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VIRTUAL LAF CONFERENCE

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SUBJECT: Diurnal Rhythm of Potassium

PC has done some very extensive research into the importance of potassium in LAF and has come up with some exciting new possibilities for keeping afib at bay by controlling potassium and aldosterone levels throughout the day. A highly important topic. Please join the discussion and share your experiences.

Hans

Introduction

There has been a GREAT deal of BB (Bulletin Board) discussion about potassium. Such discussion has been devoted not only to its importance in general but also specifically to AF. There have been many anecdotal stories testifying to the latter. On the other hand, I'm sure there are many LAFers that are unable to detect any appreciable benefit from potassium supplementation. Perhaps there is an explanation for this.

Although discussion has focused mainly on intake, there has also been some discussion about urinary loss. However, there has been NO discussion of what happens in between intake and urinary excretion/secretion of potassium. That is the topic of this post. I apologize in advance, if this strikes many as too technical. I've omitted some of the references to make it less overwhelming. It may not be important for you to know the why of it, but for me discouraging the unwelcome visitor is easier, if I understand why he comes. If you wish, just skip to the last paragraph.

Background Information

I initially assumed that because blood potassium is so intimately associated with aldosterone, it's diurnal rhythm would follow that of aldosterone (and ACTH/cortisol). But such is not the case.

The diurnal rhythm of aldosterone secretion in healthy individuals parallels that of cortisol and is ACTH dependent. The lowest values are observed from midnight to 4AM. Values peak in the morning around 8AM after which there is a gradual decline throughout the day (assuming a normal sleep-wake cycle).

Furthermore, cortisol and ACTH are not always secreted uniformly throughout the day. Episodic spikes can occur when the body is stressed. In humans urinary potassium excretion peaks in the early morning between 0530 and 0730 with a minimum at night from 2100 to 0530. Therefore, the diurnal rhythm of urinary potassium excretion seems to be controlled by the diurnal rhythm of cortisol and/or aldosterone. Not so for blood potassium.

While researching an article on Magnesium and Potassium in LAF

<http://www.afibbers.org/conference/PCMagnesium.pdf>

I stumbled onto an excellent article entitled "Importance of Potassium in Cardiovascular Disease" at

<http://www.medscape.com/viewarticle/438088>

In fact I was so impressed with its progressive views on potassium (their well supported position that hypokalemia is more problematic than hyperkalemia flies in the face of mainstream medicine dogma) that I listed some of these in an 11/29/02 post on the BB. I either missed or just plain forgot (more likely) a reference in that article indicating that plasma potassium follows a diurnal rhythm with a peak at noon and a trough at midnight with an average peak-to-trough difference of 0.62 +/- 0.05 mmol/L. In other words blood potassium is lowest when aldosterone secretion is lowest and blood potassium climbs as blood aldosterone/cortisol are peaking.

Because a one mmole reduction in blood potassium generally implies the net loss of 300 mmoles of potassium from the body, it would require over 7 gm of potassium to replenish that lost between its blood concentration peak and its trough.

According to one study, the frequency of hypokalemia (potassium less than or equal to 3.0 mmol/L) is related to the time at which the blood potassium is measured. Not many blood samples for evaluation of potassium are drawn in the evening, especially around midnight (its diurnal nadir).

There is a net flux of potassium from intracellular fluid to extracellular fluid (mainly blood) in the morning and a reverse net flux later in the day. The net fluxes between these two compartments counterbalance the diurnal rhythm in urinary potassium excretion. The flux appears to be driven by osmotic pressure.

Hans brought to my attention another article by Dr Allan Struthers ("What Is the Optimum Serum Potassium Level in Cardiovascular Patients?" - 2004) in which he states that potassium supplementation is pretty useless at least in heart failure patients in the absence of an aldosterone antagonist, e.g., spironolactone or eplerenone. "A serum potassium increase of 0.25 mmol/L elevates serum aldosterone concentrations by 50% or 100%." Virtually 100% of ingested potassium is absorbed and, at least initially, distributed in the blood (total blood volume is about 5 liters). Therefore, just over 1 mmole or about 50 mg of ingested potassium should result in a 50-100% increase in aldosterone.

I'm not sure that I buy this statement completely for normals. In one study of 150 normals 60 mmoles of supplemental potassium daily (about 2.4 gm) increased urinary potassium excretion by only 20.6 mmoles/24h (about 0.8 gm). This potassium supplementation was not accompanied by an aldosterone blocker.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=11446724

In another study of eight patients with long QT syndrome the equivalent of 250 mg of spironolactone and 9 gm of supplemental potassium daily (70 kg person) increased blood potassium from 4.0 to 5.2 mmoles/L. Four weeks of this therapy resulted in no serious complications.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14642687

So, although the addition of an aldosterone antagonist may not be necessary, it certainly is effective and does not seem to pose excessive risk. "Clinicians can be comforted by the fact that hyperkalemia does not typically occur in patients with normal renal status, because large potassium loads are efficiently and rapidly excreted." Dr. Michael Lam (www.lammd.com) on p. 246 of his book *How to Stay Young and Live Longer* indicates 15gm daily potassium as safe in a healthy adult. However, although I'm a physician, I'm not your physician and this is not a blank endorsement of the above combination.

Furthermore, these aldosterone antagonists (potassium sparing diuretics) appear to more effective in increasing blood potassium in the morning and ineffective in the evening. This latter finding is certainly consistent with the diurnal rhythm of aldosterone. It's hard to block aldosterone, if it's not being secreted (evening). Furthermore, angiotensin converting enzyme inhibitors (ACEIs) decrease urinary potassium excretion but do not affect either blood potassium level or its diurnal rhythm. This is also predictable given the fact that changes in blood potassium directly stimulate aldosterone secretion without the renin angiotensin system (RAS). And ACTH, responsible for the diurnal rhythm, also works independently of the RAS.

Other tidbits – Simultaneous supplementation of magnesium with potassium and an aldosterone antagonist increases cellular uptake of both potassium and magnesium.

Urinary excretion of potassium increases during fasting (ACTH stimulates aldosterone secretion).

Blood magnesium peaks around 0330 and reaches its lowest point around 1530. Its diurnal variation is greater than that of blood potassium.

Discussion

The discordance between the diurnal rhythm of blood potassium and aldosterone is both contradictory and perplexing, at least to me. What is driving the drop in blood potassium? A partial answer may be insulin. Other hormones may be involved. For example, TSH (thyroid stimulating hormone) has a diurnal rhythm and peaks at 11PM.

Blood potassium values decrease postprandially because of insulin released in response to an ingested carbohydrate load. Blood potassium after our largest meal of the day (dinner in America) slowly declines due to insulin (and the absence of any additional dietary potassium). It continues to fall and eventually troughs around midnight. Because the cell membrane of the heart is HIGHLY permeable to potassium ions (there are many passive potassium channels), it would seem that this slow decline in blood potassium causes slow leakage of potassium from within cardiac cells due to the growing concentration gradient (difference between inside and outside). This situation is not rectified until breakfast, underscoring the fact that it is indeed the most important meal of the day.

This intracellular potassium scenario would certainly explain the at risk period (late PM/early AM) for most with vagally mediated episodes. Insulin appears to be incriminated in such individuals. This effect would be accentuated with a larger meal. Potassium supplementation in the evening would seem to be a good idea for VMAFers especially. Addition of an aldosterone antagonist would improve not only intracellular potassium but also intracellular magnesium as well. In ALAF aldosterone/catecholamines and not insulin seem to be the culprit hormones. Insulin and catecholamines both stimulate simultaneous cellular uptake of glucose and potassium (see below). This insulin induced uptake occurs primarily in fat, liver and muscle, including cardiac muscle. However, cardiac muscle (v. skeletal muscle) is relatively less dependent on glucose generated ATP and relatively more dependent on oxygen generated ATP. This latter process occurs in the mitochondria and is called cellular respiration. Heart muscle cells have the greatest concentration of mitochondria at about 5,000 per cell (v. 50 for skeletal muscle). This is one reason why CoenzymeQ10 (protects mitochondria from oxidative damage) deficiency associated with statin therapy is causing an epidemic of heart failure.

Furthermore, aerobic training is associated with enhanced insulin sensitivity in skeletal muscle but diminished insulin-stimulated glucose uptake in the heart. Aging further diminishes this insulin sensitivity in the heart. Therefore, compared to skeletal muscle glucose and potassium uptake by the heart is relatively less, causing the potassium concentration gradient for the heart to be relatively more problematic than for skeletal muscle. So, at least in the physically fit and the elderly, potassium is more likely to leak from heart cells. This may be why low blood potassium appears to effect cardiac muscle more than skeletal muscle, smooth muscle, liver or fat cells.

Obviously aldosterone/catecholamines can aggravate VMAF and insulin can do the same for ALAF. That's why we have a mixed category.

IMHO the common denominator linking VMAF and ALAF (adrenergic lone atrial fibrillation) appears to be potassium, at least in part. I think P cells are the other part. P cells provide the arrhythmogenic substrate, hypokalemia provides the PACs (and PVCs) or trigger factor and autonomic tone provides the rest. These would fulfill Coumel's three required ingredients for AF. Autonomic tone and hypokalemia both cause shortening of the atrial effective refractory period (AERP). The Bordeaux Group has clearly shown that the PVs in those with paroxysmal AF provide a much more arrhythmogenic substrate via markedly shorter AERP than PVs in controls (see previous CR topic discussion). In the March 2004 AFIB Report Hans reported an article from the Cleveland Clinic stating that P cells, normally found only in nodal tissue (SA node, AV node), were found in 5/5 with AF and in 0/5 controls without AF. I think these P cells become damaged, because it takes many years for LAF to develop. Otherwise, we'd have LAF from birth. And, of course, the success of PVI for AF certainly supports this interpretation.

My own personal experience with LAF episodes suggests that vagal tone and low potassium work in concert. My 9AM

potassium values are usually right around 4.5. That would put me well under 4 during the night. The simultaneous appearance of high vagal tone and low potassium would accentuate the shortening of AERP. This would conveniently explain my typical middle of the night episodes.

However, during the late morning or afternoon I've had occasional episodes (less than 10% of the total) that appear to be related to possible dehydration and/or hypoglycemia. Both of these stimulate not only catecholamine but also ACTH and aldosterone release (as does physical or emotional stress). Oftentimes I've had just a pastry for breakfast. Talk about an open invitation to an insulin surge. My HR is usually over 70 with low vagal tone at the time, but the episode is nonetheless triggered by a vagal maneuver. Presumably the insulin and fasting state induce the hypoglycemia. According to one study, AERP is shortest under hypoglycemia (v. hyperglycemia) in the left atrium (v. the right atrium). The hypoglycemia induced catecholamine secretion (for gluconeogenesis, i.e., glucose is produced by the liver to address the hypoglycemia) may cause additional shortening of the AERP. It achieves this through the potassium channels. A greater potassium gradient would presumably augment this shortening.

On very rare occasions I've triggered an episode by a short sprint. Here again, the timing of the episodes in the late afternoon before dinner suggests hypoglycemia and catecholamine activity. In fact the catecholamine surge that occurs causes a rapid, transient transcellular shift of potassium, resulting in a short-lived but dramatic fall in blood potassium of approximately 0.5-0.6 mmol/L, depending on the magnitude of the effort. Although these shifts are evanescent and readily reversible, the transient drop in blood potassium triggers PACs (and PVCs) and sometimes AF.

I've also had episodes that are postprandial, but only in the evening (presumably because there is more reinforcing vagal tone at this time). Initially I thought this was due primarily to the alkaline tide associated with a meal and subsequent urinary potassium loss. Then I thought that it was due to the effect of insulin and loss of cardiac intracellular potassium due to the increased concentration gradient. Then I thought I might have a mild problem with gastroesophageal reflux (GERD)/lower esophageal sphincter (LES). GERD is increased in athletes, especially in those that run, which I do. However, now I'm inclined to think that evening meals with poor K/glucose and K/Na ratios are the primary problem. I once thought that seafood (lots of salt) at dinner was a trigger. Looking back on such episodes, these meals were often low on the veggies and high on the simple carbs (love my desserts).

My present view of my flavor of LAF is that

Late evening or early morning episodes – probably vagally induced and low potassium related (diurnal nadir)

Late morning or afternoon episodes – probably physical stress/dehydration/hypoglycemia and low potassium related (insufficient potassium intake and excess potassium loss)

Early evening episodes – especially low potassium related, aggravated by an imprudent dinner (see above)

Undoubtedly the majority of you are different. But if you look closely at your personal particulars, perhaps there is a common thread.

Like James D, I've become less inclined to differentiate adrenergic from vagally induced. Both arms of the ANS cause shortening of the AERP. So does low blood potassium. So either arm in combination with low potassium can trigger an episode.

Hans went from typical stress related adrenergic AF to typical vagally mediated AF, when he briefly took spironolactone, which has a vagotonic effect (in addition to being a potassium sparing diuretic). So, it seems that LAF can appear anywhere along the spectrum of autonomic tone. And remember, Hans always ran right at the lower limit of normal with his blood potassium. And his aldosterone, a vagolytic, and cortisol were always elevated (both aldosterone and cortisol bind to mineralocorticoid receptors, i.e., cause urinary loss of potassium). Furthermore, although there was never much change in his blood potassium (3.5 – 3.7 mmoles/L). His urinary potassium (and magnesium) excretion continued to escalate, as he approached the next episode. Obviously there was continual leakage of potassium from the intracellular compartment to maintain the constant blood potassium concentration in the face of escalating urinary loss.

Many LAFers have commented on what seems to be a repeating periodicity to their episodes. It seems that the length of my episodes were directly proportional to the time interval before the next episode. Others, including myself, have speculated that the answer to both of these observations may lie with ANP (atrial natriuretic peptide). This is secreted during episodes via a mechanism that involves atrial cell stretch. It is an aldosterone antagonist. Perhaps during the

episode there is a repletion of intracellular potassium. Perhaps when sufficiently repleted, the episode terminates. Perhaps after termination subsequent life style and diet combine to slowly deplete these intracellular potassium stores until some threshold value is breached and another episode is triggered.

Another interesting question is why proton pump inhibitors (PPI) not only relieve GERD but also appear to relieve AF. Is it only because there is less irritation of the lower esophagus (and less vagal stimulation)? Or is it also because of an improvement in potassium balance? Gastric acid production is a two step process. First, gastric parietal cells secrete KCl into the lumen. Then the gastric cell H⁺/K⁺ pump goes into action and the end result is HCl in the lumen. This latter is the proton pump, because H⁺ is no more than a proton. By inhibiting it less H⁺ is lost in the gastric juice. Less potassium is lost in the urine, because the blood is less alkaline (since the gastric fluid is less acidic). Who knows what the critical factor is? Perhaps Dean can provide some insight.

I think Jackie has hit upon the proper regimen in taking bedtime complex carbohydrates and supplemental potassium. Better listen closely to that girl. And, Jackie, I must thank you again for that tip from your nutritional pioneer and chiropractor Royal Lee, who said "if you can feel your heart beating at night when lying in bed, you are deficient in potassium". This undoubtedly is due to the mild BP elevating effects of low blood potassium. The heart has to work just a little harder, enough to make you aware of its beating, when all else is quiet. Because the insulin induced drop in blood potassium that occurs after a carbohydrate meal is caused by osmosis (entry of glucose into a cell brings water with it, thereby decreasing the concentration of intracellular potassium, thereby stimulating the Na⁺/K⁺ pump to increase intracellular potassium, thereby lowering blood potassium), it would seem prudent to always ingest potassium with your carbohydrates. MW of glucose is 174 and the MW of potassium is 39, which is a 4.5 to 1 ratio. Perhaps 5 to 1 might be a good ratio for dietary simple sugars to potassium, especially for between meal snacks (if you must). As Jackie has pointed out, KCl can cause gastric irritation, at least if taken on an empty stomach. You should never let a meal go by without potassium supplementation thereby exploiting its buffering effect in this regard.

