Pup season, and pup problems. As we refine our protocols for raising these little abandoned pups from Maine, we are learning more about growth patterns, behavior, and physiology. This last week we’ve battled some ticks, twitches, and crashes not related to glucose, but may be stress and sodium related. See this weeks Up On A Soapbox for more.
Gray Seals: Wasabi NMLC 15-005 PHg
strangulation ligature to neck, swollen right hind flipper / abscess, and pulmonary infiltrate / pneumonia, high WBC, eosinophilia
male [admit] wt=22 kg, SL= 98.5 cm, [current] wt= 43.0 kg BS=4/5
stranded 3/18/15 Nantucket; admit: 3/20/15
last blood: 5/12/15 WBC increased and increasing, eosinophilia; 6/2/15
last fecal 5-19-15; cestode ova, Diphyllobothrium type
PE: [pre-release]; Showing signs of stress behaviors with captivity. HR=120- bouts of sinus arrhythmia, RR 10, lungs clear, eyes clear, no aural d/c, limited oral exam WNL. Neck lesion is healed. Front flippers WNL, Right hind flipper is now normal, Left WNL. ABD palpation unrewarding but WNL, scar from removed tag on flipper is healed, other WNL. A: OK for pre-release CBC, OK to tag. Tag gun broke, while #17 LHF tag placed with 3mm incision with #10 blade and used tools to connect tag. Pending CBC OK for release- CRW

Gray Seals: Cilantro NMLC 15-007 PHg
lungworms (resolved) and infected brand, Step. phocae abscess (resolved), tapeworms, intestinal flukes (resolved)
male [admit] wt=32 kg, SL= 114 cm; [current] wt= 23.9 BS=2.5/5
stranded 5/3/15 Cape Cod/ IFAW; admit: 5/4/15
last blood:5/4/15; increased WBC, hyponatremia
last rads: 5/4/12: dorsal pulmonary consolidation, pneumonia likely Lungworm; 6/2/15: two views L Lateral, VD: position is good mild rotation on lateral, no pleural disease, prominate aorta, lung parenchyma WNL A: resolution of the lung consolidation, phocid lung films are often of low sensitivity for disease, but these are markedly improved from the initial study, which supports the resolution or resolving nature of the lungworm pneumonia-CRW
last fecal: 6/2/15; NPS {no parasites seen}
PE: EENT WNL, HR 100 sinus arrhythmia, RR= 20 Stressed apneupstic, mm pink. Lungs clear. Still a little thin Flippers WNL, behavior WNL. Branded skin is now healed, no evidence of abscesses externally. Other WNL-CRW
discontinue doxycycline
A: pending radiographs, consider CBC/SCP and pre-release evaluation; approved
Gray Seals: Ginger NMLC 15-011 PHg
alopecia, wounds, lungworm (TX week 2), tapeworms
female [admit] wt=19.7 kg, SL=95 cm; [current] 17.5 kg BS=2/5
stranded 5/17/15 IFAW Cape Cod; admit: 5/18/15;
last rads: 5-19-15
last blood: 5-18-15
last fecal: 5-26-15; *Parafilarides* an *Otostrerongyus* larva, tapeworm ova
Husbandry report: coughing up live and dead worms.
Visual: superficial wounds appear to be healing well.
PX: fair
PLAN:
increase Fenbendazole 50 mg/kg PO SID 3 days (week 21)
continue doxycycline 100 mg PO BID 14-28 days
continue albuterol nebulization PRN

Harbor Seals: Dill NMLC 15-009 PPv
abandoned pup, dehydrated resolved, spitting up continues
male [admit] wt=7.6 kg, SL=84 cm; [current] =7.3 kg BS=2/5
stranded 5/13/15 COA Deer Island ME; admit: 5/15/15;
last blood: 5/15/15; 5/19/15; 5/28/15 ACTH Stim and EP
last rads: 5/15/15, 5-19-15: has passed all sand and rocks
UA(floor): SG 1.022, trace blood, protein+, trace ketones, nitrites ++, sediment: inactive small same
PE [Williams]: TPR=95, 120, 30 stressed, thin, other PE WNL
A: determine significance of failure to gain weight and spitting up

**Harbor Seals**: Basil NMLC 15-012 PPv
abandoned pup, hypoglycemia resolving, electrolyte disturbances resolving, reopened umbilicus
male [admit] wt=8.1 kg, SL= 69 cm; [current] 9.3 kg BS=1/5
stranded 5/24/15 COA Deer Island ME; admit: 5/25/15;
last blood: 5/26/15; 5/28/15 EP
PE: TPR=96.1, 120, 10, umbilicus reported to be bleeding, no lesion at PE, shaved area and WNL for age, OK to clean daily with dilute beta dyne. EENT WNL, teeth, mm pink and moist, no aural d/c, eyes clear and bright, neck WNL, flippers WNL abdominal palpation WNL, thin, other WNL A: likely the other seal was sucking and caused minor injury, cleaning should suffice-CRW

