Release Notes 2022-03-27 : : This work reports another episode in the life of one dog, Happy, who was previously followed during heartworm recovery. It may describe a trivial coincidence but the response seemed compelling suggesting a link between riboflavin intake, against an already plentiful list of nutrients, and a possible heart problem. Putative diet related DCM is still an area of interest at the FDA and at least one paper found reduced riboflavin content in foods associated with DCM reports [62]. This result may also be a clue about prior coincidence of coughing with aromatic amino acid intake that seems peculiar to her. Although her kibble had changed during a similar time frame suggesting that as a possible contributor too. It also introduces a combination of ingredients that may form an "anti-pathogen energy drink" for a class of dogs. At least one other dog has shown a health improvement on this and waiting for 16s rRNA to determine if any potential pathogens have been removed.
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Note that any item given to a non-human must be checked for safety alone and in combination with other ingredients or medicines for that animal. Animals including dogs and cats have decreased tolerance for many common ingredients in things meant for human consumption.
I am not a veterinarian or a doctor or health care professional and this is not particular advice for any given situation. Read the disclaimers and take prudent steps to evaluate this information.

Happy Again : Possible Canine Riboflavin Deficiency

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The report describes a sudden decline in the activity of a dog, Happy, previously followed for her recovery from heartworm. Her coughing had been gradually increasing but with no obvious deterioration in overall activity, eating, or other indications of health. For several days however she was very quiet and had difficulty coming up a short flight of steps or jumping as she normally does. This was thought to be heart related. One day response to riboflavin seemed subjectively good so that was continued. Her supplement list was changed to include more riboflavin and niacin in addition to sodium benzoate and silver added for other reasons. In a few days she recovered to almost normal activity with elevated coughing frequency. It remains to be determined if her chronic cough will resolve with these changes but it does seem to be better than the recent past.

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FIG. 1: Happy sitting in the sun. 2022-03-27. Color balance off and terrible compression artifacts obscure her coat.

1. INTRODUCTION

The relationship between diet and overall health is complicated and basic aspects remain unclear in humans and animals such as dogs. This report may not be all that noteworthy except that the FDA recently began investigating some mysterious new cases of canine DCM that were thought to be diet related [4]. Investigation continues more generally into non-hereditary causes of DCM [5]. An examination of dog foods associated and not associated with DCM identified several differences including riboflavin levels [62]. While not the first thought for heart problems, in retrospect, riboflavin would be a good candidate for a contributor to idiosyncratic nutrient issues as it exhibits many important interactions. Reactions with ascorbic acid and amino acids as well as other light and dark reactions, have been a nuisance for formulating parenteral nutrition since at least the 1990's [38] . One known transporter in rodents, rRFT2 , is "highly sensitive to riboflavin derivatives such as lumiflavin, FMN and FAD" [50] suggesting that anti-riboflavins or competitive inhibitors of transport may be likely depending on host genetics and processing, storage, and even serving conditions of the foods. FAD and FMN enzymes participate in many reactions including those of cholesterol and vitamin D pathways [56] that are current topics in the health of older humans.

Happy was described previously as she recovered from a heartworm infection with her cough monitored as a possible indicator of heart health [45]. She was followed until she had no obvious symptoms of ill health. Subsequently, her cough returned slowly over many months. Many causes of cough cam be identified but heart and respiratory problems such as a collapsed trachea are both suspects. This work describes her sudden decline with symptoms beyond just cough and her recovery that appears to be related to the supplement change.

2. DESCRIPTION

Happy has been described before as her recovery from heartworm was documented [45]. Her recovery was unremarkable but notable for large amounts of dietary vitamin K and increased coughing coincident with aromatic amino acid supplements added to her diet. A change of kibble also coincided somewhat with the prior coughing. She remained cough-free for many months after that work but subsequently her coughing began to increase gradually and she had intermittent itching problems. Like many, dogs occasional tearing in one eye was also present. One or two days in January 2022 she was reluctant to eat and passed one bloody diarrhea but otherwise has been quite healthy and stable. This was dismissed as just a response to some foreign object she probably ate.

