterone operates in the renal tubules. ADH operates in the collecting ducts. The collecting ducts are located in the renal medulla (the interior of the kidney), where the interstitium has greater "tonicity" or "density". Cells lining the collecting ducts are normally water impermeable. ADH makes them water permeable. Because of this water density gradient (water flows from where it is less "dense" to where it is more), water will flow from the urine in the collecting ducts through to the lining cells and beyond. This is an important differentiating feature, because there is no increase in Na⁺ reabsorption in the collecting ducts, unlike with aldosterone in the renal tubules. In the latter water follows the Na⁺ reabsorption.

So, regarding ADH/vasopressin, IMHO it seems that if SIADH were present, then there would be more than normal retention of water. This would elevate the hydrostatic pressure sensed by the JGA and lead to decreased renin and aldosterone. This would be good for K⁺ and hence SIADH should help not hurt LAF, VMAF or otherwise.

If the body's response to long term dehydration were primarily through the RAAS, then it would be bad for LAF. If it were primarily through ADH, then it would be good.

Better that we hydrate all the time and be rid of this concern. I could have some of the above details wrong, but that is the gist of what I remember from so many years ago.

PC

Hans,

The Aldosterone Connection seems to fit my situation somewhat. I have had AF for 3 years now and have always felt that my episodes serve some purpose. I feel great after they end and know that for the next few days they will not return. I can always end an episode early by exercising but depending on how soon after, has an effect on how quickly the next one will come. The longer the episode goes the longer before the next one begins. My question is, in my case how does exercise fit into the Aldosterone equation?

Thanks,

Paul

Thanks for explaining PC but I am a bit confused.

I have read that SIADH may be caused by "enhanced hypokalemic ADH secretion...", so there would be periods of hypokalemia - paroxysmal AF? You also said that there would be more than normal retention of water if it were present. However, " In SIADH, there is no oedema." (see below) - not sure how this works though.

Also if decreased renin and aldosterone helps retain K is it not possible that K levels may get too high - causing arrhythmia?

And why does the treatment of hyponatremia and dehydration caused by SIADH include replacement of sodium and fluid losses, replacement of other electrolyte losses (e.g. potassium, bicarbonate) and possible hypertonic saline if sodium is dangerously low

Also as the hypothalamus [MSG can have devastating effects on the hypothalamus] controls every endocrine gland in the body, and alter blood pressure (through vasopressin and vasoconstriction), also "Increased plasma osmolality (osmotic regulation) and severe hypovolemia and hypotension (hypovolemic regulation) are the most potent stimuli to vasopressin release" <http://thalamus.wustl.edu/course/hypoANS.html>

I for one am known for suddenly dropping blood pressure - which on the whole is low anyway. During AF though I could go from 90/70, 115/105 (scary as I wondered what would happen if the systolic and diastolic became the same no) and then suddenly down to 70/35. this was a particularly bad episode of AF and I decided to monitor my BP with continuous readings. It would seem plausible that both aldosterone and vasopressin were fighting to maintain some sort of equilibrium - if it was not just the differing forces of each heart beat.

I apologise if this is getting away from the aldosterone issue, but I am seeing it as the other end of the AF aldosterone adrenergic spectrum because "On a broader, less localized level, the kidney is primarily responsible for maintaining water and electrolyte balance in the body. The kidney is alternately triggered to action by the hormones vasopressin and aldosterone".

Only trying to understand and you are so good PC.

http://www.ace.cc/Critical%20Care%20Topics/electrolyte_disturbances.htm

Hyponatremia with dehydration

Hyponatremia with dehydration is often caused by SIADH, heart failure, cirrhosis, excessive administration of hypotonic IV fluids and oliguric renal failure.

Treatment of hyponatremia and dehydration includes replacement of sodium and fluid losses, replacement of other electrolyte losses (e.g. potassium, bicarbonate) and possible hypertonic saline if sodium dangerously low

<http://66.102.11.104/search?q=cache:3MvfYF15sVEJ:www.endocrinesurgeon.co.uk/pituitary/pituitary8-3.html+symptoms+of+SIADH+&hl=en&ie=UTF-8>

SIADH leads to retention of water and hyponatraemia (low blood sodium levels). Even though in some situations the hyponatraemia may be very severe, there may be no clinical symptoms. The reason that symptoms may be absent is that the type of hyponatraemia found in SIADH is due to a dilutional effect, not one of sodium depletion. The general symptoms that patients may complain of in SIADH are listed below and are experienced when sodium levels fall below 125mmol/L.