I heartily agree with the general recommendation to shift from simple to complex carbohydrates in our diets. I used to think this advice was better directed at those that struggle with their weight. However, given my problems with episodes being triggered when I skip or delay meals, I think thin people can also benefit from it. Eat properly and don't skip meals. Graze rather than gorge. Earlier is better than later.

I've been experimenting with spironolactone off and on for over two years. It peaks in blood in about 2 hours with a 10-20 hour half life. I started with just 25mg per day and slowly increased the dose. Initially I didn't supplement with potassium, but soon started supplementing a small amount. Then I tried increasing the dosage of spironolactone. Then I'd withdraw spironolactone or potassium, reinitiate, etc., and gauge the effect on episodes. Although I consider myself adventurous, I don't take chances needlessly. I'm presently experimenting with a total daily dose of 100mg spironolactone divided between AM and PM. In the PM I accentuate the potassium supplementation (1.5 – 2.5 gm per day in 300mg pulses throughout the day), because it is during this time frame that blood aldosterone level is lowest. Might as well stimulate the production of more aldosterone via potassium supplementation. Then at least the PM spironolactone has some aldosterone to block. Accentuating the afternoon magnesium supplementation (I prefer neutralized aqueous magnesium AKA Waller water throughout the day) gives even more bang for the buck, since spironolactone conserves magnesium as well as potassium. This is precisely the time when magnesium absorption should be greatest, since blood magnesium is lowest at 1530. Although my PACs are better controlled with this approach, the experiment is ongoing, at least until I either sprout tits (gynecomastia) or require Viagra (impotence), both reportedly adverse effects of spironolactone. Increased vagal tone continues to be my main trigger and disopyramide continues to deflect that problem. Furthermore, I think good potassium balance potentiates the disopyramide. This is certainly consistent with the fact that disopyramide is both a sodium and a potassium channel blocker. If the potassium gradient is less, then fewer potassium channels have to be blocked.

One brief word on Waller water. This is an aqueous magnesium preparation divined by our own Erling Waller. He was one of the first to realize that many LAFers owe their malady to magnesium deficiency, at least in part, since it is inextricably entwined with maintenance of intracellular potassium. He created the recipe (soda water and milk of magnesia), which can be found at www.afibbers.org/Wallerwater.htm
Thank you, Erling.

In a previous post on the BB I suggested that a portable potassium meter might be a very useful item for an LAFer. Horiba and Hoskin Scientific make good ones, but they are not quite ready for prime time, at least not in humans. I

recently purchased an Omron BP monitor (less than \$50 at Costco) and have found that relative evening BP (slightly higher systolic than normal) and/or the presence of PACs when lying on my right side (see previous CR topic) both provide feedback on probable intracellular potassium. Being on top of my daily potassium supplementation definitely decreases my evening PACs and BP. Although this is only an indirect approach at best, it presumably helps prevent PM AF.

Conclusion

You can't directly control the arrhythmogenic substrate (PVs) except through PVI. You can't effectively control vagal or sympathetic tone except through meds. That leaves low potassium. The long and the short of this post is that if you want to get serious about controlling your episodes, then you must get serious about your potassium intake. You must address not only how much you ingest but when you ingest it. Either avoid those situations that assault your internal potassium balance (stress, hypoglycemia, dehydration, ...) or increase your daily potassium (and magnesium) intake with appropriately time targeted supplementation. Although food sources are best, they are much less convenient and intake is less quantifiable. And then there's the glycemic load problem they pose. Presently there is great resistance within mainstream medicine to combining potassium supplementation with an aldosterone blocker. Hyperkalemia and life threatening ventricular arrhythmias are of great concern. However, with the pioneering work of Drs. Struthers, MacDonald and others this overemphasized concern may soon take a back seat to a rational combination regimen. In my view it is quite plausible that this LAF epidemic might disappear entirely if such an aggressive regimen were pursued by those afflicted. The study that needs to be done is one similar to the above referenced one on LQTS (long QT syndrome), but on LAF patients instead. But until then please remember my above disclaimer and make sure you have good renal function. In fact I'm due to have some lab work done this week to monitor my blood potassium.

I sincerely hope you find this information useful.

PC

Hmmmm. PC, this is a lot to think about. Also, the more technical parts of it are going to require some re-reading in order to get full comprehension. But i think i mostly follow you. If i understand you right, maybe my habit of taking my second dose of supplements and washing them down with the second glass of l.s. v8, with its convenient 850 mg of K [mostly from added KCl] right before going to bed might be partly responsible for my yearlong freedom from afib. That is, the timing of that dose of KCl may be what makes it so effective. Chronobiology, indeed.

PeggyM

PC - great job! Thanks for all of your work. I know that eating early and my Mg & K supplement program have done a great job of keeping me in NSR so far. I may tweak the timing a bit after further study of your work.

As to the cheapest/easiest source of potassium. I had been taking 3 gr/day in the form of 30 - 99 mg capsules. I read about being able to get powder at the drug store, so I went & asked. All they had were prescription tablets. Went to several health food stores & they didn't know about anything but 99 mg tablets. I finally found Now Foods Potassium Chloride Powder. This is pure KCl. There is about 120 grams of K in the container & it costs \$3.16 at iherb.
<http://store.yahoo.com/iherb/potassium2.html>

This is about a 40 day supply for my 3 gr/day habit, so its pretty cheap. By way of comparison, the prescription potassium was about \$30 for the same quantity of K. The health food supplement cost is around \$45-\$55 for the same amount of K (in 99 mg tablets). Certainly well worth it, to stay in rhythm, even at the high cost, but I like the lower cost better.

I usually mix 1.5 gr in some juice to cut any stomach issues (& get a little carb kick). My digestion is actually better than when I took 15 caps, 2x a day. I think all the filler didn't agree with me.

George

PC - Well, you've outdone yourself this time! Hans was correct...this is brilliant. We're reached a milestone here in BB history....this is truly a time for pause and celebration. My deepest appreciation for your wisdom and efforts. Thank you.

Amazing when you lay it out like this, how simplistic or "obvious" it becomes...when you guide us down the path....yet look how long you've grappled with the biochemistry of this dilemma. What a wonderful thing to have finally "discovered."

I want to see this published in the Journal of Cardiology. :)

Now, let me comment on the dietary aspect you touched on for the evening snack and a few carb comments, in general.

For the evening snack, I always say protein based and a complex carb with a good fat. I don't ever recommend just a complex carb as a snack.

Since I've had the insulin resistance problem which I've fairly well reversed, eating carbs of any type - singularly - is just not a wise choice. At least that's what my experts say who deal with metabolic syndrome.

I will never condone sugar or simple carbs in a diet at any ratio. That's just asking for trouble. The very fact that a person has a "sweet tooth" is evidence that they have trouble handling simple sugars. Possibly, some people can pull it off by protecting with other measures (like a handful of potassium tablets) but with all the other conditions besides AF caused by dietary simple sugars, I don't think it's healthy to even discuss including them except for a very rare treat. As Ron Rosedale, MD, likes to say... what's the body's carb requirement? Answer - zero. (or words to that effect)

Back to the topic at hand.... Potassium

Again, this is a brilliant piece of work. I commend you and thank you whole-heartedly for all the time, effort and brain power you have devoted to this extraordinary post.

I will be copying it and passing it out to physicians who are interested in treating AF patients by means other than drugs and ablation.

Afibbers of the world should be indebted to you for this information.
Now if they will only listen.

Kind regards,

Jackie

PC, thanks for continuing to apply your mind to gaining an understanding of what initiates afib. Another great job! If I was in Hawaii the only thing I could ponder would be the wahinis on the beach :)

I've always assumed that I didn't have a problem with potassium because My serum levels were always near or just over the high end of the spectrum at 5.0. I know that serum potassium levels are only representative of 1-2% of potassium in the body but they have not been mentioned as not being representative of the intracellular levels in the same way that Serum magnesium has. Is this indeed the case? If so then all the more reason to get intracellular levels tested. Once again I am left in the dark. Universal Health Care can be very limiting.

Interestingly (at least to me), After Christmas I had a little bout of flu that lasted about 24 hours and involved many trips to the bathroom with severe diarrhea. I thought that I was losing valuable electrolytes so I started adding 1/4 tsp of KCL (no salt) to my favorite magnesium water source -Concentrace mineral drops. Thirty drops in a 600ml bottle supplies about 125 mg of Magnesium. The interesting part was that I stayed in NSR for 6 days, which for me is somewhat of an event as my normal rhythm is 2 days normal and 3-4 days afib. I thought it must be the potassium so

continued to add it to the water. I stayed afib for 8 days. Why would that be the case?

Initially I was doubling my water intake to make up for the losses so I was probably getting about 2000 mg extra per day. After two days that was probably cut in half. After 5 or six days of afib I stopped the extra potassium supplementation altogether as I was starting to think I was getting too much of the extra stuff that is in No Salt. If the potassium was the reason for the NSR extension why did I stay in afib for such a long time after? Or was I just not taking enough?

Perhaps I should follow George's lead and get the KCL powder to avoid the extra stuff (adipic acid, fumaric acid, silicon dioxide, mineral oil) that's in the no salt. Continue the experiment a bit longer and see what happens as it were. I think my renal function is ok. Which tests are indicative of good renal health?

Good Health

Adrian

George,

Thanks for the advice about potassium in powder form. It turns out Hans just passed on that same information to me. And I placed my order through www.afibbers.org/vitamins.htm under "Essentials for the Heart" for this Now Foods product.

Jackie,

Thanks for the kind remarks and especially for the comments on sugar. I'm one of those that love sweets.

Adrian,

IMHO the reason you and the rest of us stay in AF despite taking more than adequate potassium lies in the fact that it takes more than potassium to start and/or stop it.

It's all about shortening of the refractory. It is what enables the reentry (wavelets) required to sustain AF.

Low potassium causes it, both arms of the ANS cause it, and the abnormal P cells in paroxysmal AFers (see related CR topic) cause it.

There is a certain threshold value for length of refractory period below which AF is triggered. For any given AF episode the contribution of any one of the three may vary.

I personally don't think I will ever be able to go without an antiarrhythmic. However, by being super aggressive with potassium supplementation, I'm hoping that I will be able to reduce the amount of antiarrhythmic I will require to stay in NSR. Besides there are many other advantages to good potassium balance.

It is becoming more apparent to me that to achieve that good potassium balance, an aldosterone blocker is absolutely essential balance

And good renal health is reflected in blood creatinine (less than 1.3) and BUN (blood urea nitrogen, less than 20).

PC

Wow,

A classic braincrammer for sure! I like to think I'm quite a bright chap what with a PhD and all.... However, reading PC's

posts always provides me with ample evidence that I'm not actually all that clever at all. I've read the post twice now and for 20 or so minutes each time. And I'm still struggling. AF is a confounding animal because of the multiple and subtle factors involved, and I really prefer to deal with things in simple terms if at all possible. What I've gleaned and deduced from PC's post in basic/simplistic terms is:

1. Blood K values are highest at midday and LOWEST at midnight. Therefore it is in the middle of the night as it were when cardiac intracellular K will be lowest as it leaks out into the blood plasma. (Will lower blood K or Mg always thus equate to lower intracellular K or Mg or is this (once again) an over-simplification?)
2. Blood Mg is highest at 330 and lowest at 1530.
I'm thinking, therefore, that cardiac intracellular Mg is highest at 3.30 in the am.
3. A large evening meal will increase insulin which will lower blood (and intracellular) K.

Some additional and pertinent facts pertaining to me:

1. All of my AF episodes have occurred at around 3.30am.
2. A couple of years ago I had a IM Mg injection at 9am after which I had a PAC-free day (unusual for me) BUT a hellishly ectopic evening.
3. I once tried to take spironolactone, and after the first day of taking it I had a REALLY heavy evening of ectopics and runs of ectopics: I awoke at 3am convinced I was in AF but the episode/long runs of ectopics reverted to NSR after about 20 seconds... relief.
4. I have heightened startle and quite a bit of muscle twitching in my eyes in particular. I also tested at bottom of range for leucocyte Mg and was mildly deficient further to the Mg-loading test (associated with the IM Mg injection mentioned above). But, whilst likely being low in Mg, Mg supplements - in whatever form incl taurate & glycinate - always demonstrably increase ectopy.

So when I get my AF episodes, blood Mg is highest and blood K towards its lowest. Mg supplementation always increases ectopy for me. However, I test at the low end for intracellular Mg. My blood/serum K is (taken 9am typically) around 4.3 - 4.5.

If VMAFr's like me get AF when blood (and intracellular) Mg is highest, does this indicate that Mg isn't a problem for VMAFr's?? (That would for me tie in to Mg supplements always increasing ectopy.) But that is I accept a gross and absurd generalisation and I'm sure I'm the exception rather than the rule for a VMAFr in this regard.

I obviously remain quite perplexed as to what to do for the best. I already eat a VAST amount of organic veggies and salads every day. I'll try adding a Jackie-style snack in the late evening along with a hit of K to see what sort of difference that makes. I'm hardly, however, in much of position to experiment given I haven't had any AF for 15 months (and grateful for it). I do, however, continue to experience a LOT of ectopy - mostly at its worst around midday strangely enough. I also frequently get one or two quite unpleasant and uncomfortable runs of ectopy whilst driving. So hard to find rationality in amongst all of this!

Thanks again PC for making me think.

Mike F.

PC,

For certain, you are headed for a Nobel Prize...

What precisely is your 24 hour schedule with respect to K and Mg supplementation and timing?

How do calcium and salt enter into this picture?

Have you been diagnosed with hypoglycemia?

To refresh our memories, is the daily recommended amount of K 3.5 to 5 grams?

Carol

Potassium canrenoate (intravenous) doesn't sound like a good over the counter solution but it seems to support what you are saying. Aldosterone antagonist helps lengthen the AERP?

Adrian

http://www.ishne.org/scientificnews_06_04_05.shtml

*Fletcher J, Buch AN, Routledge HC, Chowdhary S, Coote JH, Townend JN.
Acute aldosterone antagonism improves cardiac vagal control in humans.
J Am Coll Cardiol. 2004 Apr 7;43(7):1270-5.*

The authors of the present study examined the acute effects (<45 min) of aldosterone antagonism on heart rate variability and baroreflex sensitivity, markers of cardiac vagal control, in 13 healthy subjects. Evidence for the beneficial effects of aldosterone antagonists comes from studies showing increased survival rates following their addition to standard heart failure therapy. Many mechanisms have been suggested for this action, including effects upon the autonomic nervous system. Heart rate variability and baroreflex sensitivity were examined 30 min following the administration of potassium canrenoate (intravenous) (aldosterone antagonist) or saline (control).