The present work began when her activity level dropped quickly as she had to climb each step rather than jump between them on a short set of stairs. She could not jump on the couch and was generally quiet. Through out this time, her kibble was a combination of American Journey Lamb and Sweet Potato Puppy [1] (American Journey LLC, 1855 Griffin Rd Dana Beach FL 33004 1-800-672-4399) and Nature's Logic Canine Chicken Meal Feast (Nature's Logic PO Box 67224 Lincoln NE 68506 888-546-636) [3] or similar (may or may not have been "Puppy" etc). Sodium

benzoate and a tin-silver [58] arginine HCl (referred to as SnAg) mixture had recently been added to the diets of all dogs living with Happy. This has not been described in detail but briefly 2 to 3 chunks of 96-4 Sn/Ag alloy metal 1-2 cm on a side are allowed to set in 100-200ml of tap water with variable amounts of added arginine HCl. Arginine content (2-5 grams) and incubation times (1-48 hours) varied considerably. This was thought to be a speculative way to reduce oral and GI microbial problems. This did not appear to be a contributor to her overall decline as it was not overtly deleterious to the other dogs and she had had the SnAg intermittently in the past with no safety signals. It was continued as part of the adaptation to her disease due to concerns elaborated in the Discussion. All vitamins were reduced when food intake was restricted due to weight concerns. Her snacks and vitamins overall were cut in half as her prior weight of 6.08kg in Nov 2018 had increased to 7.35 kg on 2022-03-16. After this change, vitamin K intake remained above 1mg on most days. Riboflavin was considered along with other vitamins and one significant dose preceded some recovery less than a day later. Within 2 days with the consistent higher dose riboflavin she returned to normal activity levels and increased coughing. While still hesitant to trot up and down steps and not yet observed to jump in the kitchen, she is playful again. Some daily totals of relevant nutrients are shown in Fig. 2. Leucine is used as a reference for baseline vitamin intake. Besides the specific vitamins described here, incidental B-vitamins are included in the background nutrition. Happy also received intermittent multi-B vitamins which are shown as yellow (although MUQED [46] is supposed to be able to explode items into components that has not yet been tested). The multi-vitamin B-3 was in the form of nicotinamide rather than the isolated supplements which contain niacin.

Thinking outloud
the MUQED files should break down the multi-B and report these as different entities

The peak amounts or riboflavin were from .125 of a capsule or 12.5mg of riboflavin.

Her condition-specific vitamin mix stabilized as 4 servings (or doses) per day of approximately 1/32 tsp citric acid, 1/32 tsp potassium chloride, 1/64 tsp sodium benzoate, 50mg riboflavin, 15mg niacin and uncontrolled amounts of SnAg. The SnAg concentration and amounts were highly variable.

Thinking outloud
This "SnAg" seemed to be beneficial to another dog here, Beauty, who is having her "spit up" fluids explored by 16s rRNA sequencing. When it was "weak" for a day, the arginine solution had not had much time to corrode the tin-silver, she seemed to regress a bit. This needs to be standardized or at least characterized if it seems useful. It is incredibly simple and cheap.

Date	Note
2022-01-11	bloody diarrhea, not eating, temporary
2022-03-03	begin benzoate/SnAg with other dogs
2022-03-04	noted as slow coming up steps
2022-03-07	try riboflavin/niacin for treatment
2022-03-08	some improve originally thought niacin
2022-03-09	continue riboflavin
2022-03-11	cut baseline snacks in half for weight
2022-03-12	noted as almost normal but hesitating to jump
2022-03-17	continues activity, maybe coughing less
2022-03-23	continues activity, coughing stable
2022-03-26	jumping more frequently for food as in the past.

TABLE I: Some notable observations regarding Happy

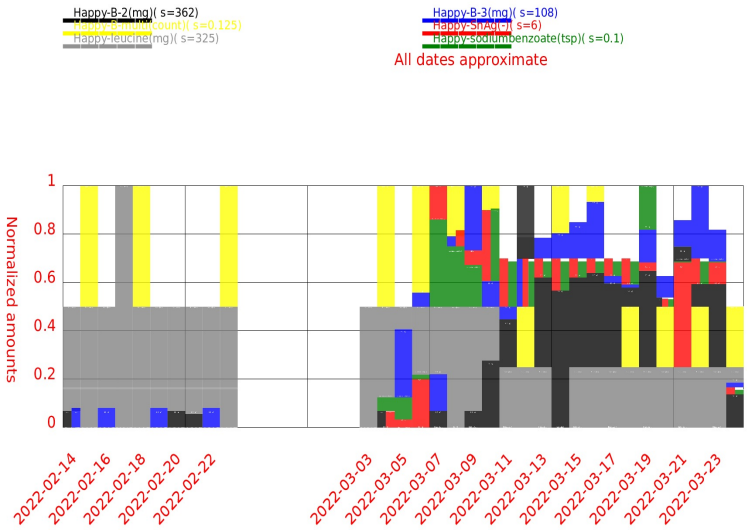

FIG. 2: Happy's daily intake of selected nutrients. Note that when two normalized amounts are similar, they are split vertically in no particular order. The original SVG contains additional text that is too small to convert.