Malaise
Nausea
General weakness
Poor mental function
Anorexia
Confusion
Irritability

If left untreated the sodium levels can fall to less than 110mmol/L that can ultimately lead to fits and coma. In SIADH, there is no oedema.

Fran

Fran,

My last look at the physiology of ADH was many years ago. I don't even remember SIADH. My comments were primarily directed to the former.

Hence, I'll only try to answer a few of your questions.

I. "If decreased renin and aldosterone helps retain K, is it not possible that K levels may get too high - causing arrhythmia?"

Hyperkalemia is a potent stimulator of the RAAS. Hence, aldosterone would never let this happen.

II. SIADH may be caused by "enhanced hypokalemic ADH secretion"

Aldosterone and ADH both cause water retention. Hyperkalemia stimulates aldosterone secretion and hypokalemia inhibits aldosterone secretion. So perhaps there are situations, e.g., hypokalemia, in which ADH is "enhanced". Otherwise, the inappropriate ADH should dilute not only blood Na but also blood K. In this latter situation SIADH should CAUSE (not be caused by) hypokalemia.

II. The absence of edema in SIADH

This SIADH induced hypokalemia could result in some loss of Na (since there is decreased secretion of aldosterone). Maybe this counter regulatory mechanism keeps the patient with SIADH from becoming hypertensive and edematous. Extravascular water flows into the vascular space, because there is less Na in the vascular space (v. the extravascular space). Extravascular Na would serve as a constant source of Na to replenish that lost from the intravascular space into the urine. There would then be hyponatremia without intravascular depletion of Na. There would also be no hypertension or edema.

Without an explanation like this, it seems to me that inappropriate retention of water in this condition would lead to hypervolemia and volume overload. This should increase blood pressure and eventually lead to CHF and to edema, as the water spreads from the intravascular space to the extravascular space.

So, the bottom line, Fran, is that I don't really know and will have to join you in the dark on SIADH.

This whole exercise has given me a brain cramp.

PC

Paul,

My current feeling is that anyone who have episodes at regular intervals to the point where they can pretty well predict when the next one is going to happen ought to consider the aldosterone connection and have the renin and bicarbonate tests to rule out a problem with the adrenal glands.

Exercise increases the production of ANP, so in accordance with the "aldosterone hypothesis" it makes sense that the episode would terminate earlier if you exercise. However, I believe that the timing of the exercise is important - it seems to be more effective after 8-12 hours of afib. It certainly cannot be ruled out that the "exercise effect" is affecting the autonomic nervous system rather than the aldosterone/ANP system. I really don't know :~)

Hans

This is a link, for understanding and calculating the measurements of respiratory vs. metabolic acidosis by Ph, CO₂, and HCO₃, if anyone is interested.

<http://www.bishop.edu/health/ABG.pdf>

Richard

Could there be something to learn from this, even though it doesn't exactly apply??? Also, Hans, did you have results of Ph testings and CO₂?

New Values after treatment pH 7.48; pCO₂ 44 HCO₃ 35

6-8 The patient now has alkalosis (pH>7.40) and it is metabolic, HCO₃ is 35 and the pCO₂ is high 44; i.e. the patient has chronic metabolic acidosis with an increase in pCO₂ because the alkalosis inhibits the respiratory drive.

9 Non-renal H loss is typically seen in vomiting, or in suction of the gastric or upper GI tract. We are not told that the patient is vomiting, so we don't know, but probably it doesn't apply here.

10 H⁺ secretion by the kidney occurs in the proximal tubule and the collecting tubule. The table below lists the conditions that affect them and all are discussed in the syllabus.

Proximal Tubule

High pCO₂

Decreased ECF Volume (Hi AII, hi Filtration Fraction)

Hypokalemia (makes the cell acid)

Chronic Acid Base status

Collecting Tubule

high pCO₂

Aldosterone

Lumen negative potential produced by stimulated Na absorption

Hypokalemia (makes the cell acid)

Increased NH₃ production

Chronic Acid Base status

11. Aldosterone is likely to be elevated in patients with CHF on diuretics. Aldosterone stimulates H secretion in the collecting duct directly and stimulates Na reabsorption there as well. Increased Na reabsorption will make the lumen of

the tubule more negative which will tend to stimulate H secretion.