Active treatment reduced resting heart rate (-6 +/- 1 beats/min [mean +/- standard error mean]) compared to control (0 +/- 1 beat/min) ($p < 0.001$) and increased measures of high frequency (HF) heart rate variability. Root mean square of successive RR interval differences increased by 21 +/- 5 ms versus -6 +/- 5 ms control ($p < 0.001$); HF power increased by 1,369 +/- 674 ms² with aldosterone antagonism compared to -255 +/- 431 ms² following saline infusion ($p < 0.01$). Baroreflex sensitivity (alpha-HF) was increased after active treatment (+4 +/- 2 ms/mm Hg vs. 0 +/- 1 ms/mm Hg control [$p < 0.05$]). No changes in plasma potassium levels were observed. The results of the present study provide evidence that aldosterone antagonists acutely improve cardiac vagal control, irrespective of any diuretic effects, and may in part explain their beneficial effects in treatment of heart failure.

Comment: The independent relationship between impaired cardiac autonomic control and prognosis in disease states such as heart failure suggests that high levels of sympathetic activity and reduced vagal control may exert direct deleterious effects. Clinical studies have demonstrated that in heart failure patients, chronic treatment with spironolactone improves cardiac autonomic control measured by heart rate variability. These studies could not, however, exclude the possibility that the improved heart rate variability was secondary to the beneficial haemodynamic effects of spironolactone rather than any direct neuronal or receptor-mediated effects. The present study demonstrated that, acute administration of the aldosterone antagonist potassium canrenoate results in an increase in HF measures of heart rate variability and an increase in baroreflex sensitivity, suggesting that aldosterone exerts a tonic inhibitory effect on cardiac vagal control. These results cannot be attributed to changes in circulatory volume, blood pressure, or potassium concentration, or by chronic effects on vascular fibrosis and compliance at the arterial baroreceptors.

(Polychronis E. Dilaveris, MD, FESC)

As regards to PC's comment:

"Low potassium causes it, both arms of the ANS cause it, and the abnormal P cells in paroxysmal AFers cause it."

I suppose there is one other element, that of remodeling. This is why people who've had afib for a while generally don't respond as well to just upping the K or avoiding triggers.

I've felt, in my case, if I can get the potassium level correct in my cells, then the other causes don't matter. However, if my potassium is low, then I really need to be worried about triggers.

I use the level of ectopics, as measured by either the Polar S810 HR monitor or the FreezeFramer HR monitor, as my guide as to how I'm doing getting the potassium level correct I've tried unsuccessfully to correlate my level of ectopics with what I take in for supplements & food. Also with time of day or activity level. My total program is working well enough to keep me out of afib, however I can't answer the question as to what variable(s) change for me to go from 1 ectopic / hour to 30 / hour in the same day. Being a purist -- I'd like to drive them to 0 and keep them there. It also gives me a great appreciation for those medical researchers (like PC), trying to glean an insight. In fact looking at the results from the paper Adrian posted, made me remember trying to measure some of those HR variability parameters on myself, and how much a couple of ectopics changed the outcome.

George

Adrian,

Forgot to answer one question in your first post about potassium and whether blood potassium reflects tissue levels, unlike magnesium. The answer is YES and NO. Yes it does, if at the time the blood is drawn there is no significant recent stimulus for insulin or catecholamine secretion. Otherwise, no it understates tissue levels.

Regarding the article on potassium canrenoate, it's a good one. In an 11/6/04 BB post on BRS (baroreflex sensitivity) and aldosterone I referred to it with a hyperlink for the article. But keep posting what you find.

Carol,

I've never had a blood glucose drawn at the appropriate time to definitively document hypoglycemia. All my evidence is circumstantial. In fact most of my conclusions regarding LAF rest on circumstantial evidence correlated with what I've gleaned from the literature. I think it is important to remember that hypoglycemia/hypokalemia are strictly defined lab values. In reality they are quite dynamic and bounce all around during the circadian cycle. Furthermore, a value of 3.4 mmoles/L potassium may be hypokalemia and 3.5 may not be, but the difference is semantic and not substantive.

As far as salt is concerned, I've gone round and round in my own mind on this. First I avoided it assiduously, then I didn't and even added it to my ww. Now I don't. But in view of the heavy supplementation with potassium, perhaps it would be wise to add some sodium. After all it is the Na/K ratio that determines the stimulus for aldosterone. No need creating more such stimulus needlessly. On the other hand, aldosterone is vagolytic and perhaps slightly elevated aldosterone levels might not be all that bad. I guess it depends on what kind of receptors aldo hooks up with that create this vagolysis. I know that too low a dietary K/Na ratio is bad. Perhaps too high a ratio isn't good either. So, in the end, I just don't really know what to do about salt.

Calcium is more of a problem in remodeling. Hopefully we're not there yet. So I don't really avoid it or seek it out in my diet.

Regarding my potassium supplementation regimen, I think it is very important to say that any diligent effort in this area is doomed to failure, unless accompanied by an aldosterone antagonist, due to its reflexive effect of aldosterone. I think Dr. Struthers is right in this regard. Although I usually run K's of about 4.5 mid morning, 3gm of daily potassium and 100mg of spironolactone only increased it to 4.7. I'm now taking 5-6 grams of supplemental potassium per day along with 150mg of spironolactone. In about a week or so I'll get another blood potassium drawn and, if it's at least 5.0 at 9AM (implies a midnight blood potassium of less than 4.5), I'll increase both (maybe 8grams and 200mg respectively).

George,

I'm with you on the correlation between intracellular potassium and PACs. Whenever you notice them, you are at risk for an episode and it will usually come as a result of a vagal maneuver which will put you through the AERP threshold. Just remember that it's pretty difficult to reach that "no PAC" nirvana in the absence of an aldosterone blocker, no matter how much potassium you take and no matter when you take it. It is the somewhat irrational fear of hyperkalemia by mainstream medicine that is preventing MDs from prescribing an aldosterone blocker with potassium supplementation over 3gms or so, which is the present recommendation from them in the absence of an aldo blocker.

Mike,

I wouldn't rock the boat on spironolactone or anything else. Don't fix it if it ain't broke.

Although magnesium is critical, potassium is the principle player in all this. That Na/K ATP and Mg requiring pump is in great demand for the 6 hours between 9PM and 3AM, when the potassium gradient is greatest and all those passive potassium channels on the cell membrane are leaking potassium. P cells or pacemaker cells are different from nonpacemaker cells in that they have different Na and K channels that allow them to depolarize spontaneously. Hypokalemia enhances this tendency to depolarize or fire. Hence, LAFers get ectopic PACs from the P cells within PVs during periods when blood potassium is low. Reentry occurs because of a shortened refractory period. A shorter refractory period makes any cell more receptive to abnormal beats. If it was longer then, then the cell would be refractory and couldn't propagate the impulse sent by the ectopic site. I hope it doesn't sound too complicated.

I have no doubt that we will soon see an article in the medical literature that will show that P cells can be found at other sites outside the PVs. Such P cells require focal ablation in addition to PVI. Pappone's group in Milan has shown that ablation of "vagagal reflexes" during the procedure in addition to PVI improves outcome.

PC

PC,

Thanks for the further input.

Apols if you have already answered this somewhere above, but can I please repeat my possibly over-simplistic Q "Will lower blood K or Mg always thus equate to lower intracellular K or Mg?" (I.e. low plasma K or Mg will lead to K or Mg leaking out of the cardiac cells.)

Further to your comment to me above that 'if it ain't broke don't fix it', whilst I take your point (my not having had a full-blown AF episode for 15 months), what I WANT to fix is the considerable and frequently unpleasant-feeling ectopy that I experience.....

I'd bet that I get more ectopy on a daily basis (100 or more singles and one-to-several short (few second) runs of ectopy) than the average AFR here who I'm postulating will, in contrast to myself, get an AF episode almost every time they experience the same kind of run of ectopy which I experience on an almost daily basis. I, however, have not had a full blown episode of AF for 15 months. Further to being as educated as my non-medical brain will allow me further to reading your own postings, I'm thinking that whilst my ectopic foci fire quite frequently, my AERP does not (thankfully) seem to shorten enough to permit such firing to instigate AF... at least for the vast majority of the time.

I figure if I can greatly reduce the ectopy, then I could well be far safer as regards the likelihood of future AF episodes. Question is, how could I best approach accomplishing this?? Can leaky K channels cause ectopic foci to fire more readily?? Is my problem that I simply just have too many ectopic foci and there's little I can realistically do to stop them firing short of ablation?

Any further input would, as ever, be most appreciated.

Thanks again for your admirable endeavours PC,

Mike F.

PC, can you clear this up for me, please? You say that "Regarding my potassium supplementation regimen, I think it is very important to say that any diligent effort in this area is doomed to failure, unless accompanied by an aldosterone antagonist, " and "Just remember that it's pretty difficult to reach that "no PAC" nirvana in the absence of an aldosterone blocker, no matter how much potassium you take". I am not saying this to give you an argument, but to

clear up some confusion on my part. If the foregoing statements are true, how come so many of us have had such sterling success at getting rid of both ectopics and afib by supplementing with low sodium v8? Is there something effective in it besides the added KCl?

PeggyM

Hi Peggy and Mike,

Philippe Coumel said "There are always three main ingredients required for the production of a clinical arrhythmia, the arrhythmogenic substrate, the trigger factor and the modulation factors of which the most common is the autonomic nervous system." Hans called this "the concept of the triangle of arrhythmogenesis".

As I've stated repeatedly in the past, daytime (adrenergic type) episodes are due more to low intracellular potassium, whereas nighttime (vagal type) episodes are due more to vagal tone. Vagal tone shortens the refractory period more than sympathetic tone. Sometimes a vagal maneuver can trigger a daytime episode but it's primarily a problem with potassium.

As I've also stated in the past, too much autonomic tone can combine with just a little dip in intracellular potassium to trigger an episode. Similarly a big dip in intracellular potassium combined with only slight autonomic tone can do the same.

I've even gone so far as to say in a past post that ALAF ought to be called hypokalemic LAF. Hans' experience with spironolactone certainly supports this interpretation. I think all LAFers begin as VMAFers and these middle of the night episodes go unnoticed until they change to more typical adrenergic type episodes due to deteriorating potassium balance. In these latter individuals the diurnal rhythm of aldosterone/cortisol combined with self induced (stress related) spikes are dominant and determine when episodes occur. Once the potassium problem is addressed either the episodes will disappear entirely or they will become more vagal, as they did for Hans. Perhaps more spironolactone (I think Hans was only on 25 or 50mg) and potassium supplementation may have improved the situation. Who knows. Undoubtedly there are other factors that impact autonomic tone that may have been at work.

So, Peggy, for you and others I'd say that potassium imbalance in the past has been the dominant contributor and autonomic tone less so. Your innate vagal tone is also probably less. But we all still have the arrhythmogenic substrate in the P cells.

You are probably more like Erling and Fran in the makeup of your triangle. Even Erling had a visit from the unwelcome visitor several months back when he was admittedly imprudent on a hot day and got considerably dehydrated. Fran also had a very brief episode about a year ago when she was under a GREAT deal of family related health induced stress and was forced to depart from her usual dietary regimen.

And, Mike, all I can say is low intracellular potassium causes PACs and PVCs. K and Mg are the best antidote for this, but they seem to aggravate the problem in your case.

PC

PC, I think I am just not understanding what you are saying. Can you try to restate it somehow so it will get thru to my pinhead? In your statements above, you seem to be saying that potassium supplementation is not helpful in correcting ectopics and afib itself unless accompanied by an aldosterone blocker. Do I have that right?

If I do understand you correctly, then I do not understand how so many of us have gotten rid of our ectopics and afib by drinking sufficient quantities of l.s.v8, which I have believed contributed only potassium in the form of KCl added by Campbell to make up for the salt they did not add to this version of v8. Does something in the v8 act as an aldosterone blocker, or have I missed something important in what you said? Or can someone else help with this? I get this elliptical feeling when I read your reply above, as though you and I are talking past each other somehow.

PeggyM

Peggy,

Sorry that I've not been clear enough.

What I'm saying is that

- 1) Potassium supplementation definitely works.
- 2) In a few it may "cure" LAF even in the absence of an aldosterone blocker.
- 3) However, for most in order to "cure" LAF (P cells will forever lurk in the background should we be remiss in either our potassium intake or unintentionally accentuate its excretion) the required potassium supplementation must be accompanied by an aldosterone blocker.

Right now I'm at the early stages of an experiment to test the validity of speculation that ANP induced rebalancing of intracellular potassium during an episode not only may terminate the episode but also may determine the interval before the next episode.

During frequent prolonged vacations in Hawaii it has always my impression that LAF episodes were more frequent here. Before discovering the beneficial effect of disopyramide after returning to the Mainland I was able to go 5 weeks in HI without an episode simply because I increased my water intake to at least 2 liters per day. So, I thought my problem was at least partially rooted in aldosterone and potassium loss.

While living on the Mainland I was able to completely avoid episodes with 750mg disopyramide per day. I could never get to 625mg without going into AF within a day or two.

Upon moving to HI I had to increase my dosage to 1000mg per day to achieve complete protection. As I've said, I've been off and on spironolactone (max 50 mg) with and without at least 2gm of supplemental potassium. Although I could get back down to 750mg disopyramide per day with this regimen, that was it.

If ANP is able to rebalance intracellular potassium, why can't spironolactone and potassium supplementation do it as well. Theoretically one should be able to recreate the intracellular potassium balance present immediately after termination of an episode.

I'm now on 5-6gm of supplemental potassium (in addition to plenty in my diet) and 150mg of spironolactone (sure is nice to be able to write my own prescription). With this combination I've been able to go three days and counting without AF or PACs while on just 500 mg disopyramide. I've had my blood potassium redrawn while on this regimen and am awaiting the result. It's most premature to draw any conclusions at this juncture, but I find the prospects encouraging. Will keep you informed.

PC

Ok, PC, that makes sense. I think there are more than a few of us getting success with K supplementation, though, whether using v8 or "the hard stuff" to supplement with.

PeggyM

Peggy,

I believe the situation is like this:

Some people may benefit from extra potassium without blocking aldosterone, but they are likely in a minority. There are two ways of blocking aldosterone; You can either do it by inhibiting its production or by preventing it from docking at the mineralocorticoid receptors (MC receptors).

ACE inhibitors and Angiotensin II Type 1 Receptor Blockers inhibit the synthesis of aldosterone through their action on the RAAS system, spironolactone and eplerenone act by blocking the MC receptors. Finally, potassium-sparing diuretics like triamterene and amiloride act by directly preventing the excretion of potassium through the kidneys.

As I recall from earlier postings you were or are taking lisinopril (an ACE inhibitor) and Erling was and perhaps still is taking triamterene. Both would help to conserve potassium and thus elevate levels.

Hans

PC:

I have had similar experiences to Mike in the taking of spironolactone, more pvc's, even at a very low dose. Also, over the last few years of bloodwork my potassium levels have always been quite good---4.5 to 5.1, I understand your saying that if blood were drawn at 1:00 a.m., they might not be as good.

I need to qualify that I only took spironolactone for a few months last summer, so your hypothesis of taking spironolactone/potassium boosts k doesn't pertain to all the other years when my blood potassium levels were good.

In looking through some of my lab values (4/03) I note that I had an aldosterone, 24 hr urine test which was 2.0 (low) -- - lab values for a random sodium diet: 2.3-21.0 ug/24 hrs. Potassium level 4.4, with mag. 4.6--mag. is on the low end of the scale. Now does this mean if my aldosterone level goes up (assuming it will) will my potassium go too high.

As regards to kidney function my creatinine has always been good, last one 0.9 (lab value 0.5-1.2 mg/dl)but my bun is always high, over the lab value--33.0 (6-25), it has been that way for years and years, I am always told that I do not drink enough water (which is true), I really have a hard time getting enough fluids, I hope the docs are right and this is the reason, now having said this, for me, taking in more K might have adverse effects.