**Harbor Seals**: Rue NMLC 15-013 PPv
abandoned pup, borderline hypoglycemia (resolving)
male [admit] wt=7.1 kg, SL= 7.4 cm; [current] 7.5 kg BS=1/5
stranded 5/26/15 MMoM ME; admit: 5/27/15;
Visual Inspection [Williams]: WNL
Harbor Seals: Mace NMLC 15-014 PPv
abandoned pup, elevated GGT (50), low globulin (1.2)
male [admit] wt=6.4 kg, SL= 69 cm; [current] 6.7 kg  BS=1/5
stranded 5/24/15 COA, ME; admit: 5/28/15;
last blood:5/31/15
last rads: 6/2/15: chest and abdomen lateral, gas in stomach and colon, no sand, other WNL
PE [Williams]: TPR=98.8, 120, 10; full term abandoned pup, EENT WNL, teeth not erupted, no
aural d/c, thin, flippers WNL, active and normal pup behaviors, mm pink, lungs clear, no
murmur, other WNL for age and species. IOP tonovet L=30, R= 39.
Up on a Soapbox : Hyponatremia in Phocids
if seals are the salt of the earth, so why are their sodiums so low?

Sodium is the major extra-cellular cation, and is responsible for fluid balance, muscle and nerve function and other vital body systems. Electrolytes are generally maintained within a pretty narrow margin so any disturbance is cause for concern. Hyponatremia is defined as a low serum or plasma sodium. The first problem however, is defining what exactly is the normal sodium for a seal, a pup, a weanling, Harbor seals, Gray, Hooded etc. The truth is we just don’t know. We do not have normal ranges but studies of relatively small numbers of individuals perhaps in various states of health. Next is actual measurements and while electrolytes tend to do better, none of the devices we use to measure values in seals have been calibrated or validated in these species. If you want to live in a world were the normals are known and well defined and lab values can be trusted, I suggest small animal medicine or even better . . . work with humans. There are even species differences here as dogs can run 10 point (mEq/L) lower than cats, so the species and age group are all important.

In small animal medicine I look for a sodium between 137-157, with low values in the 130s and anything lower then that is critical with 120 being a life threatening condition. Sodium elevations with dehydration and salt ingestion are serious above 160 and anything around 180 can cause death in 6-12 hours. We commonly see dehydrated seals come in with sodium level near 190 and seem to do well with appropriate fluid therapy. Perhaps seals are tolerant of hypernatremia and less tolerant of hyponatremia, this might make sense for animals living in salt water.

Understanding low serum sodium (hyponatremia) in seals is not new. A hyponatremia syndrome has been seen in wild and captive seals, and was identified early in the course of marine mammal medicine and husbandry as a cause of death of seals living in fresh water if not supplemented with salt in their diet (Geraci). In fact, this is Geraci 101. As Joe Geraci was my mentor and one of the founders of the National Marine Center we owe it to Joe to get this right. Dr. Geraci was lecturing and refining this metabolic disease back in 1978:

A New Look at Hyponatremia, A Disease of Captive Seals IAAAM 1978

Joseph R. Geraci; D.J. St. Aubin, Department of Pathology, Ontario Veterinary College, Guelph, Ontario

Hyponatremia is a metabolic disease of phocid and otariid seals. It is characterized by a gradual or sudden decrease in plasma sodium and chloride, and unpredictable changes in potassium. The condition is stress mediated, and appears with moult, malnutrition, and non-related diseases. Studies presently underway confirm stress disease interaction as the basis of hyponatremia. Diagnosis, therapy and control of the disorder will be discussed.

Teaming up with his old partner in science Dr. Aubin, Geraci and Aubin (1986) published on adrenocortical function in pinnipeds, and while exact mechanisms were elusive, adrenal cortex depletion associated with stress causing a real or relative mineral corticoid deficiency was the cause of hyponatremia.
If all of this sounds complex, it gets worse. While seals are unique, their underlying physiology is still mammalian, so we need to delve into my (imperfect) understanding of sodium physiology and pathology to start and unravel this mystery. Sodium control involves almost every body system, so disease almost anywhere can have an effect. This all happens simultaneously but we’ll start somewhere, and look at blood pressure. If blood pressure drops the juxtaglomerular cells near the glomerlous of the kidney detect this and release renin and ACE (angiotensin-converting-enzyme). Renin is an enzyme that changes the angiotensinogen, made in the liver, to angiotensin I. ACE is also released by the lung, and is an enzyme that changes angiotensin I to the active form angiontensin II. Angiotensin II has at least 5 major effects: 1) increase sympathetic activity 2) a direct effect on the kidneys to increase tubular absorption of sodium and increase excretion of potassium 3) causes the adrenal cortex to release aldosterone, which also causes the kidneys to save sodium and pass potassium {note two things do the same thing is a strong metabolic effect and indicates the importance of this system} 4) vasoconstriction of arterioles and 5) increase ADH (anti diuretic hormone) release from the posterior pituitary which also has an effect on the renal tubules to increase water absorption. The net result of this system is to increase intravascular sodium which pulls in water to maintain blood pressure and direct effects on the vasculature, as the BP goes up, renin and ACE production is down regulated which leads to less active angiotensin II and thus the balance is restored. A classic physiological negative feedback arc. 