12. Serum K is 3.2. As you see in the Table above, this will tend to stimulate H secretion. Because hypokalemia induces cellular acidosis this stimulates H secretion.

13. Diuretics inhibit Na absorption and the most commonly used ones do it in the thick ascending limb (furosemide) or the distal tubule (thiazides). They often produce volume depletion which stimulates HCO₃ absorption in the proximal tubule. Volume depletion increases aldosterone which stimulates H secretion in the collecting tubule. Most importantly, the diuretics increase Na delivery from segments that are proximal to the collecting duct. In the presence of high aldosterone, the collecting tubule is primed for Na absorption; increased Na delivery will produce a large increase in Na transport and therefore a large membrane potential negative inside. This will stimulate H secretion.

Case 2

Initial studies pH 7.8, pCO₂ 20, HCO₃ 39

1. The patient has alkalosis that is both respiratory and metabolic.

Second studies soon after demerol pH 7.5, pCO₂ 50, HCO₃ 39

2. Carpo-pedal spasm, an acute painful spasm of the thumb apposed to the little finger and spasm of the sole of the feet. It is induced, it is thought by severe intracellular alkalosis which causes increased firing at some neuromuscular junction. Clinically it is also seen in severe hypocalcemia.

Painful condition often induce hyperventilation. Demerol (an opiate) reduces the pain, relieving the hyperventilation (pCO₂ went up from 20 to 50 mmHg) uncovering the underlying "pure" metabolic alkalosis.

3 This patient started with excessive vomiting which means acid was lost from the body leaving excess HCO₃ behind. However, if her ECF volume was normal, she would be able to excrete the excess HCO₃ easily. But continuous vomiting resulted in extracellular volume depletion. This led to high renin and Ang II which increases reabsorption of NaCl and NaHCO₃ in the proximal tubule. High aldosterone also stimulates H secretion in the collecting tubule. Hence, not only is she losing acid but she could not excrete the excess HCO₃ because the kidney is now primed to secrete H ion which is equivalent to generating new HCO₃ and adding it to the body fluid. Hence, the alkalosis. The urine pH as we would expect is acid (5.5) and is produced by H secretion by the collecting tubule. It is the kidney that is producing the metabolic alkalosis since it is secreting excess H ions under the stimulus of aldosterone. If the urine pH was alkaline (i.e. full of HCO₃) she wouldn't be alkalotic!

4 The plasma HCO₃ went up from 39 to 42 because they were removing acid from her stomach which is equivalent to adding HCO₃ to the body fluids.

5-6 Correct treatment is giving this patient NaCl which corrects the volume depletion reduces Ang II and aldosterone and allows the kidney to excrete HCO₃. When this occurs the urine pH will be high due to excretion of HCO₃

Giving spironolactone will inhibit the effect of aldosterone but it will not get rid of the excess HCO₃ retained. It is likely that the urine pH will rise due to inhibition of H secretion.

KCl replacement will improve hypokalemia, even that will be equivocal since it is difficult to correct hypokalemia in the presence of hyperaldosteronism. It will not correct the alkalosis significantly since the patient still has an excess of HCO₃ and cannot excrete it. It will have no effect on urine pH.

Infusion of 0.1 N HCl (i.e. 100 mEq/L of H) will certainly correct the alkalosis, but it will have no effect on volume depletion or hypoaldosteronism or urine pH. The alkalosis will recur unless the HCl is continued, so it is not a "radical" treatment.

http://healthsciences.columbia.edu/dept/ps/2004/Academic/second_year/renal/acid_base.doc

Richard

For Fran and others interested who have the wish and spare time to really have an in-depth look at just what the kidneys are doing, have a look at:

<http://health.howstuffworks.com/kidney.htm>

Enjoy!

Mike F.

Well, I've been out of rhythm since Thurs. PM, so I'm off to the hospital. One good thing about this, is that I'm going to insist on the different tests you've indicated Hans, even though the timing might not be all that good. Before I leave I wanted to share a link, and some thoughts. In most cases, my arrhythmias have either been due to exercise, exertion, or MSG. I can't help believe that the sodium in the MSG could be setting off an imbalance of my alkaline or acid tide. I'm also pondering the issue of lactic acid buildup, since I started doing Nautilus and the treadmill at the beginning of this week. I also moved some furniture. In the very beginning, right before diagnosis, I had just purchased my Nautilus equip., second hand, to set up a gym in my home. Upon starting this, is when my problems began. The only thing I'm still not sure about, is whether I'm leaning towards alkalosis or acidosis. I have also reflected on the fact, that I was not producing enough HCl, hence GERD. Or was I not producing enough bicarbonate. I have to say HCl, because higher protein meals, and elimination of carbs and sugars, alleviated my reflux problem. Anyway, I have got to get to the bottom of this!!!!