Just a comment about feeling your heartbeat when lying down at night, I have had this phenomenon for a number of years as well. When I was having my symptoms of Graves disease, this would drive me crazy until I was diagnosed and given a beta-blocker which helped greatly before my thyroid was ablated. As we know, being hungry makes your heart beat faster and harder. For me, I believe the drug synthroid, which I now have to take, is part of the problem in my strong heartbeat, which I am still aware of at night. What I am saying is that it isn't only low K--that is too easy--there are other dragons to slay.

Great piece of work PC, I too am reading and re-reading, I guess you are our guinea pig, disopyramide, spironolactone high K intake---a little scary for me.

Liz

Hans, i am cutting the 10mg lisinopril tablets in half and just taking 5mg each morning. Perhaps you also recall a lot of posting about bedtime aspirin to reduce bp? I am still doing that. It obliterates the morning bp surge. This still leaves the much smaller bp surge around 2-3 pm, which is controlled by the very small dose of lisinopril. If anybody ever figures out why bedtime aspirin has that effect i hope they will tell me. By that i mean, what is the mechanism by which aspirin has that effect when taken at night and not when taken in the morning? Something to do with chronobiology, but what exactly?

PeggyM

Peggy,

Off hand I have no idea why the bed-time aspirin works to reduce blood pressure, but I'll look around and give it some thought and let you know if I come up with anything.

Hans

Liz,

Thyroid disease further complicates an already complicated process. TSH, T3 and T4 all cause urinary magnesium (and probably also potassium) wasting and who knows what else wrt LAF. I'm just brushing in the broad strokes.

You might be interested in some of the articles summarized at <http://www.ithyroid.com/potassium.htm>

Good luck

PC

PC,
Great research. I too would like to know why PPI's can control afib . My last blood test 11 months ago showed blood pH of 7.5 and K of 4.5. This blood was taken in a period when my heart was very stable.

What we need here is a comparison of the blood tests for GERD afibbers who have had success with the PPI's measured against the rest of the afibbers to see if any variation exists in the blood profile. This may shed some light onto why PPI's work.

Still digesting your post.

Dean

PC,
You might find the link below regarding relationship between pH and K interesting. Bit beyond me.

http://www.usyd.edu.au/su/anaes/lectures/acidbase_mjb/kandh.html

Dean

Hi Dean,

That link and its references regarding potassium and pH are a little dated. They varied from 1966 to 1982.

It is now generally accepted that low potassium can both cause and be caused by alkalosis, all else being equal.

In renal tubule cells H⁺ and K⁺ have an inverse relationship. When blood pH climbs, then H⁺ goes into blood and HCO₃⁻ (along with K⁺) goes into the urine=>alkalosis can cause hypokalemia. When blood pH drops, then HCO₃⁻ goes into the blood (along with K⁺) and H⁺ goes into the urine. If blood K⁺ drops, then it also drops within renal tubule cells. Therefore, H⁺ > K⁺ in renal tubule cells, H⁺ cation is preferentially excreted in the urine with the organic anions (making them organic acids), causing an alkaline blood.

PC

Hi PC,

So when you do your 9 AM serum potassium test, I presume it is a fasting test, i.e. you don't eat breakfast or take any supplements in the morning before the test. Is this correct?

I've thought about asking my GP if he will let me draw my own blood at midnight (or failing this allowing one of my medical friends to do it for me since the lab near me isn't open at that hour).

Thanks!

George

Hi George,

For me it's not a fasting specimen and it's really only "marginally" postprandial. I try to avoid the extremes of either hypoglycemia or an insulin surge to make the blood potassium result easier to interpret.

I would just assume that your noon (or thereabouts) blood potassium is about .6 mmoles/liter higher than it is at midnight and proceed accordingly. No need to reinvent the wheel.

PC

My experiment to demonstrate that ANP may well be at the "heart" of episode termination has been relegated to the trash heap (not the idea, just the experiment). Despite 200mg spironolactone per day and 6gm of elemental potassium per day, episodes increased in duration and length while on 500mg disopyramide (strong vagolytic).

However, as Thomas Edison once said, "I didn't fail 1000 times, but learned of 999 materials that are not suitable as an incandescent light bulb filament" (or words to that effect). Similarly, I found that spironolactone is quite vagotonic. This property of spironolactone was discussed in Session 33 (Baroreceptor Sensitivity and Aldosterone) of the CR Proceedings at <http://www.afibbers.org/conference/session33.pdf> [Adrian, that article on the effect of aldosterone blockade on vagal tone you recently posted was also cited at that time.]

My own episodes became very atypical. I'd have quite a few PACs then go into tachycardia and that would transit to AF. This followed an afternoon jog twice, when my HR never came down after finishing the jog. Retrospectively, it appears that the more spironolactone I took, a relationship began to develop. Clearly the value of spironolactone in the conservation of potassium is more than offset by its vagotonic activity. I know Hans will agree with that statement. In fact Mike F. posted in Session 33 that he had the worst day of ectopy he'd ever had after one day of spironolactone. I now know why.

My explanation of these atypical episodes is as follows (taken from session 33):

"Moreover, sympathetic and vagal activity do not exclude one another; both may be active at the same time. In fact, vagal effects are more pronounced in the presence of high sympathetic tone and vice versa ("accentuated antagonism") (Levy 1971). When a premature atrial beat hits the atria at a point in time when autonomic tone has created favorable conditions for atrial arrhythmia to occur (in particular shortened refractoriness), both initiation and perpetuation of AF are facilitated. In addition to the above, vagal stimulation produces a marked variability in atrial refractoriness, which also facilitates AF (Liu 1997)."

<http://www.ub.rug.nl/eldoc/dis/medicine/a.e.tuinenburg/introduction.pdf>

p. 24

Although at first this might appear as a setback, it really might be a good thing. If my experiment has succeeded, then ultimately I would just be trading one drug (disopyramide) for another (spironolactone). However, since aldosterone is quite vagolytic, perhaps this property can be harnessed at the appropriate times of the day to forestall VMAF. While aldosterone production through the renin angiotensin aldosterone system (RAAS) and stress related ACTH are not good, perhaps its production in response to increased K/Na in the blood is not all bad. Increasing potassium intake before (say starting at lunch and escalating to bedtime) its diurnal nadir might produce the desired vagolysis.

In the past many of my infrequent episodes in the afternoon (following a round of golf or any activity during which there is prolonged standing) were sometimes thwarted by potassium supplementation. But I was only taking a few hundred grams. The next time I feel the hardingers (PACs) of the unwelcome visitor after such activity I plan to sip a lot more (grams) potassium dissolved in some kind of juice.

So, this is my next experiment. Aggressively supplement with potassium starting in the afternoon and escalating to bedtime. Take a K-Dur (800mg of elemental potassium) at bedtime, because this is a sustained release formulation. And continue my disopyramide, although I'll probably go back to 750mg per day until the spironolactone washes out of my system. Then I'll try to slowly lower the disopyramide dose again. I know most of you will be much more comfortable with this experiment v. the last one. If this one fails, then perhaps there is an aldosterone blocker out there that has no vagotonic activity. I'll have to investigate eplerenone, triamterene (Dyrenium) and amiloride (Midamor). All the ACEIs and the ARBs are decidedly vagotonic, as we've discussed.

I think as a predominantly VMAFer I've been losing sight of the vagal forest for the potassium trees. But don't forget Erling's advice about magnesium. This is all moot if you are Mg deficient.

This is beginning to resemble my approach to golf. Hope springs eternal.

PC

PC,

I think the conclusion of your experiment with spironolactone is an important milestone in our research. We have now both found that the potassium-sparing properties of spironolactone are outweighed by its propensity to markedly increase vagal tone. Since you are a vagal afibber and I am (was :~)) an adrenergic/mixed afibber I would think that it is fair to conclude that spironolactone is not likely to be helpful to anyone with lone atrial fibrillation. It will certainly be interesting to see if potassium supplementation - and of course, Waller water will do the trick or you will find that a potassium sparing diuretic is needed as well.

Hans

Hi Hans,

Thanks so much for responding. I agree with you 100%.

During my experiment (spironolactone and heavy potassium supplementation) my blood potassium got well over 5 and yet AF still made an appearance. Clearly, the vagotonic downside to spironolactone exceeds its upside in potassium conservation.

VMAF

Excess aldosterone may not be the enemy in VMAF. The problem in VMAF may be insufficient aldosterone (a strong vagolytic) with consequent enhanced vagal tone (please visit Session 33 in the CR on Baroreceptor and Aldosterone). It is well known that endurance athletes have low levels of aldosterone.

In view of this it would seem that in VMAF ANP (atrial natriuretic peptide) and its potassium conserving properties may

be less important than aldosterone (vagolysis) in terminating an episode. Aldosterone troughs between midnight and 4AM (peak vagal tone) and starts to climb after that, peaking around 8AM (peak vagolysis). The diurnal nadir of blood potassium at midnight certainly further depresses aldosterone secretion. This would certainly coincide with the time that most night time episodes are triggered and terminate respectively. I've always noticed that my HR is always higher than normal and HRV is lower than normal immediately after termination of an episode (Polar S810). This will last for several hours depending on how long the preceding episode lasted. I think this may be due to the blood volume lowering effect of ANP (the result of the big pee, as Hans calls it). When blood volume dips to a certain threshold level, aldosterone secretion responds, vagolysis ensues and the episode terminates.

During the initial phase of aerobic exercise withdrawal of vagal tone precedes the increase in sympathetic tone. Perhaps this is mediated by aldosterone. I've converted to NSR during a light workout, but, if it happens, it always happens early never late.

ALAF

Hans' adrenergic LAF (ALAF) was clearly associated with well documented increased cortisol and aldosterone. In view of his experience with spironolactone (morphed from an ALAFer to a VMAFer while on it) it would seem to me that decreased intracellular potassium (spironolactone should have improved this) might not be the primary problem in LAF. Although low blood potassium is clearly not good for a LAFer, episodes are often triggered by a vagal maneuver in both VMAF and ALAF. Perhaps ALAF episodes are also triggered by acute dips in blood aldosterone and attendant increase in vagal tone (vagal maneuvers). Aldosterone responds quickly to any change in posture, e.g., standing, lying down, and more readily explains circumstances surrounding initiation of an episode than does intracellular potassium. After all P cells are pacemaker cells and exquisitely sensitive to any change in autonomic tone.

In summary, ALAF and VMAF may represent opposite ends of not only the autonomic spectrum but also the aldosterone spectrum (too much aldosterone in ALAF and too little in VMAF). This interpretation conforms well with the principle of "accentuated antagonism" where vagal effects are more pronounced in the presence of high sympathetic tone and vice versa (Levy 1971).

Decreasing aldosterone (without medication) would seem to be more difficult than increasing it. As previously mentioned, a low sodium/high potassium intake from noon til bedtime might help in this latter regard.

The real question is whether low blood potassium causes shortening of the ERP (effective refractory period) directly via decreased intracellular potassium or whether it does this indirectly through the resulting decrease in aldosterone (and increased vagal tone). I vote for the latter.

PC

Pure VMAF episodes are associated with increasing vagal tone that may be associated with decreasing aldosterone. Pure adrenergic LAF (ALAF) episodes may be triggered by withdrawal of vagal tone (as opposed to increased sympathetic or adrenergic tone) that is associated with increasing aldosterone. Here again "accentuated antagonism" would be at work. It might be the extremes of vagal tone (and not autonomic tone in general) where LAF episodes are triggered.

So far I've been emphasizing aldosterone. However, cortisol also binds to mineralocorticoid receptors (MR). Stress is a major trigger for many LAFers. Several studies have shown that stress induced increased cortisol causes a decrease in cardiac vagal tone and decreased cortisol causes an increase in cardiac vagal tone. In this regard it is similar to aldosterone (see below). Perhaps the yet to be defined mechanism for this involves a receptor (similar to the MC receptor) that binds with either aldosterone or cortisol.

"Aldosterone exerts a tonic inhibitory effect on cardiac vagal control." This latter effect ACUTELY increases cardiac output to meet the increased demand from postural changes. I wonder whether the vagotonic action of spironolactone is due to a direct block of this tonic inhibitory effect of aldosterone on cardiac vagal control or whether the concomitant increase in renin and angiotensin (known vagotonics), due to loss of feedback inhibition, is dominant in this regard.

While on spironolactone, I developed mild orthostatic hypotension (faintness upon standing). This suggests to me that the former may be an important mechanism by which spironolactone increases vagal tone. This would appear to be the explanation for Hans transition from ALAF to VMAF while on spironolactone.

In the past when episodes appeared weekly I was able to extend the interval between episodes from 7 to 33 days by simply increasing water intake. But then I slowly relapsed back to weekly episodes despite continued hydration. Increased fluid intake should increase blood volume and lead to a decrease in aldosterone. At first I thought this improvement was due to less urinary potassium wasting (less aldosterone). But, if aldosterone is lower, then vagal tone should be higher. What gives? I think the answer lies in the effect of hydration on the RAAS (renin angiotensin aldosterone system). The RAAS is the major determinant of total aldosterone secretion. If this component is decreased, then the contribution of an elevated K/Na to aldosterone secretion is relatively increased. One then has more control over aldosterone (see below). Perhaps after 33 days I'd become too attuned to hydration and less attuned to potassium intake. Hydration increases renal perfusion and loss of electrolytes.

Triamterene and amiloride, both potassium sparing diuretics, work at the level of the distal convoluted tubule, but do not bind to mineralocorticoid receptors. They impair sodium reabsorption in exchange for potassium and hydrogen. Thus, they should not directly increase vagal tone, unlike spironolactone and eplerenone. In fact they may modestly increase blood potassium and thereby elevate the K/Na ratio. This would increase aldosterone secretion and thereby increase vagolysis. This would increase the component of total blood aldosterone due to K/Na wrt the other two components of aldosterone (RAAS, major and ACTH, minor). This is good because increased potassium and decreased sodium intake would have greater impact on aldosterone secretion. This in effect gives us greater control over aldosterone secretion via diet and/or supplements (especially useful for a VMAFer).

Perhaps this is one reason why Erling has had such good fortune with triamterene, although using it only "off and on". Going off it might remove his control via potassium intake of BP and AF. Since triamterene also increases H⁺ reabsorption in addition to potassium, I wonder what effect triamterene has had on his blood pH. It certainly would be a nice countermeasure to the alkalosis associated with drinking un-neutralized Waller water. And triamterene and amiloride both increase renal reabsorption of magnesium. Nice combination.

Just food for thought.

PC

PC, thanks for the laugh. My golf swing also has a percentage of hope applied to it. Some days more than others.

With all the increasing and decreasing I'm not sure I understand all of what you said. So what I chose to understand was over hydration can lead to electrolyte loss? The serum levels of potassium are lowest at midnight and if one has low aldosterone levels there will be increased vagal tone. All a recipe for vmaf.

Last night I fully expected to go afib (past due) so I drank a late LSV8 and swallowed 3 99 mg KCL's. As expected around 3:00 3:30 I had some ectopic activity that usually results in afib but it didn't last . I was amazed that I was still normal in the morning. Slow but normal. I'll try it again tonight and see what happens.

Hope to hit it long with a down the left with a touch of fade.

Adrian

Hope I find the ball

First, I think that the KCl powder I started taking a couple of weeks ago works much better than the potassium citrate tablets I was taking for my 3 grams/day of K. On many days I sample my ectopics while I meditate using my Polar S180 monitor. It works best for this purpose while meditating as otherwise it is prone to noise from dropped leads. One rarely sees this noise on the monitor itself, as the watch has a smoothing and averaging function. However on the r to r

readings it is obvious. Anyway, since switching to the powder, I've gotten many 20-40 minute readings with a rate of 0 to 6 ectopics per hour. This is qualitatively better than before by a factor of two. I've not gathered all the data for quantitative comparison as it is scattered between my home, office & laptop computers.