Happy was also getting unknown amounts of a product called Lung Gold [6] which was not believed to be a factor at this point. Most of her background dietary intake is summarized in Appendix C using mostly self-explanatory abbreviations with more details in the MUQED description files [46]. Daily total intakes are shown in Appendix D for a recent sequence of 10 days.

As of 2022-03-23 her activity level is very high although coughing appears to be related to excessive excitement and barking but difficult to determine any heart related component. On 2022-03-26 her "coughing while curled up resting" may be decreasing.

3. DISCUSSION

It is not clear if some underlying disease got worse and was mitigated by these vitamins or Happy ate some other substances causing a temporary condition that resolved on its own. Currently, her activity level is very good and her coughing may be approaching low levels again suggesting the vitamin mix is effective against some chronic condition. Happy eats a lot of things outside, she may have ingested some toxic or infected substance that simply took a while to clear. If there is a causal link between the supplements and this episode which is presumably related to her chronic cough , then a recovery from coughing is eventually expected.

The working hypothesis is that her cough relates to respiratory and/or cardiac limitations. Several vitamins had been informally tested in the past without much obvious response. Part of the motivation for adding riboflavin was that intake of it, along with tryptophan, was shown to correlate with reduced blood pressure in a UK twins study [40] . While Happy's symptom's may not be due to blood pressure per se, the assumption is that the raised blood pressure is caused by some other metabolic stress that can be caused by riboflavin deficiency.

Daily riboflavin requirements for dogs and consequences of insufficiency have been discussed in many publications. Cardiomyopathy is not commonly listed as a symptom of riboflavin deficiency. One work estimated a minimal intake at $66.8\mu g/kg/day$ with deficiency symptoms including "weakness,erythemia,ataxia, ocular lesions" and collapse [23]. A study in 1942 suggested between 60 and 100 micrograms per kg BW for a growing dog with deficiency symptoms including tachycardia [57]. A sufficient riboflavin intake then for Happy should be under 1mg. Using more modern data , an RER calculator [2] with a weight of 7 kg gives a resting requirement of 301 kcal which could be multiplied by about 3 when she is normally active giving an energy need of less than 1000calories/day. A recent AAFCO publication [1] suggests 5.2mg/kg of feed with 4000kcal/kg of food leading to maybe as much as 1.3 mg/day when she is active. Recent therapeutic doses exceed 200mg/day. Other lists of deficiency signs include, " [...] some skin lesions and

[1] https://www.aafco.org/Portals/0/SiteContent/Regulatory/Committees/Pet-Food/Reports/Pet_Food_Report_2013_Annual-Appendix_B.pdf

inflammations, such as stomatitis, cheilosis, oily scaly skin rashes, and itchy, watery eyes. " [39] Her most prominent symptom ,in addition to her cough, was weakness which is not specific. She did have itching episodes and sporadic tearing in one eye but these had not gotten worse.

Riboflavin is central to many biological processes [52] including, " mitochondrial energy metabolism, stress responses, vitamin and cofactor biogenesis, where they function as cofactors to ensure the catalytic activity and folding/stability of flavoenzymes" [51] and glutathione reduction [18] . It came up as a possible suspect in the dog food associated DCM along with several other B-vitamins and "tryptophan betaine" in a comparison of DCM associated and control products [62].

Thinking outloud
As a microbial product potentially able to become an amino acid analog the "tryptophan betaine" is interesting here and in derivative work [43] (and note in passing a similar tyrosine compound has also been observed [21]).

It is listed in one work along with several other vitamins including vitamin K which may be beneficial in heart failure [25] . Links between riboflavin and cardiopmyopathy appear documented in limited case reports. Cardiomyopathy has been associated with auto-antibodies against flavoproteins [64] and there may be other obscure links between the versatile riboflavin and heart disease. Additional riboflavin has been able to compensate for various mitochondrial genetic diseases [27] . A riboflavin responsive myopathy has also been documented [14]. One small study found higher rates of B-2 and B-6 deficiency among heart failure patients than controls but supplement usage did not seem to help [37]. Riboflavin requirements may vary depending on polymorphisms. In one small study of a Methylenetetrahydrofolate reductase variant increased homocysteine was observed but it could be normalized with adqquate riboflavin [49]. Happy could have pre-disposing genetics that make this result almost unique to her.