Here's some excerpts from one link, but you may find the other link equally important. I only hope, Hans, that the problem lies with an adenoma. That would be so much easier to resolve, in my opinion.

In addition to reabsorbing essentially all filtered bicarbonate, the kidneys excrete the daily acid load, derived mainly from sulfur-containing amino acids. The hydrogen ions that are excreted in the final urine are secreted mainly in the collecting tubules [see Figure 3]. This secretory process is facilitated by aldosterone.

Once these anions have been completely eliminated by urinary losses, however, regeneration of bicarbonate requires renal excretion of retained hydrogen ions.

<http://www.headachepainfree.com/potassiumbalance.htm>

<http://www.int.med.utah.edu/icuweb/files/AB2.pdf>

alkalosis/acidosis

Richard

Richard,

Sorry to hear you are in afib. I hope you get converted quickly. You may have to go easy on the exercise - unfortunately. I have found that any kind of strenuous exercise is sure to put me into afib so I limit my exertions to two daily, brisk half-hour walks.

All the best

Hans

Hans,

Could you possibly explain something, without me having to go back and re-read everything. When at the hospital yesterday, they said that high bicarbonate indicated acidity, and that the reason it rises is to buffer the acid. You say you have metabolic alkalosis, so I'm a bit confused here.

Thank you for your concern, and I'll take your advice on walking, as I don't want to go out of rhythm again, like I did.

Thank you,
Richard

In an attempt to become more educated about aldosterone and H⁺ ion secretion a few things have become more clear to me. Perhaps this was obvious to others, but it appears that aldosterone is not limited to exchanging K⁺ when it comes to reabsorption of Na⁺.

Aldosterone enhances reabsorption of sodium in the distal tubule and collecting duct, helping to reabsorb the final 3-5% of the filtered (by the glomeruli) load of sodium. Without aldosterone that would be lost. One can't lose more than .5% of this filtered sodium without becoming dehydrated. Aldosterone is a very big player.

Aldosterone regulates potassium channels by increasing the number of these channels, both active (ATP) and passive. It regulates K⁺ secretion/excretion throughout the tubule, but Na⁺ is involved in this only in the distal tubule.

The cells of the distal tubule have a Na/K pump (ATP and Mg requiring) on their basement membrane side. On the lumen side of these cells, there is a pump for HCO₃⁻. They also have intracellular carbonic anhydrase, i.e., H₂O + CO₂ --> H₂CO₃ --> H⁺ + HCO₃⁻. This leads to competition between H⁺ and K⁺. For every Na⁺ reabsorbed either H⁺ or K⁺ is secreted/excreted.

Aldosterone lowers blood K⁺ not only through the Na⁺/K⁺ and HCO₃⁻ pumps in the distal tubule but also via other primarily passive channels throughout the tubule.

Insight into this physiologic process might explain why some people develop PACs and even AF when taking Mg or K supplements. The whole process is very dynamic and counter-regulatory measures are constantly in a state of flux. If blood K⁺ levels transiently increase due to supplemental intake, then there is a commensurate increase in aldosterone to counteract this. Transiently there might be a slight drop in blood K⁺, triggering the PACs. If blood Mg⁺⁺ increases, this might make aldosterone more efficient in excreting K⁺ and H⁺ (Mg requiring ATPase pump).

And it's not just the kidneys that are involved in this ballet.

Gastric cell secretion of H and Cl into the lumen for digestion of food is accompanied by simultaneous extrusion by these same cells of K⁺ and HCO₃⁻ into the blood (alkaline tide). This slightly increases blood K⁺ and HCO₃⁻ levels. Increased blood K⁺ stimulates secretion of more aldosterone. More K⁺ is presented to the kidneys and K⁺ (v. H⁺) is preferentially excreted/secreted into the urine in exchange for Na⁺. If you can't excrete H⁺, you limit reabsorption of HCO₃⁻. Because blood HCO₃⁻ is already increased from the alkaline tide of the meal and increased K⁺ competing with H⁺ is limiting renal reabsorption of HCO₃, there is both alkaluria and kaliuria. No wonder the postprandial period is so arrhythmogenic.