So I decided to wear my monitor while I slept to see if I could tell any difference in a night/early morning reading as compared with my readings upon awakening and in the evening and relate the ectopics to the diurnal cycle. The monitor is capable of storing 30,000 beats, which is about 8 hours at a 60 bpm rate. Again, noise is an issue, so I used EKG gel on the electrodes to help the conductivity. The results – about 15 ectopics/hour on the first pass. After I looked closely at the data & adjusted it for noise the results are 3.3 ectopics/hour distributed over six hours as follows: 7,1,6,0,3,1. You might ask how I adjusted. Well, the monitor will produce two kinds of anomalies – one a fast beat followed by a slow beat, the second, just a slow beat. I assumed that the beats had to be over 150 for the first kind to be “real” (a visual cut off). For the second, if one lead drops, the monitor is likely to report a rate that is almost exactly 1 / 2 of the current rate. A real ectopic will not be an exact multiple, so I eliminated those of the second pattern that were within a beat of being evenly divisible into the current rate.

Because of the hour to hour variability, I can't say there is any difference between day and night readings.

I do, however, think I can tell the difference between PAC's and PVC's. Here is my reasoning. When I had a 24 hour Holter test last summer, I averaged 2 PAC's and 24 PVC's an hour. When I first started my monitoring program, I noticed that the second kind of anomaly occurred about 12 times more often than the first. So I assumed that the PAC's would have the “fast/slow” signature and PVC's the “slow” signature. As my supplement program has progressed, the prevalence of the second kind of anomaly has dropped, while the prevalence of the first has remained relatively constant. So I'm thinking that possibly the PVC rate has dropped in response to my supplements, but the PAC rate is constant. However, multiple working hypotheses are always appropriate, and my assumptions could be pure baloney.

PC, thanks for all of your work & insights.

George

PC et al,

Let me see if I have this right: stress releases cortisol which in turn makes more aldosterone, which decreases vagal tone (or do I have it bass ackwards?). Since I am a VMAF-er, does this mean I should create more stress for myself? Stress has never caused an episode & exercise (relatively stressful for the body) usually stops them, even when the HR is in the 160-180 range.

Sounds totally weird, but for the last 32 days I have been drinking half-caf coffee again, stopped the LSV8 and have had the longest NSR time in over a year. I should add that I also started taking 150 mg. propafenone before going to bed. Does the propafenone also have an effect on aldosterone?

Thanks for all the thought-provoking (stress-free) recent postings. Lots of good stuff here!

Cheers, **Reet**

Aloha PC

I'm also a “slow” leaner as I have said before!. My supplement regime at this point in time (as it does change due mainly to availability) is a banana when we walk the dog at around five am, with my breakfast; 3 g fish oil, 500 IU vit E, 500 mg chelated Mg (with amino acid), 1 g vit C low acid formula with bio-flavonoids. I rotate my breakfast one-morning high protein and the next mixed with carbs. We have our “main” meal lunchtime this reduces the demand for a “big” meal late pm, snack in between with fruit, nuts, etc. I try to NOT eat simple carbs after mid afternoon. Only have a light mixed meal around six pm with my supplements; 2 g fish oil, 500 mg Mg, 1 g Taurine powder. At least 300 ml of

IsV8. This is with WW at two to three lt day at "reduced" pH around 7.5. via litmus paper testing.

My vlaf periods at the moment are between mid night and five/six am for only a short time of half to two hours at most. lately over the last couple of months or more only quarter of an hour max, this happens about once a fortnight or so. As you can see my record keeping is rather "flexible" now that my vlaf has reduced so.

Questions; If I were to add Triamterene or Amiloride to my pm IsV8 juice to retain my K/Na balance/ratio what amount would you add? Would it be bio-available mixed with my IsV8? or WW? Or is there a companion supplement to aid bioavailability?

As always, I really look forward to any of your posts, much appreciated.

Getting warmer by the day here at 35 deg c today.

Take care, **David S**, vlaf 67 yy .

I got through another night without going afib but strangely, today at about 2:30 pm I was sitting having a coffee break sans coffee and slipped into afib. Very disappointing! I will keep up the K and see what happens.

Adrian

Adrian, George, RK, and David,

Thank you much for your posts. They are much appreciated.

I'll try to clarify my thinking that may sometimes seem contradictory.

Adrian,

You are correct in all that you took from a complicated post, except that part about hydration and electrolyte loss. Hydration would drive down aldosterone of RAAS origin and therefore should be a good thing for K and only bad for Na.

Also, my days of hitting a power fade are long gone. I need a draw to be able to compete with the flippy wristed kids. Although "a fade you can talk to, a hook she just don't listen", I gotta go with the draw.

George,

I suppose it might be possible to somehow differentiate a PAC from a PVC on the Polar S810, but it escapes me. Perhaps you've found a way.

We had this discussion on the BB a couple of years ago. A gal named Stacy posted on this board in mid 2002 that she could and I believe her. She was a long time Holter monitor wearing afibber. That's the value of feedback with "electronic gear".

If the PAC occurs sufficiently long after the normal beat so that it doesn't occur during the refractory phase, then it will result in a ventricular contraction that you will hardly feel (less time for ventricular filling). However, if the next normal beat starts sufficiently close in time after the PAC and encounters the refractory period induced by the PAC, it is terminated and results in no ventricular contraction. This means that the following normal beat will occur after an interval of time that is longer than normal (a "slow signature") and the left ventricle has more time to fill. The bolus of blood ejected by the ventricular contraction will be more than normal. This is the "palpitation" that technically is not a PAC and you will definitely feel it at times when you are "quiet". AF will not only result in beats at differing rates but also in beats of differing intensity, because ventricular filling varies.

Many PACs do not result in a ventricular contraction. These events (also called nonconducted PACs) are different from all other PACs which result in a ventricular contraction. Like many (but not all) ectopic beats they reset the SA node, i.e., the next beat will occur in the cycle after this ectopic beat (v. the previous normal beat). These PACs occur fairly early in the cycle, i.e., relatively close in time to the preceding normal beat. However, when this PAC impulse reaches the AV node, the node is still in the refractory stage from the preceding beat. The PAC stops and goes no further, hence no ventricular contraction. High vagal tone is responsible for this slow down in conduction time through the AV node. Physiologically it is designed to slow the impulse in its spread to the ventricles so that the ventricular contraction doesn't occur before all the blood from the atrium has arrived in its respective ventricle. This kind of PAC would also result in a "slow signature".

But in the absence of an EKG or the equivalent differentiation of PAC from PVC should be impossible.

RK,

Aldosterone is stimulated from three sources 1)ACTH (least prominent) and would include physical and emotional stress;2)RAAS (most prominent) and would include any drop in BP, dehydration, etc.:3)K/Na (intermediate). I'm proposing that by increasing potassium intake and/or taking a potassium sparing diuretic (amiloride or triamterene) one could increase aldosterone (vagolytic) and perhaps deflect VMAF episodes (increasing blood potassium would also lengthen ERP).

Frankly I don't know what, if any, effect propafenone has on aldosterone. Hans was on this before his ablation. So, perhaps he knows.

David,

Amiloride usually is taken 5mg once or twice a day. It inhibits secretion/excretion of H⁺ and K⁺ (and also Mg⁺⁺). So, it causes a mild acidosis. This would work very well with unneutralized WW and the mild acidosis also helps elevate blood potassium. Here again my thinking is that amiloride would decrease BP and increase blood potassium both of which should stimulate secretion of aldosterone, a vagolytic. I found that I can get amiloride (Midamor) at Sam's Club and Walmart for less than \$20/30 five mg tabs. I'm not sure whether this contagion has spread Down Under yet.

Triamterene is usually prescribed at 100mg twice a day after meals. It should work in the same way as amiloride.

These are just my thoughts, reading between the lines.

PC

PC,

Your response and thoughts as regards the following would be most appreciated.

In simple terms (!), I understand from your posts that:

1. Plasma K peaks at noon;
2. Net flux of K from intracellular to extracellular occurs in the morning;
- (3. Cortisol peaks (along with aldosterone) at around 8am;)
- (4. Urinary K excretion peaks at around 5-30 to 7-30am.)

My VMAF has occurred 5 times from 1999 to date with all episodes of several hrs duration occurring and self-converting in the early am (no meds). I'm fairly sure that all of the 5 episodes kicked off at around 3-30am or so. As such, I would appear to be a thankfully reasonably infrequent VMAFr.

HOWEVER, I also have a period each day in the late am where I appear to be vulnerable - very noticeably this last few days - to uncomfortable runs of ectopy between 11am and 1pm. Today I've experienced four such runs which feel fluttery and uncomfortable lasting just a few seconds. Such runs seem to diminish as the day proceeds with ectopy in

general seeming to calm down as the day goes by. A glass or two of wine in the evenings will usually calm things down to zero if I so choose to imbibe.

Could this period of enhanced vulnerability to runs of ectopy at midday be connected with 1. and 2. above??

I'm assuming here that 1. above is the net result of 2. above?

Is the aforementioned a wholly different issue and not in any way connected to my intolerance to the aldosterone antagonist spironolactone?

Could my violent and chronically stressed childhood have caused some cortisol imbalance which could contribute to my problems in some way and if so how?

Any views and thoughts would be most appreciated.

Cheers,

Mike F.

P.S. Are you going to try the amiloride or triamterine on an experimental basis??

Hi Mike,

You seem to have distilled the pertinent particulars.

I think you've answered your own question.

Your reaction to spironolactone was a response to its vagotonic effect (you appear to be VMAF).

Your noontime run of ectopy may well be the result of low intracellular potassium. Think about it. Plasma levels are going up. Urinary excretion has peaked and is slowly decreasing (but continuing). Where is all this potassium coming from? I don't think most of us consume nearly enough potassium in the AM to meet the shortfall.

So, yes I think they are unrelated, other than both being potentiated by your arrhythmogenic substrate (P cells).

Can't answer your question about cortisol. Perhaps in the future some study will show such a correlation.

And, yes I plan to try amiloride.

PC

Mike F

Hans' book page 143 says: " Children who had experienced a traumatic childhood had consistently higher cortisol levels than did children in more harmonious families".

I have high cortisol level, my parents fought a lot (fist fights) I remember running out the door hearing my Mother Yell " Help, help he is killing me" and being brought up in Europe where it was unacceptable for children to show emotions, and "Kids should seldom be seen and never heard" sort of atmosphere ... that would explain my adrenal exhaustion and inability to cope with stress.

WOW I just popped into Afib now just from the stress of posting this!

Ella

PC, thanks for the response - much appreciated as always.

Ella, Oh dear, my sweet lady, I did NOT want to assist you going into AF by touching old wounds and reminding you of highly stressful past events. I do, however, relate precisely to your thoughts as expressed: your comments also reminded me of some past reading which talked of the cycle of chronic stress thru adrenal burnout to elevated cortisol levels. There's NO doubt in my mind that at least some of my autonomic systems are a little skewed away from normal as a result of my childhood. I hope you've popped back out of AF by now Ella!

Mike F.

No Worries Mike, I have been under tremendous stress the last 2 months, so not your fault at all! Yes, back in NSR. Thank you,

Ella

Anyone know how to invent a wheel?

Well PC, notwithstanding your comments about reinventing the wheel, I've talked to my GP who has kindly figured out that I can get late night blood draws at the hospital w/o paying ER charges & he will support my crazy experiments.

I'd like to see the short term effects of K supplement timing. Since it is feasible to test during the time I'm most interested in with VMAF, I might as well do it.

One thing I'd like to test is whether PC's scheme of a fairly even intake of K has a different outcome than my daily divided dose at ~7 AM & 6 PM. Another would be the effect of shifting my doses to say 11 AM and 10 PM. A third would be keeping the 7 AM and 6 PM doses of 1.5 grams K and adding a third dose at 10 PM. With each of 3 alternatives I'd have 12N and 12 midnight blood draws for comparison.

As I noted in my previous post, I tried to use my Polar monitor to sample ectopics while I sleep. That experiment was less than satisfactory since I had a number of "noise" events. One always wonders if it is a "real" event or just "noise" when adjusting. I've had good luck with the Polar, as long as I'm quiet (like meditating) while sampling. I'm investigating putting together a 3 lead, home-made, EKG, from off-the-shelf parts, to see if it will have decreased noise. I'll hook it up to a computer for recording, It wouldn't be portable like a Holter, but a lot cheaper for repeated use. I could also use it to prove/disprove my PAC/PVC wave signature theory (however I think PC pretty well killed it with his explanation above) as well as sleep-time recording. If I have success with the EKG, I'll probably sample sleep-time ectopics under various K supplementation schemes.

Lastly, I picked up a diabetic's glucose meter to see what my glucose and therefore insulin responses are doing, especially in the evening/early morning. I had to do a bit of checking as many are not accurate enough for a normal to use. They are fine for a diabetic- I need insulin now or I'm low, but the much tighter ranges that a normal would use don't exist on some of the models. They're probably +/- 15 mg/dl (at least that is what their data says). The data on the one I got - the Bayer Ascencia Contour is more like +/- 2.5%. This is the tightest range I could find. I can see the glucose meter business is like the cell phone & printer businesses - give it away and make money on the consumables, as I got the meter for free with the purchase of test strips.

As you can see, in addition to afib, I'm afflicted with "engineer's disease." I'm always trying to measure something to figure it out!

Thanks, PC, to your well-thought out responses to my ideas. I really appreciate them.

George

Hey George,

Don't apologize for engineer's disease. There's nothing wrong with being analytical with the AF conundrum. It might even keep us off the streets and out of trouble.

Now that I'm off spironolactone, I've been rethinking the time to specifically target potassium supplementation.

As I replied to Mike, from before midnight to noon there is a transcellular shift of potassium from inside cells to the blood and extracellular fluid, since the gradient has maxed (midnight). From 0530 to 0730 urinary potassium wasting due to aldosterone is peaking. I'm sure very few people (except maybe Fran and a few others) have seriously started addressing their looming intracellular potassium shortfall at this time. In the absence of sufficient dietary and supplemental potassium the potassium in the urine is essentially coming from within cells. ALAFers are most at risk in the morning. A little stress in the face of this shortfall and it's instant AF. VMAFers that don't address the potassium shortfall and that aggravate it with hypoglycemia or insulin can also trigger an episode at this time. I know I have.

So, you might consider hitting the potassium supplementation heavy from the time you arise in the AM through the noon hour. I think the key is slow and steady with replacement potassium (more like the tortoise than the hare). Sometime after noon the erosion of intracellular potassium has stopped and the flux of potassium ions has reversed itself, i.e., goes from extracellular to intracellular. It would seem to me that this reverse flux requires some potassium from an outside source, otherwise from whence does it come. Here again slow and steady. Otherwise an abrupt increase in blood potassium is going to stimulate some aldosterone (vagolytic). This is not all that bad a proposition for a VMAFer at a time when his vagus is toning up.

So, start early, slow and steady throughout the day with a sustained release hit at bedtime.

PC

Hi George,

Taking potassium in fluid form not only makes the infusion more continuous and less discrete than pill form but also is more bioavailable.

Why don't you try KCl (No Salt or Nu Salt) in water. I'd suggest Waller water but potassium interferes with the absorption of magnesium and you have to be very careful with how much magnesium you drink.