Previously, it was observed that Happy's cough increased soon after adding aromatic amino acids to her diet [45] but the observation was considered a coincidence especially after another dog, Brownie, had recovered uneventfully with aromatic amino acid supplements [47] . The possibility remains however of an idiosyncratic reaction or overall issue with the diet. There is some concern about excess amino acids such as leucine causing effective niacin deficiencies but results are not always consistent [41]. Aromatics with a polar group may make emulsifiers, enhance solubility, or otherwise modify riboflavin availability. Sharing the aromatic component, they may also compete for transport.

Riboflavin may also relate to bacterial infections as it can aid clearance [28] Anti-riboflavins are known to occur as microbial as well as plant products. For example, antibiotics roseoflavin and 8-demethyl-8-amino-riboflavin from Streptomyces davawensis [54], and hypoglycin from the Ackee fruit [9] [19] [31] are thought to act as anti-riboflavins. Intestinal bacteria in humans and rats can create lumichrome from riboflavin which may be absorbed via non saturating mechanisms [12] . It is not known if any particular canine pathogens can create other relevant metabolites.

Riboflavin depletion was explored in the context of chemotherapy sensitivity and its protein destabilizing effect was thought to be a benefit in "synthetic lethality protocols" [48] . There are many possibilities for marginal riboflavin status interacting with noxious or infectious ingested objects.

Various aspects of riboflavin chemistry make it a particular challenge to integrate with a diet with predictable bioactivity. Many of the basics of riboflavin solubility and stability properties were described in theses from the 1940's to the 1960's [63] and there is modern interest too [36] . Riboflavin solubility is dependent on the concentration of other ions but is quoted at about 87mg/l [7], 120mg/l [33] or 300mg/l in water while riboflavin phosphate is quoted at 112mg/ml [53] https://link.springer.com/content/pdf/bbm%3A978-1-4615-2131-0%2F1.pdf . Solubility factors include beonzoate and nicotinamide and pH. As early as 1947 nicotinamide was used to enhance water solubility of riboflavin [32] and considered again in 1996 [24]. Today, it is used routinely and work has identified differences between solubility and absorption [16]. Benzoate was also considered in a 1954 thesis [33].

Happy typically gets riboflavin mixed with citric acid, potassium chloride, sodium benzoate, and silver/tin-arginine HCl mixed well with raw ground beef. This is thought to be acidic which may reduce solubility . In alkali media however it may decompose [67] so working with the acidic solution may be a reasonable approach.