So, it seems to me that this is just further evidence that LAF is a manifestation of a delicate hormonal/electrolyte balance gone ever so slightly awry. Hyperaldosteronism just magnifies all this.

PC

I found this of interest, but you all probably knew this. I'm still learning.

PRESSURE/VOLUME RECEPTOR INPUTS TO VOLUME CONTROL;

Increased blood volumes will cause increased firing of atrial receptors, and it will also cause increased cardiac output, and hence an increase in arterial pressure and increased firing of arterial baroreceptors.

These will both result in:

- 1) decreased sympathetic outflow to heart and vasculature, causing an immediate reduction in arterial pressure.
- 2) inhibition of ADH secretion, leading to diuresis.

3) decreased stimulation of the renal sympathetic nerves, reducing renin secretion.

The converse applies - reduced blood volume increases ADH secretion and sympathetic effects.

<http://www.kcl.ac.uk/depsta/biomedical/cyo/jp0111/Kidney%20Lecture%205.pdf>

Richard

Well I am one who finds K and Mg supplementation a big problem. Also against all that is advised for candida and leaky gut my diet doesn't vary very much. I find that my breakfast lunch, tea and snacks are made up of very similar ingredients, albeit I mix them differently. It keeps me very stable. In light of what PC has posted it may be that my aldosterone has adapted in light of a static nutrient intake - and when I go off the norm - bang.

Very interesting...

Fran

PC,

Are you suggesting that afibbers with hyperaldosteronism should avoid heavy-duty supplementation with K and Mg as this may further increase aldosterone levels and ultimately decrease rather than increase K levels?

Incidentally, it would be interesting to know the proportion and characteristics of afibbers who have found K and Mg supplementation to be detrimental - I know there are some.

Hans

Hans,

In looking over my cortisol test, that was done in April, 03, during a time I was out of rhythm, my results showed normal levels of DHEA. My overall test results, however, indicated adrenal fatigue, non-adaptive, whatever the latter means. The test also revealed a borderline result in Gliadin Ab, SIgA. Gliadins are polypeptides found in wheat, rye, oat, barley, and other grain glutes, and are toxic to the intestinal mucosa in susceptible individuals. I had failed to see this, previously, or just had forgotten, but before I went out of rhythm, I had been consuming oatmeal again. Sometimes, in the past, I would occasionally have a bowl, but lately, I had been having it more often. It's interesting to me, that this would have even been on my cortisol test.

My cortisol levels were elevated at the 11am-noon time and the test said this was often associated with a stress response or rebound effect to do with the glucose counter regulation process. My levels were then elevated again between 11pm-midnight, indicating a lack of sensitivity to suppression at the pituitary-hypothalamic-axis. This condition is usually assoc. with a tendency to endogenous depression and REM sleep disturbances.

I need to have another test done, as I could have very well had some depression and sleep disturbances during that time, as I had been out of rhythm for 15 days.

Richard

Hans,

I think heavy duty (to bowel tolerance on Mg) supplementation with K+ and Mg++ is highly advisable. But I think it is

important to combine them and to maintain the intake over time.

Obviously increased intake of K^+ will increase secretion of aldosterone. But this will be partially offset by the increased hydrostatic pressure secondary to greater reabsorption of Na^+ . So there should be a net gain in total body K^+ .

In a similar vein I've gone round and round a bit on dietary intake of Na^+ . Decreased Na^+ intake should result in increased aldosterone secretion and greater loss of K^+ . Increased intake should do the opposite and conserve K^+ . However, there should be a gradual readjustment of the aldosterone "setting". Any drop in Na^+ intake will result in relatively greater loss of K^+ .

So I've decided that a middle of the road approach maintained over time might be best. Would love to hear your thoughts on this.

And while you're at it, please let me know your thoughts on Vit D. This is another supplement that seems to be a moving target for me. I recently read that prostate CA is half as frequent in those with normal levels of Vit D (v. those whose levels are low). However, it appears that prostate CA is 70% more frequent in those with elevated levels and the article (the most recent Reader's Digest) recommended avoiding Vit D supplementation, especially if you live in the Sunbelt.

PC