Potassium from food sources is less absorbable without chloride. So, the above approach would also be better than even the powdered potassium gluconate in juice or water.

This approach also addresses your hydration at the same time.

PC

Jackie and PC: MANY thanks for your patience and diligence in endeavouring to educate myself and doubtless others here.

PART ONE

My current state of enlightenment (should that have a 'dis' in front of it?!) is as follows:

1. Hypokalemia denotes low levels of K in the blood plasma and, in response, K leaks out of the cells into the plasma (the gradient is flattening out).
2. This is not good news for us guys here cos this lack of intracellular K can:

a) shorten the AERP of atrial cells thus facilitating AF, AND
b) encourage ectopic foci in the PVs (and, for some, to a lesser extent in cardiac tissue elsewhere other than the PVs) to fire off as ectopic beats. QUESTION: are both a) and b) as aforementioned correct??

3. One of the chief problems for sufferers of excessive ectopy and/or AF is a lack of K in cells resulting from a lack of satisfactory UPTAKE of K from blood plasma into cardiac cells and/or leakage of K from cardiac cells - with both of the aforementioned likely resulting from either

a) Faulty operation of voltage-gated K channels in the cardiac cell walls and/or
b) A lack of intracellular Mg in the cardiac cells which is necessary to facilitate the uptake of K into the cells.

SO, we NEED Mg inside our cardiac cells BEFORE we can expect satisfactory levels of K to STAY INSIDE the cardiac cells.

Am I on the case so far??!!

PART TWO

Notwithstanding PART ONE above and returning to this quote from Jackie's last post above:

"Potassium levels should be monitored carefully during magnesium repletion in the hypokalemic patient; magnesium causes a shift of potassium into cells and thus may intensify the hypokalemia if [magnesium is] given alone." Altura, et al (1)

I'm sorry guys, but I'm still floundering a bit with this one. We need to get and keep K in the cells, and Mg in the cell helps in this regard.

Is the scenario such that the K can flow real fast in and out of the cell, and if there is plenty of Mg in the cells (in this case via acute supplementation) then K gets into cells and then, cos the gradient has steepened and the serum is accordingly hypokalemic, then the K just leaks out again even with the Mg in the cell? What, in essence, I'm still struggling with here is how - for me and others - Mg supplementation results in increased ectopy because it gets and keeps K in the cells when this is the very scenario we desire??

PART THREE

Lastly, PC has already attempted to educate me to the effect that cortisol peaks at 8am and this tallies with the time of the greatest urinary wastage of K/greatest flux of K out of the cells into the plasma. If I've got that bit right, then that would explain why abnormally elevated cortisol levels (in chronically-stressed individuals) would make the K situation even worse (and particularly in the mornings) than it otherwise would be. Cortisol ain't good news for getting and keeping K in cardiac cells.

Mike F.

Adrian,

Sorry to be so long in responding to your question on why potassium seems to hurt not help your AF. I've been thinking about it. I certainly don't have all the answers. It's difficult because my insight is limited to my personal experience (more VMAF) and what I've read. I learn about other experiences from all your posts on the BB. Extrapolating that to a more general situation encompassing all LAFers is hit and miss.

Here's my take on what's happening and perhaps you can find the answer.

ERP x (P cells + low potassium + ANS) => AF Risk

We can do nothing (other than PVI) about the P cell component except to limit oxidative stress to them and further shortening of their ERP. Although there are some options outside of meds for controlling the ANS component, this is

otherwise a difficult proposition.

Controlling fluctuations in blood potassium is all we have left. And even this is of limited benefit if P cell ERP is especially short and/or the ANS is particularly strong. You've got to have some wiggle room in order for potassium supplementation to work. Even if these two contributors are less significant, for the vast majority of us it's not possible to control fluctuations by increasing potassium intake alone, either by diet or supplements. There are too many counterregulating hormones. As Dr. Struthers states, 50mg of potassium can nearly double aldosterone levels. However, there are situations that we can recognize that contribute to the problem. Knowing that there is a diurnal variation to blood potassium and taking a bedtime hit of potassium is one. If you are thin, avoiding hypoglycemia and its catecholamine mediated drop in blood potassium is another. This is certainly aggravated if one were to also exercise under hypoglycemic conditions. And those with strong vagal tone secrete more aldosterone when upright. Insulin also increases the potassium gradient. Hans in his first book described how LAFers have a flatter glucose tolerance test (GTT) curve, i.e., the effect of insulin is more prolonged in LAFers. Stress of any kind mobilizes cortisol, causing urinary potassium and magnesium wasting. Stress also stimulates an increase in catecholamines. So, time your potassium but spread it out during the at risk period.

Controlling fluctuation of blood potassium is a balancing act. And this assumes that P cells and ANS are not the overarching determinants of episode initiation.

One other word of caution wrt potassium supplementation. It takes the body between 3 and 4 days to adjust to dietary changes in potassium and salt. Once you abruptly increase potassium intake the body adjusts over a few days and, in the absence of any medication to the contrary, excretes it. So, when you lower your intake, you are immediately behind the eightball on potassium balance for a few days. This may have been at work for your extended episode. Also, large doses of potassium, e.g., 1-2 grams in OJ, have occasionally terminated an episode. But this can only happen early in the episode and, unless the reason for the low blood potassium is addressed, it will reappear. Maintaining good hydration will decrease the role of RAAS and increase the blood K/Na ratio tolerated by aldosterone.

Magnesium is obviously important in maintaining potassium balance but there are some codicils. Mansmann once stated that potassium interferes with magnesium absorption and vice versa. I've personally experienced this effect when increasing potassium intake while maintaining the same magnesium intake through Waller water. There are so many pitfalls along this road that it's hard to know what's happening. Indeed for some of these pitfalls there is no explanation given what is known.

All of this is why I continue to experiment with medication (amiloride and triamterene) in the hopes of getting a better handle on retaining potassium.

After your 8-day episode I bet you had a nice long run of NSR while you slowly depleted your potassium stores.

PC

Hi again,

I'm not sure I can give you a good answer to your question, Mike. I'll give you my present view on it. Also, please see my just posted response to Adrian above.

Increasing total body potassium stores is a good thing. This is what ANP does during an episode that creates such a nice environment immediately post episode - no PACs. The accumulated potassium is very helpful in minimizing the gradient during the interval before the next episode. But eventually the good work done by ANP is overcome through negative potassium balance (less in and more out) during that interval.

Perhaps not all cells have the same affinity for magnesium. P cells may have less than skeletal muscle, liver or even other heart cells. Remember it's a special pacemaker cell, more like a nerve. So, maybe magnesium supplements cause greater potassium uptake in these other cells with an attendant acute exacerbation of the gradient. I don't really know. But this would certainly explain an associated increase in ectopy with magnesium supplementation.

PC

PC,

I have been using the KCl powder in water for about 3 weeks, with what I think is a positive effect over the tablets. Certainly I have an easier time digesting the KCl water than the tablets. I did learn something from your post - that I shouldn't take the Mg at the same time as the KCl. I will try staggering the times that I take each. I just use the Mg Glycinate instead of Waller water, for ease of use. I've tried Waller, but was more hassle than I wanted to deal with - the tablets are easy -hence my divided dose routine. I've also noticed that my eyelid twitch is significantly reduced which is a good sign.

As an aside, my glucose meter results are enlightening. I see when I'm eating too much or carbs that are too fast & getting a spike, then later going a bit low. Since my diet is vegetarian, mostly vegan (all carbs all the time) - I'm certainly not adopting an Adkins approach to keep the glucose even. Mostly just paying more attention to quantity and glycemic index of my carbs. It is already having a effect on my weight, as I've shed some of the 10 pounds I gained when I was out of rhythm for 2.5 months last fall & not exercising as much. I've always wondered if someone could loose weight just by using the meter as biofeedback to keep the blood sugar level. This really helps keep me from having a low blood sugar event in the early AM when my serum K is low and I'm very vagal, too.

Thanks again for your comments.

George

George,

I have a friend whose dog is diabetic and I used to give him insulin shots when my friend went on vacation. I also used a little portable glucose meter to monitor blood glucose. It came with a little "auto pricker" to obtain a very small sample of blood from the dog's ear. Put a drop on the accompanying filter paper, slip it into the meter and voila - instant blood glucose reading. Is that how yours works?

PC

PC,

Essentially, it seems the research is on how to do it with the least blood, so your stick can be as small as possible. On mine, you put the test strip in the monitor, which turns it on. Then prick your finger and put the strip next to the blood drop on your finger. The capillary action draws the tiny amount of blood into the strip. Then 15 seconds later the meter give you a reading. It stores several hundred readings with a date/time stamp.

As I mentioned above, this is my second one. The first one had a wide error band. This Bayer Ascencia model is about +/- 2.5%, according to the data in their downloadable manual.

Interestingly my preconceived notions of what meals will give me a spike don't always match the data. I do know how to spike it, though - pig out on fast carbs! I've tested frequently (hourly) early on, just to see what is happening. However now I generally test an hour after a previously untested meal to see if there is a spike and 1st thing in the morning to see what is happening with a fasting reading.

George

Thanks George. Maybe I'll get one.

Let me know if you ever have an episode that you think might have been triggered by hypoglycemia induced catecholamine release and your blood glucose reading at the time.

PC

PC,

OK, actually, the K & Mg supplement program is working so well, it is becoming a low probability event. After being out of rhythm for 2.5 months and having an event every 10-12 days before that, I've been in NSR for 3.75 months. I had one 3 AM event 2.75 months ago that I think was triggered by late pigging on junk. So it could have be a) hypoglycemia, b) GERD (though I have no other symptoms of it) or, c) a vagal response to eating. All of the events that I could remember that occurred before I was out of rhythm for 2.5 months also had late eating correlated with them.

After your comment about not taking K & Mg together, I took my 1.5 grams of KCl before I meditated (& sampled my ectopics with my Polar) tonight. Normally I meditate before eating, which is when I take my Mg & K. Well I had only 2 ectopics in 45 minutes tonight, with a gap of 44 minutes between ectopics. A very clean sample. Recently I've been having 4 ectopics in 20 minutes, so this is a significant decrease. I may test your more even intake of K & see the effect. I'd test more often (like hourly), however I have to remain motionless to avoid noise & this is hard for me to do and precludes other activities.

I got the Ascencia Contour monitor free here <http://www.diabeticexpress.com/content/MfgHome.aspx?strMfgName=Bayer> with the purchase of 100 test strips. These guys also had cheapest price on strips.

The manual can be viewed here: http://www.ascensia.ca/eng/prodserv/custService/pdf/asc_contour_eng.pdf

George

PC , Thank you for your thoughts. The period of NSR immediately following the long 8-day afib period was only 3 days. Chaotic ones at that. In fact I finished 12 days afib Feb 4. Perhaps that was due to slacking off on the K intake. Chasing a small window of K variability due to the damaged P cell substrate and vagal (bradycardic) ANS tendencies may indeed be the wrong approach for me but I still think I need to give it a better shot, if only to eliminate it as a primary supplement protocol. So I am back to trying increased potassium amounts. I've been mixing KCL in my Concentrace mineral water which has about 125 mg of magnesium, and drinking it all day. Perhaps my evening water bottle should be with KCL alone and the morning bottle just Mag thus avoiding increased aldosterone? mmm

It may prove eventually that the only way for me to cure this three headed monster is via cellular repair and perhaps ANS balancing.

Cheers

Adrian

PC,

From your above reply to myself:

"The accumulated potassium is very helpful in minimizing the gradient during the interval before the next episode."

And:

"Remember it's [P-cell] a special pacemaker cell, more like a nerve. So, maybe magnesium supplements cause greater potassium uptake in these other cells with an attendant acute exacerbation of the gradient. I don't really know. But this would certainly explain an associated increase in ectopy with magnesium supplementation."

OK, I think I maybe confused as to the use of the word gradient wrt K.

I've always taken this to be the difference between the K inside and outside the cell - the steeper the gradient, the more IN the cell and the less OUTSIDE. Given that the intention for us folks here is to get and keep the K levels inside the cell HIGHER than in the plasma outside, then a steep gradient is that which we are striving to achieve?? However, your two statements above seem to conflict with my aforementioned surmisals..... in that you firstly refer to the beneficial effects of ANP in MINIMISING the K gradient and secondly stating that acutely exacerbating (increasing) the gradient will increase ectopy respectively.

I know I'm maybe being a bit of a pain here, but I'd really appreciate a bit of further fine tuning!

Mike F.

Hi Adrian,

Potassium interferes with magnesium absorption and vice versa. So, don't let the combination of KCl and Mg push you beyond bowel tolerance.

Also, the next time you experience a daytime episode that may be triggered by hypoglycemia induced low potassium try drinking a large glass of OJ with at least a gram of elemental potassium. OJ for the low blood glucose and the potassium for the gradient.

I don't think this would work for night time episodes. It might also work for stress triggered episodes.

Others have reported success with this on the Internet. Please visit "LAF and the Hormone Connection" in the CR Proceedings.

PC

George,

Hope your good run continues. Just remember that more potassium may not be better. Aldosterone is stimulated and you can find yourself peaking and troughing on the potassium, esp with larger doses. And one of the troughs will get you.

Thanks for the info on the glucose monitor.

PC

Hi Mike,

No pain here.

IMHO P cells do not behave like other cells wrt magnesium and potassium uptake. They are not like normal muscle cells, cardiac or otherwise. We know that they have special K and Na channels and they can depolarize spontaneously.

So, as far as P cells are concerned, GRADIENT RULES. Helping the rest of the body maintain its potassium and magnesium stores does not help P cells, at least not nearly as much. The value in maintaining these stores wrt P cells is that enhanced stores are better able to handle swings in the gradient.

Hope this is more clear.

PC

PC,

As I understand your comment, a large ingestion of K will increase aldosterone, a vagolytic. As I mentioned in a previous post, I started taking my evening 1.5 grams K before my meditation so as to not combine the K with my Mg supplement. I sample my level of ectopics with my HR monitor during meditation. What I'm seeing is a decrease of ectopics from 12 to 15/hour to 3/hour. However, I see no increase in average HR (it is usually in the 55-57 BPM range and that is where it has stayed). If I understand correctly, if aldosterone is secreted, my HR should increase because of aldosterone's vagolytic activity. Is this correct?

George

George,

You read me correctly. What about your RLX (or HRV) reading on your Polar S810? Is it lower than normal for that time of day?

The only explanation I can think of is that the vagus has two arms - one from the nucleus ambiguus (NA) and the other from the DMNX (dorsal motor nucleus of the tenth cranial nerve). The former controls HRV and the latter controls HPV (heart period variability, i.e., diurnal rhythm to vagal tone). This means that during the day the NA is responsible for vagal tone and during the night DMNX is.

Perhaps aldosterone is only vagolytic wrt the NA and not the DMNX. We're in uncharted waters here.

PC

PC,

Well from the day previous to the one where I started taking the K before meditation, there is no change in RLX. Over time there is a fair variability in RLX, and the most recent readings are on the high end. However, I know from playing around with my other monitor - Freeze Framer, that I can change HRV with my breathing. Sometimes I do that breathing in meditation, so its pretty hard to tell anything (sometimes I fall asleep!). One thing I've learned, both from the Polar S810 & the Freeze Framer is that there is a reasonable amount of variability in HR when you are just resting. From my old, non R to R HR monitor, I would think that my HR would be constant. Now that I can see the beat to beat variation, I can have a band of HR that is 10 to 15 BMP wide (or even 20), especially if I do some of my yogic breathing techniques. It is all very interesting.