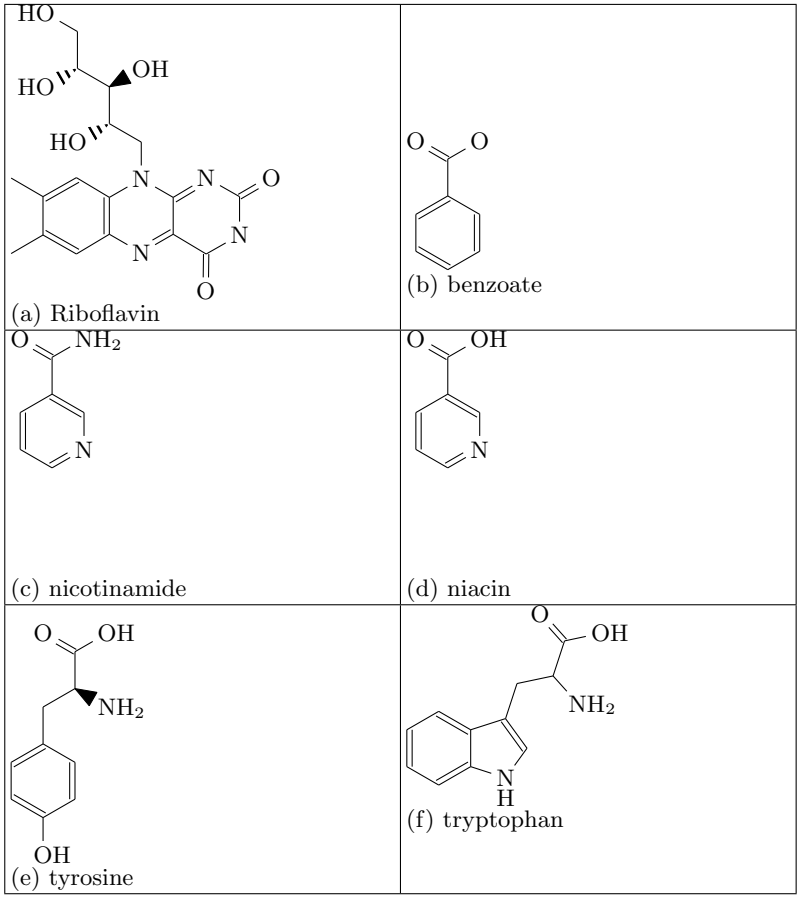

TABLE II: Riboflavin shown along with some interesting or possibly interacting molecules. Drawn with mol2chemfig using information downloaded from PubChem.

It may also be worth noting that on 2022-03-05 Happy had about .25 of a capsule of a thyroid glandular product previously described with chronic usage in much higher doses [44]. Thyroid hormone T4 is apparently required for riboflavin transformation making hypothyroid conditions mimic riboflavin deficiency [22] . This may have perturbed T4 levels briefly due to reaction to briefly elevated T3. As an aside, it is interesting that blood pressure may increase with perturbations in thyroid function in either direction [17] . As the cause of high blood pressure is largely unknown and riboflavin intake may correlate with its development, this may be a useful pathway to elucidate.

[**mjm : Probably something interesting here if I can sort it out...**] Riboflavin, maybe more than other vitamins, destroys some nutrients including amino acids [61] and understanding its chemistry is therefore important to improve availability of all components. The protonated form in acid media is cationic (positive) (protonated at N1, between oxygen and adjacent ring [59]) and the alkali is neutral [11] . Rf^- is the dominant species at pH=7.3 which is missing the N3 proton [68]. Summarised as [30], " ... an equilibrium between the cationic form (RFloxH2+) and the neutral form (RFloxH) at low pH (pKc=0.4), and between the neutral form and the anionic form (RFlox) at high pH (pKa=9.75). "

Each added component may contribute to the observed results too. Niacin has been controversial for cardiovascular effects in humans [29] [60] and derogatory results considered in terms of dosing and other details [66]. As many problems became concerns in combination with statins, it is not clear how they are relevant here. It also can effect clotting parameters [55] [35]. However, modulation of riboflavin availability may be a more important issue. Requirements for dogs are in the range of $200 - 400 \mu g/day/kgBW$ [20] making them about 2-3mg/day for Happy.

Roles for the other components could include modulation of GI organisms and their metabolites. Silver-arginine combinations are trendy topics in antimicrobial research [10] [65] . Sodium benzoate and silver-tin are likely able to modify GI microbial metabolism [71] [70] . There may be some impact on biofilm formation [13]. Hopefully 16s rRNA PCR from another dog will help determine what impact the beznoate and SnAg may have had on oral microbes.

Benzoic acid has been used to remove glycine and nitrogenous wastes [69] possibly effecting her amino acid fluxes. It is thought to increase whole body protein turnover in essence due to detoxification [15]. The idea that it could improve protein cycling, replacing older proteins with new ones, is intriguing. It would be interesting to see if it could have helped another dog here, Sera, as that was the hope with her cataracts [42]. Benozoate or benzoic acid has gotten

a lot of press as a food preservatives [8] and it has also been used as a feed additive [72] [34] and explored as an oral antimicrobial agent [26]. Benzoate improved solubility of riboflavin [33] and it may help emulsify a mixture of olive oil and water containing tryptophan leading to better absorption of lipophilic nutrients (unpublished observations).

If indeed nutritional idiosyncrasies are common in dogs, a background of "good nutrition" may be important for minimizing a range of defects. That is, an isolated defect in riboflavin processing may not be obvious when combined with other marginal factors. Ideally, the default supplements work well for most but fail in informative ways that maximize less harmful diagnostic symptoms while minimizing disease progression. Overt informative error signals may eventually allow fine tuning from a default "best shot."