In our cases, we typically encounter a run away system in dehydrated animals where the serum sodium is too high, blood volume is continually too low and the system continues to increase sodium. Water always follows sodium. This firsts depletes the interstitial fluid as the body will try to get water from where ever it can, in seals including the blubber. This is what we call dehydration and without fluid support the effect is eventually fatal. We can stop this metabolic spiral by giving fluids; orally, SQ or IV. 

For hyponatremia to exist at least three things have to happen. First, there has to be source of relative electrolyte free water, and our electrolyte solution may be a little low in sodium allowing this to happen as a rebound from treatment for dehydration. The second thing is the presence of ADH. We saw earlier that one of the main stimulus for ADH release is angiotensin II. Lastly, you need functional kidneys. Other factors in seals pups that may cause excessive ADH activity include: pain, anxiety, oxytocin release, adrenal insufficiency, nausea, and general stress related issues.

Enough mammal physiology, what about seals ?

Lander (et. al, 2003) looked at the serum chemistries of wild harbor seal pups and weanling, and if they were admitted as dependent pups. She also looked at pre-release animals. There was quite a bit of variability but if the ranges were all combined, we see the sodium levels from 148 to 166 mEq/L. Roletto (1993) found a tight range in Pacific harbor seals (147-153), and our friends in Boston who keep captive harbor seals at the New England Aquarium report a general range in their collection as 147-157, which is typical.

But I’m a practical kinda guy so you have draw a line somewhere

I am defining hyponatremia in seals as a value < 145 mEq/L, serious hyponatremia as < 140
Treatment for mild hyponatremia may involve simply getting the seal to eat, supplementing the diet or tube feeding in salt (sodium chloride), or providing LRS or 0.9% saline SQ or IV (or PO). Treatment of serious acute hyponatremia is to give 0.9% saline IV. Use of hypertonic saline is to be reserved for seals under constant veterinary supervision and monitoring, as changes must be carefully controlled and correction of long standing hyponatremia must not occur too quickly as this can be as fatal as the disease in the first place. I’ll leave the brain swelling lecture for another time.

Emergency management of an animal in crisis should include IV fluids and an rapidly acting steroid with some mineral corticoid activity, like injectable pred (prednisolone) or cortisol but none of these products are readily available, so while it has little mineral corticoid activity, DexSP 0.2 mg/kg IM or IV will do in a pinch but followed up with oral pred as soon as oral medications can be given.

In the case of true aldosterone depletion the treatment most likely to be successful is desoxycorticosterone pivalate, but no controlled studies have been done in seals. This drug is available as a long acting injection [Percorten-V] for the treatment of Addison’s disease but there are risks to this approach. Just a few of the potential adverse effects include: depression, anorexia, diarrhea, vomiting, weakness, and coat changes, not to mention the inability to remove the injection thus the animal is forced to deal with it’s biological effects for around one month. Addison’s disease is a deficiency of cortisol, which has both gluco corticoid and mineral corticoid activity. Testing for this life threatening disease is indicated for patients with elevated potassium and decreased sodium, collapse, shock, vomiting, and failure to handle stress. The classic diagnosis is an ACTH Stimulation Test that fails to show a rise in body cortisol. In our limited experience we have seen pups mount an appropriate response and cortisol levels can be normal in seal pups, even with electrolyte disturbances. Atypical Addison’s disease (the bugaboo of budding endocrinologists) is a patient with Addison’s disease without the electrolyte disturbances, these animals are treated with replacement pred. But this does not explain our harbor seal pups that do have low sodium and high potassium levels, and a normal ACTH response. This could be an new disease Atypically Atypical Addison’s Disease™ (trademark-Williams) which represents a true aldosterone depletion, and we’re looking into this. I don’t know about you, but if you made it this far, congratulations, and I think we can agree that this is enough physiology for one day.

And for all this talk and four harbor seals in-house, we’ve really only measured one marginally low sodium value one time (Dill 144 mmEq/L; an ACTH stim was normal at that time) which responded quickly to fluids, and not documented low sodium during or as the defined cause of one of the “pup crashes”. Still, seals can die of hyponatremia and may be more sensitive to low serum sodium values then other mammals so we’ll continue to monitor and lean what we can. We have a pending resting aldosterone value out on Dill, that will be interesting.

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