George

PC , I went back and read it all again and I think that the statement you posted in the prior post may be the key to unlocking what my particular flavor of afib is about.

> "Excess aldosterone may not be the enemy in VMAF. The problem in VMAF may be insufficient aldosterone (a strong vagolytic) with consequent enhanced vagal tone (please visit Session 33 in the CR on Baroreceptor and

Aldosterone). It is well known that endurance athletes have low levels of aldosterone.

In view of this it would seem that in VMAF ANP (atrial natriuretic peptide) and its potassium conserving properties may be less important than aldosterone (vagolysis) in terminating an episode. Aldosterone troughs between midnight and 4AM (peak vagal tone) and starts to climb after that, peaking around 8AM (peak vagolysis). The diurnal nadir of blood potassium at midnight certainly further depresses aldosterone secretion. This would certainly coincide with the time that most nighttime episodes are triggered and terminate respectively."

Would I be experiencing hypoaldosteronism? I was tested last year and had a level of

aldosterone 126 pmol/L range(28-860) .

Renin, active 7ng/L range (<26)

The collection was done at 0900 hrs which is one hour after peak aldosterone level. At that time I was not taking extra K.I was a part time endurance athlete. At the time of my afib discovery 2.5 yrs ago I was training for a half marathon. Are there ways other than extra K to increase aldosterone?

Adrian

Hi Adrian,

You guys are really beginning to get it. Thanks for reading a difficult somewhat technical post and taking the time to really understand it and apply it to your own situation. It really gives me valuable feedback on what's happening, instead of just assuming my experience is indicative of that of the rest of LAFers.

Although I've not read it anywhere, it may well be that the diurnal rhythm of vagal tone is due to the diurnal rhythm of aldosterone. When it's high, there is vagolysis and when it's low there is stronger vagal tone.

Except for decreasing salt intake, I unfortunately don't know of any other way to increase aldosterone. And it appears more than possible that you have marginal aldosterone levels.

PC

Good work Adrian.

I am now of the opinion that my own 3-4am AF episodes may well be connected to very low aldosterone levels at that time. It is well established that adrenal burnout due to years of sustained stress (in my case as a terrified child and a highly anxious adult) can cause hypoaldostremia - e.g. see:

<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=185776>

Mike F.

Mike,

I've been giving more thought to your problem understanding the apparent contradiction between gradient issues and intracellular levels of potassium in the initiation of AF.

As I've said, IMHO gradient rules wrt P cells. For heart muscle cells, unlike specialized nerve cells (P cells), there is some uptake of glucose (and potassium) stimulated by insulin, although less than for skeletal muscle, fat cells, smooth muscle and liver.

In support of this opinion I'd like to relate my personal experience and observations.

Since being on disopyramide (vagolytic) my episodes (shorter and less frequent) are much more likely to start with tachycardia and transit to and from tachycardia/AF than before disopyramide. I think this is because the disopyramide makes the atria less receptive to initiating and maintaining AF. Left atrial ERP is too long. AF eventually pops up for the same reason that fast pacing can trigger AF in dogs.

EP studies in paroxysmal AFers have even demonstrated reentry in the PVs while the heart is in NSR. I am not quite sure how this works, but suffice it to say that the potassium gradient is a major determinant of P cell depolarization.

In fact I've noticed that I can terminate within 5-15 minutes midnight (+/-one hour) episodes with 1-2 grams of potassium in juice. But episodes that start at 4-5AM I can also terminate within 5-15 minutes with breath holding (voluntary apnea). But not vice versa. I think low potassium, e.g., too much salt in the evening meal, drives the former and too much vagal tone (the 9PM disopyramide level is way down by 4-5AM) drives the latter.

If we can find the right potassium sparing diuretic (one that won't directly interfere with the vagolytic properties of aldosterone), then both problems should be solved (more potassium and less vagal tone).

PC

George,

Why don't you direct your considerable analytical intellect toward daytime effect of acute increase in potassium on HR and RLX? If what I surmise about the DMNX and NA is correct, then you should see a definite acute increase in HR and drop in RLX, unlike at nighttime. The half life of aldosterone is 15 minutes, so the effect will not be long lived.

PC

Mike,

That does seem to fit with you. Have you had your renin sampled as well that would indicate hyperreninemia to go along with hypoaldosterone? I think I would be more hyporeninemic. Unfortunately what I have researched points toward kidney problems RTA Renal Tubular Acidosis. See <http://www.emedicine.com/med/topic1139.htm#target1>

I'm not saying this is definitely my problem but it is interesting. Hyperkalemia is one indicator, I've always tested high in K but never extremely so. I think its time to get tested again. Been about a year now. I'll be sure to get the kidneys tested.

Cheers

Adrian

PC,

So, I come home from a beautiful day skiing at Breckenridge to find that I have an assignment! My 17 year-old son wanted to drive home so that I could relax after such a hard day. Unfortunately I had to tell him that his driving does not relax me, I'm sure some of you can relate. The good news about your kids getting their license is that you don't have to ride with them and wear out the imaginary break.

There are many factors that can change heart rate (like my son's driving) & heart rate variability (RLX). So I've tried to think how I could conduct this experiment and control for as many of these variables as possible.

Here is my thought: I should, repeating on several different days, meditate for 15 minutes (recording my HR & RLX). Then take a dose (1.5 grams) of KCl and meditate for another 15 minutes (again track HR & RLX). Then compare the before & after readings. Meanwhile, I'll avoid practicing any odd yogic techniques during meditation that are likely to change the outcome. I'll do this on an empty stomach on days when I have nothing else to do (ha).

George

Hey George,

No need to make it into something suitable for publication. If you expect to be watching TV or reading (nothing too exciting) for an hour or so try it out. Monitor your HR and RLX after you've become quiet and both have stabilized within an acceptable range and then take the dose you propose. It should take a few minutes for the potassium to appear in your blood and elicit a reaction from the adrenals and secretion of aldosterone. Your HR should increase and HRV (RLX) should decrease due to the vagolytic effect of aldosterone. The half life of aldosterone is 15 minutes, so the effect should have run its course within 30-40 minutes.

I've done this in a much less controlled setting (I'm kinda impatient) and found that this did happen, but I'd like to hear what your experience is.

PC

PC and Adrian,

Many thanks for the responses.

Adrian, no I haven't had any renin or aldosterone testing. I'm only surmising that my aldosterone levels are likely low (and particularly so in the early am) for the reasons given. My own serum K is usually between 4.3 and 4.5.

PC, maybe the aspect WRT gradients with which I'm struggling with is so simple so as to escaped you!

Let me try as briefly as possible to clarify my current understanding of ectopy in particular. [I'm assuming here that a P cell and an ectopic focus are one and the same thing.] As for what it is we as sufferers of excessive ectopy are trying to achieve is a HIGH/STEEP K gradient - as in MORE K got into and kept inside the P cell compared to the amount of K OUTSIDE the P cell i.e. in the plasma?

(I remain puzzled here a little in that hypokalemia relates to low plasma K. Isn't low plasma K a good thing because it means that the K is getting into and staying in the cell (the gradient is steep)? Or is hypokalemia a bad thing because it means that the cell will very quickly lose the K to the plasma (the gradient will flatten).)

Getting and keeping K in ectopic focii/P cells will stop them depolarising too quickly/firing off too early thus precipitating early/extra beats (before the SA node has initiated the next scheduled NSR beat). An ectopic focus/P cell will fire off too readily when it depolarises too quickly as a result of K flowing/leaking out of it too quickly.

Enhanced vagal tone can set the scene for the early depolarisation and irritability of ectopic focii/P cells (just as it can for the shortening of the left AERP in AF).

PC, Adrian, George. anyone; any glaring errors or bad misunderstandings on my part anywhere above?

Regards, and thanks for your patience!

Mike F.

PC,

Well, since I never sit around during the day & only watch TV if I'm exercising inside (have never been able to sit still - amazed I can meditate), I thought I'd try with this morning's meditation. 6:10 AM meditate for 15 minutes - HR 55 RLX 37 then 1.5 gram KCl. At 6:30 AM, meditate for another 15 minutes. HR 60 RLX 43. So a mixed bag. Also the KCl solution was concentrated & therefore my stomach was a bit unsettled, so this could also increase the HR. My HR generally goes up when I put anything in my stomach.

I'll try this again. Maybe I can carve out a half an hour a day at the office to try this on a couple of days during mid-day.

Mike,

My own understanding of this is very superficial, however, my idea is to get both my plasma and cellular levels of K up over an extended period. I know that to do this Mg cellular levels have to be increased. This is the focus of my K/Mg/Taurine supplement program. Clearly my ectopics respond to K. Now I should say that I don't feel my ectopics, unless I'm hooked up to my finger cuff monitor (Freeze Framer) and putting my attention on my throat. I only see the ectopics in the data from my HR monitor (and I have to be very quiet or I get a lot of noise).

I also notice I get a quick response to the KCl powder in water. When I used to take tablets, I did not get this response because I don't think they were digested quickly, if at all. Those that drink Is V8 or Is Tomato juice should get the same quick response.

George

Mike,

You want a low gradient, i.e., very little difference between the inside and the outside, so that there is less leakage from inside to outside.

On the other hand there appears to be a threshold level of K within cells, especially P cells, below which they fire (depolarize) more frequently.

Getting K and Mg to go into cells is a good thing, but this will increase the gradient. This is a bad thing, because it means that blood K will drop, especially if this happens acutely. P cells are not as responsive to the usual ways of doing this (insulin, catecholamines, supplements)

You have to maintain total body potassium stores so that the troughs in blood K are not as deep.

This is all IMHO.

Your last statement about vagal tone was right on.

PC

PC,

Here are two more results, the 1st at 10 AM while I did bookkeeping for a volunteer organization that I help. I kept my bottom glued to the chair for an hour. I tested myself for 15 minutes, then took 1.5 grams KCl in water, this time with more water so I didn't have the stomach reaction. I then monitored for another 45 minutes. The 2nd test was at about 5 PM during meditation. I meditated for 15 minutes, drank the KCl water then meditated for another 15 minutes. Results are after smoothing out noise & ectopics.

1. avg BPM 71, RLX 20, before 67 BPM RLX 19, after

2. avg BPM 58, RLX 28, before 58 BPM RLX 25, after

The 5 PM case does show the effect of KCl on ectopics and can be viewed here:

<http://home.att.net/~g.e.newman/kcltest.jpg>

showing 7 ectopics in 15 minutes before and 2 ectopics in 15 minutes after. There is a noise spike from when I was reaching to grab the KCl water at about 16 minutes.

George

Thanks George. That was kinda my result but without the gastric upset.

There doesn't appear to be any significant correlation between potassium supplement induced increase in aldosterone and HR/HRV. In fact your 10AM results suggest just the opposite of what I would have expected.

PC

George et al,

"I also notice I get a quick response to the KCl powder in water. When I used to take tablets, I did not get this response because I don't think they were digested quickly, if at all. Those that drink Is V8 or Is Tomato juice should get the same quick response."

Altho i do not have any of the equipment you gentlemen do, i do have one way to measure [roughly] speed of response to the KCl in a glass of I.s.v8. As i have often mentioned, chocolate baked goods are a too frequent indiscretion of mine, guaranteed to have my heart pounding wildly due [i suppose] to the insulin spike causing K wasting. Once i notice that hard heart pounding feeling, i go drink a glass of I.s.v8, and the pounding subsides noticeably within 15 minutes.

PeggyM

Peggy,

If you know you are going to indulge, you might take a glass of Is V8 or KCl water before and save yourself the wild pounding.

PC,

There is certainly no dramatic result. I'm always suspect of using the HR for a proxy unless I'm sitting still & quiet, like meditating - otherwise too many other variables. I will say that my exercise in trying to figure out my response to various triggers & inputs has given me a new respect for all who do medical research. I'm amazed we know as much as we do. As we say in my business - you should always consider multiple working hypotheses.

George

From one of Hans' posts over on the forum:

"ACE inhibitors conserve potassium (and reduce blood pressure) by inhibiting the RAAS and aldosterone synthesis. Aldosterone is a prime mover in urinary potassium excretion so by inhibiting it one would presumably reduce potassium excretion and thereby increase the serum and hopefully, the intracellular level of K. As you may remember, I have a very low K level (3.6 mmol/L) and an excessively high aldosterone level so my idea behind perhaps trying lisinopril is that it may help curtail my urinary potassium loss which runs to about 3.7 g/day just prior to an episode

(www.afibbers.org/results.pdf). Whether it will decrease it sharply or not in my case remains to be seen. It is also possible that it may not work at all for me as my excessive aldosterone production may not involve the angiotensin part of the RAAS at all. Only an experiment will tell."

The above (related to the thread here) interests me on two fronts:

1. "Aldosterone is a prime mover in urinary potassium excretion so by inhibiting it one would presumably reduce potassium excretion and thereby increase the serum and hopefully, the intracellular level of K."

OK, talk about two sides of the coin: aldosterone is good for a VMAFr in that it is vagolytic but.... it also increases urinary K excretion which will adversely affect the K gradient with a likely accompanying increase in PACs.

2. ""ACE inhibitors conserve potassium (and reduce blood pressure) by inhibiting the RAAS and aldosterone synthesis.

VMAFr's might accordingly be well advised to avoid ACE inhibitors since they will reduce the vagolysis provided by aldosterone: I know lisinopril (sp?) is one such med - is triamterine another also? If so, might not be such a good thing for a VMAFr to experiment with (PC?)?

Mike F.

Thanks, George, i have done just that and found it works well.

PeggyM

PC,

Here is another result, a 5:15 PM meditation for 15 minutes then 3 grams KCl in water and meditate for another 15 minutes Results are after smoothing out noise & ectopics.

avg BPM 57, RLX 29, before 61 BPM RLX 20, after

So, I think this is the result you were expecting. It just took a large dose of KCl to achieve it.

George

Hi Mike,

Triamterene and amiloride are not directly involved in blocking aldosterone either through the RAAS, like lisinopril, or as an aldosterone antagonist by blocking mineralocorticoid receptors, like spironolactone.

Therefore, they are not only not vagotonic, but should be vagolytic. Because they decrease the urinary secretion/excretion of potassium, they raise blood potassium levels. This should stimulate the release of more aldosterone, thereby providing vagolysis (and increased blood potassium). That's a good double whammy, at least for VMAFr's.

Hi George,

Thanks for the continuing feedback. That is the result I was looking for, but it should not require nearly that level of potassium supplementation.

PC

PC, i think i have lost you here. Lisinopril conserves potassium, and that is a good thing, is that right?

PeggyM

Hi Peggy,

That's a very good thing. It's just that doing it through suppression or antagonism of aldosterone can increase vagal tone. In those whose LAF is predominantly vagal this can cause problems.

It all depends on how much of the shortening of the refractory period is due to low potassium and how much is due to vagal tone in a given LAFer.

PC

Hi PC,

I'm up for trying one of the above to see if I can reduce my ectopy (by increasing plasma K and decreasing vagal tone). My BP is usually in the range 130/80. Which one of the two do you think I should try?? (And, for that matter, how are you getting on with the amiloride - have you findings to report yet?)

Mike F.

PC, if lisinopril increases vagal tone, how come i am not having afib episodes? Granted i never took much of it - 10mg tabs - and am now taking less since i discovered the bedtime aspirin thing, but 10mg is what i was taking up until discovering the bedtime aspirin bp lowering effect, just a few months ago.

PeggyM

Peggy,

I believe it all depends on where you lie on the spectrum between low blood potassium induced LAF (adrenergic) and vagally induced LAF. They are both connected by aldosterone, either too much or too little respectively (and P cells).

It would seem to me that, given your experience with lisinopril, you might be more in the former category than the latter.

Also, I think some of these reports (and my own experience with spironolactone), show this vagotonic effect only at significant doses. Furthermore, there are some ACEIs and ARBs that may not be vagotonic at any dose. Captopril may be one, because it does not seem to inhibit blood aldosterone levels like the others.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7881704&dopt=Abstract

But the long and the short of it is that I don't really know for absolute sure. This is just my opinion.

PC

Hi Mike,

I wouldn't jump into anything just yet. I promise to let you know what happens with my little experiment with amiloride. So far so good, and I'm having a blood potassium (and HCO₃⁻) specimen drawn today.

Both appear to work in the same manner independent of aldosterone. Amiloride and trimaterene have half-lives of 6-9 hours (peak 3-4 hours) and 3 hours (peak 2 hours), respectively.

PC

Always thought i was vagal, PC, episodes mostly at night and only once in the day after heat stress, dehydration, too much caffeine, and sleep deprivation.

PeggyM

Peggy,

IMHO this is not just a one-dimensional parameter, i.e., it's not only about the relative contributions of vagal tone and low potassium but also the sensitivity of their P cells. These P or pacemaker cells are directly influenced by both the ANS and blood potassium. One person may have more damaged P cells and less of an ANS/K problem may be required to trigger AF. Another, such as yourself, may have less damaged P cells and more of an ANS/K problem may be required to trigger AF. The latter ANS/K problem would be more easily rectified, at least wrt that required to trigger the P cells. Such individuals might be predominantly vagal but can drop below the ANS/K threshold with minimal correction of the potassium imbalance.

This is just my take on it. Who really knows? I have no data or article to which I can refer you.

This brings up a related question that I've that I've often pondered. There have been several posts on the BB about exercise induced AF and sex induced (and terminated) AF. Is this vagal or adrenergic?

Although I have less familiarity with pure adrenergic LAF (stress induced), I wonder if it is possible that such episodes (stress, exercise, sex) might all be vagally mediated. The carotid baroreceptor is very sensitive to acute changes in both hydrostatic pressure (BP) and pulse pressure (difference between systolic and diastolic). Could the acute onset of a stressful situation or even one not so stressful (sex) trigger a reflexive vagal response that might be more directly responsible for initiating the episode? I've always suspected this might be the problem when I've triggered an episode by sprinting (or sex). The only real difference between stress induced and exercise/sex induced LAF is the additional presence of cortisol/aldosterone in the former, which brings low potassium into the picture.

Food for thought.

PC

PC, the only thing i can contribute on that is that the daytime episode i mentioned above seemed to have been triggered by my admittedly stupid idea that what i needed to wake me up was to walk down a long flight of steep steps and then back up again. At the top of the steps i suddenly had that telltale oh-no-not-again feeling, and knew that everything was NOT all right. Spent the rest of that day and most of the next in the hospital, and it cured me of going to hospital emergency rooms when in afib, as well as finally convincing me i had to drop the caffeine altogether, and get an air conditioner. The emergency room staff was more than usually clueless, with the exception of one nurse, who actually made me laugh after evicting from my cubicle a medical doctor who announced pompously that i was totally mistaken about having a heartbeat irregularity, because if i had that i would be dead already. She actually took hold of this idiot's sleeve, tugged him backward a step, and whipped the curtain closed between him and me.

PeggyM

PC and Hans.... there is no way I'm accepting the title of Queen.... And if PC, you're a bit player, then I can't imagine what my title would be...maybe Cinderella.. cleaning the hearth.

I'm only here on my mission of creating awareness, in awe of the brain power we have amassed to help sort out this complex problem.

Without Hans providing this medium, we would all still be Googling our lives away.

I'm grateful to be part of the discovery process. And, Hans, as you say, eternal vigilance is the order of the day (for the rest of our days)....for sure. I'll drink to that! :)

Jackie

By the way.... it's bad luck to brag, but I've just passed my one year mark with no AF since the cardioversion 103 days post PVI....so hopefully this is it. I certainly hope so.

Hi all,

I'll stay out of the royal succession plans however, in a previous post above, I noted that I was using a glucose monitor as a way to control postprandial hypoglycemia and the drop in potassium associated with this (especially during the early morning hours of low serum potassium). A trigger for my VMAF is late eating in the evening. This could be a) GERD, b) postprandial hypoglycemia, c) vagal response to eating or d) not actually correlated. So I decided to monitor my blood sugar closely (& try to control it tightly) to eliminate this potential trigger. I've been on this program nearly three weeks, so here is a preliminary report of the effects of this program.

1. I had gained 10 pounds last fall, when I was in chronic afib for 2 1/2 months. I've been in NSR for over four months now, with one afib event over 3 months ago. I attribute this NSR to my Mg & K supplement program. However, I had been unable to lose the added weight in spite of daily exercise. Since I've controlled my blood sugar, I've lost 11 pounds, and this control has been the only change in my lifestyle.
2. Above, PC quotes Hans' book that excessive vagal tone is associated with a flat GTT (glucose tolerance test) curve. Well, I can say that I do not have a flat GTT. With either high GI (glycemic index) carbs or a large quantity of low GI carbs, I can spike my blood sugar with the best of them. This is also followed by a later somewhat hypoglycemic drop.
3. Despite what some of the low carb diet guru's say, most fruits do not spike my blood sugar. I've taken to making whole juice (no pulp extracted) in my 25 year-old Vita-Mix (a very powerful blender) with apples, carrots, bananas, oranges & etc. for lunch. A liter of this concoction causes a very gentle rise in my blood sugar, so I guess the GI tables for fructose are correct.
4. I've read many interesting studies on fat and insulin. A number of years ago I heard Dr. Dean Ornish speak and he was questioned how type 2 diabetics fared on his 10% fat calorie, whole food vegetarian plan. He responded that many were able to reverse their diabetes. The Weimar Institute, a Seventh Day Adventist inpatient facility in the Sierra foothills of California, reported that 50% of type 2 patients on their 19 day program (similar to Ornish's) were able to get off medicine completely and another 30% reduce their medicine substantially (these numbers are from memory, so may not be exact). I've also read studies that rats could be made diabetic with sufficient fat added to their diet. Also that circulating lipids impair insulin's ability to work. Well, I can show these results in myself. If I eat an Ornish diet with no added fat (excepting my morning ground flax), and eat slow carbs, my 12 hour fasting blood sugar is 85-88 mg/dl (divide by 18 to get mmol/l). However if I add fat to the equation, my fasting blood sugar is 110-113 mg/dl - high enough to be considered "pre-diabetes". Now these readings can be on consecutive days, depending upon my food intake the day before. One day, I had a couple of bowls of ice cream at my daughter's birthday party. Now ice cream isn't usually on my plan, but I decided not to eat anything else & see what happened. My 1 hour glucose reading was 135 mg/dl, which is a spike, but not that bad. My 12 hour reading was 113 mg/dl. The next day I was back on plan and my reading the following morning was 87 mg/dl. I found it fascinating that I could manipulate the results this way. I was also able to cause this same response by adding nuts (& their fats) to the otherwise slow carbs. Certainly adding fat

would eliminate the hypoglycemia, but could also cause hyperglycemia. Several years ago I vacationed with a friend who is a hand surgeon. He was on Atkins and I followed my normal veg. plan. We were quite the contrast at the restaurants.

My future plan is to continue the close monitoring and see if losing a few more pounds off my gut will change any of this when I challenge my system with either fast carbs or fat.

George

PC,

I have reread this discussion several times and must say that since I have increased my potassium to 1.2 to 1.5 g at mealtimes; my pacs/svts have dramatically decreased. The time between episodes has increased from every 2-3 days to 5-6 days. It may be too early to discern if a new pattern has been established but a shift has occurred over the last couple of weeks. And during this period I have started to exercise - moderate walk with intermittent short jogs. This I have not done in three years when afib became a most regular occurrence.

Thanks for your work in unravelling this mystery. I look forward to your post.

Kent

So happy to hear it.

I think you made a key statement "increased my potassium intake ... at mealtimes".

Believe me I've tried lots of combinations - KCl v. Kgluconate, accentuating K supplementation in AM v. PM and vice versa, dissolved v. tablet form, between meals v. only during meals, etc. I've come to a number of conclusions:

- 1) for some it's impossible to impact AF in this way without meds
- 2) K supplementation of any type between meals encounters tremendous neurohormonal opposition (aldosterone reacting to increased K/Na). And this creates a VERY complex situation. Aldosterone is quite vagolytic, aldosterone is not only stimulated by K/Na but also by RAS (renin angiotensin system), there is a diurnal rhythm to its secretion as well, not everybody responds similarly, e.g., the fit hyperrespond with RAS induced aldosterone when upright for prolonged period (>2h), etc. The problem is not unlike the phenomenon of aldosterone breakthrough for patients on ACEI, only more complex because of aldosterone's additional effect on vagal tone.
- 3) K supplementation during meals not only is better absorbed (because of the Cl⁻ in HCl (gastric acid) but also creates less of a ripple in the neurohormonal reflex arc. This is kinda like glucose during a meal v. as a snack wrt stimulating insulin secretion.

By taking amiloride I've frame shifted my baseline blood K upward and by taking disopyramide I've frame shifted my vagal tone downward. Nonetheless, even after tweaking a few things occasional shortlived episodes sneak through. However, these episodes are easily terminated by a gram or so of dissolved K. This was rarely possible before taking these two meds. Furthermore, whenever I feel PACs I know that my K blood level is in the risky zone and I immediately take 500-1000mg of K. This is now the only time between meals that I'll take it.

I've also noticed that I'm more likely to start with tachycardia and then transit to AF. Before it was always primarily AF with only rare tachycardia usually shortly before termination of the episode. I think this is because intracellular cardiac K stores are better now and my atria are therefore less susceptible to sustaining AF. So the PV reentry tachycardia stays "contained". Episodes when they occur are also much shorter (anywhere from a minute to 2hours). The latter are usually at night when I don't get the K onboard quickly enough.

My latest goal is to get off the disopyramide completely and prevent episodes by establishing absolute control over aldosterone with a combination of amiloride, ACEI and low dose spironolactone.

Congratulations and good luck.

PC

George,

I keep repeating my experiment of determining the effect of K supplementation on HRV (RLX). For me there is no question about it. Acute increase in K causes an increase in my HR and disappearance of my PACs. This effect is seen within several minutes of drinking dissolved K. It lasts for at least 30 minutes and after one hour (1/2 life of aldosterone is 15 minutes) my HR has dropped to slightly below its starting point. IMHO this latter is because the acute increase in K/Na driven aldosterone causes the RAS component to drop slightly, causing removal of a small amount of vagolysis.

PC

PC,

I've not been doing more of this test - it kind of disrupts the meditative routine and is not in my normal yogic program (although less disruptive than my son's death (deaf?) metal rock band practice in our basement - meditating through their songs is a good way to increase HR and decrease RLX!!).

I was snowshoeing with a physician friend last weekend & told her of this experiment. She warned me about playing with K & said it was a good way to murder people as the K leaked out of cells after death & was therefore not detectable. My own thought is that with healthy kidneys, I'm just dumping excess K in my urine. Also, I assume that since my ectopics respond favorably to my K routine, I'm not overloading my system (& it hasn't killed me yet).

Just out of curiosity, what is an acute increase in K for you (in grams at one time)? From your comment on my tests, I assume it is much less than the 3 grams it took me to get a response.

George

George,

I have band practice yet to look forward to. My son at 12 plays a pretty mean sax.

You're right. 500-10000mg is more than enough K to elicit the described response.

And I certainly have to agree with your thoughts about successful suicide with K.

PC

PC,

I assume you meant 500-1,000mg not 10,000mg.

George

Yes. Sorry about that.

PC

Hi PC and all.

Just back from a week in my beloved Isle of Mull in Scotland - including 40 miles of rough cliff and coastal walking - excellent (-:

A WHOLE week away from the Internet! AF issues never far from my mind however..... and I one way or another made it so..... read on.

For the trip I took 6 one litre cartons of organic almond milk with which to make porridge as well as to drink. I know it's fattening, but I was exercising quite a lot, I like the flavour, and - I'm assuming - it contains a shedload of Mg. Funny thing was though, on two days at around 10-11am I briefly (20-30 secs) I'm fairly sure I went into AF..... I wonder could it have been a result of the excessive Mg intake potentiating already too-low K?? (As suggested previously by PC I seem to recall.) Furthermore, I never did well with Mg supplements - always gave me more PACs. Fortunately the AF - assuming that's what it was (sure felt a lot like it....) - resolved itself quickly on each occasion.

I suppose that I should - even in the face of not inconsiderable largely unspoken admonishment from you all here - admit that my week away did include the ingestion of vast quantities of tasty crisps, large-fatish-rich meals, and err... I'm particularly ashamed to say.... a couple of bottles of fine single malt. OK, OK, the brief AF episodes might well have had rather more to do with the latter-mentioned than with the almond milk?? Well maybe, but the difference was that I had no late pm ectopy issues (although I DID have some fairly aggressive GERD...), and I did imbibe (either as a drink or as a constituent of porridge) a full litre of almond milk on both days on which I an hour or two later experienced short AF episodes.

On one of the two aforementioned occasions, the short episode of AF started after the first hundred metres of a long one-way walk (i'd been dropped-off to do). I just calmed myself down and sorted myself out and continued gently with the walk. THANK YOU HANS and the rest of you fellow forumees for having given me this fantastic medium from which I have gained such knowledge and reassurance that I can get on with my life!! [And I'm for sure back on the wagon after having so disgracefully fallen off for a week.]

I actually remember having had one or two similar late-ish-am episodes in the mid-90s but never realised what they were at the time. Come to think of it, I remember 2 days of a weak fluttery pulse (strange how it didn't feel uncomfortable or even all that alarming back then) whilst helping out a market-gardening friend between Uni terms back in 1987..... this came AFTER I'd crash-dieted 4 stones off in 4 months (down to 12st 12lbs at a large-framed 6'4" - NOT a good healthy look....) and BEFORE I spent a REALLY agonizing couple of years with GERD (relieved eventually and totally (for a few years) by 1000mg cimetidine per day. This musing about my younger days brings to mind PC's quote in a very recent above posting:

"My view is decidedly different. LAF is an early warning system that free radicals have been damaging your cell membranes and that your potassium intake is insufficient."

I appreciate what PC is saying, but I feel (as does Jackie from her response above) that stress also has a HUGE role to play in the genesis of ectopy and eventually AF - whether it be physiological OR psychological. I'm convinced that the latter (and to some indirectly related extent, the former) has greatly contributed to the emergence of my own albeit mildish AF.

Anyway folks, good to be back.

Mike F.

Hi Mike,

Is the Isle of Mull one of those offshore tax havens?

I think Jackie is absolutely right in her suggestion that your increase in PACs/possible brief AF episode may have been

due to hypoglycemia. After your high glycemic meal there was a transcellular shift of K (and glucose) from blood into cells (insulin induced), causing a drop in blood K and an increase in the K gradient. With a little vagal maneuver your P cells start "talking back to you". If you ingest some K immediately, then they'll quiet down, but you're still very near the AF threshold. And this only increases as the daylight recedes with the onset of increasing vagal tone and decreasing blood K (diurnal nadir). And, of course, straight supplementation without being packaged as a mini meal only further aggravates the undesirable neurohormonal reflex.

PC