The "take your best shot" approach rather than trying "one thing at a time," in retrospect, may seem less informative although that is not really the case. Single entity changes often result in very small observable clinical effects, requiring more averaging and precision observation, and in any case may have multiple pathway effects. Vitamins can modulate pathogen response and beonzoate and silver may both modulate related pathways. The combination used here covered many possible etiologies and conflicts are anticipated and hopefully understood. Once a beneficial strategy is found it can be optimized in several ways depending on how or if the components interact. For one active component and N-1 placebos, the active component can be found in logarithmic time removing 1/2 of the candidates at a time. Other modulation strategies can be applied with more complicated interactions until a minimal subset or optimal dose is found. While this strategy then would potentially allow disease progression reversion to the working approach is quick. In reality all of these things interact and have dose-response curves. However, a decent first-guess with a strong response is easier to work with than noisy single entity tests. Testing one thing at a time provides no recovery plan if you guessed wrong and have a weak or non-existing signal. In fact, it may be interesting to see if the DCM associated dog foods have an excess of some other nutrient that increases requirements for or destroys utility of dietary riboflavin.

The combination of riboflavin, niacin, sodium benzoate, and silver-tin in arginine HCl (SnAg) along with potassium citrate and citric acid, has been fed to several dogs. One older dog suffering from unknown appetite problems, Beauty, prefers beef that has this mixed in and she appears to be improving now. And earlier 16s rRNA PCR on some "spit-up" fluid identified many potential pathogens and it will be interesting to see how that may have changed in follow-up results. It remains to be seen if it addresses a widespread problem in older dogs.

4. CONCLUSIONS

It is still not known if Happy had experienced a sudden decline due to progression of a chronic disease or had an acute incident such as ingestion of poisonous soil or organisms from the play area. Hopefully, her underlying condition simply became bad enough that it was easier to see an improvement with supplement changes. In the case of a chronic heart condition, a relationship to niacin, riboflavin, maybe benzoate, and the other components could be rationalized. With an infectious component, contributions from silver could be suspected also. The earlier observation of increased coughing with armoatic amino acid supplements may not have been a coincidence but may indeed be idiosyncratic and related to overall nutrition status. In some cases, the interaction of the "nutrient vector" with clinical disease may be strong but very complicated making it appear as noise or unrelated and the opposite is true that placebo dosing can correlate with improvement. It will be interesting to see how much of each is operating here.

5. SUPPLEMENTAL INFORMATION

5.1. Computer Code

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Selected nurrients graph,

 2236  vihdr mjm_dog_plots.h
 2237  ./run_linc_graph -compile
 2238  ./run_linc_graph -some-diet-plots txt/pin_happy1.txt "B-3(mg)" "B-2(mg)" "SnAg(-)" "sodiumbenzoate(
     tsp)" "B-multi(count)" 2>&1 | grep bin_
 2239  eog diettablex.svg
 2240  ./backup
 2241  eog diettablex.svg
 2242  convert diettablex.svg happyagain1.jpg
 2243  eog happyagain1.jpg
```

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 2244 history
 2245 mv happyagain1.jpg /home/documents/latex/proj/happyagain/keep
 2246 history

Monthly tables,


 2262 ./run_linc_graph -dt-mo txt/happy2.txt
 2263 mv xxxtable /home/documents/latex/proj/happyagain/keep/monthly.tex
 2264 history
```

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Appendix A: Statement of Conflicts

No specific funding was used in this effort and there are no relationships with others that could create a conflict of interest. I would like to develop these ideas further and have obvious bias towards making them appear successful. Barbara Cade, the dog owner, has worked in the pet food industry but this does not likely create a conflict. We have no interest in the makers of any of the products named in this work.

Appendix B: About the Authors and Facility

This work was performed at a dog rescue run by Barbara Cade and housed in rural Georgia. The author of this report ,Mike Marchywka, has a background in electrical engineering and has done extensive research using free online literature sources. I hope to find additional people interested in critically examining the results and verify that they can be reproduced effectively to treat other dogs.

Appendix C: Monthly diet summary

Name	2022-01 Jan	2022-02 Feb	2022-03 Mar
FOOD			
KCl(tsp kcl)	0.044 ;0.046;12/13	0.062 ;0.062;23/23	0.16 ;0.062;14/14
KibbleAmJrLaPo	0.063 ;0.075;11/13	0.075 ;0.075;23/23	0.075 ;0.075;14/14
KibbleLogic	0.042 ;0.05;11/13	0.05 ;0.05;23/23	0.05 ;0.05;14/14
b10ngnc[(c)]	0.28 ;0.25;8/13	0.17 ;0.25;7/23	
b15ngnc[(c)]		0.15 ;0.25;7/23	
b20ngnc[(c)]			1.8 ;1;9/14
b7ngnc[(c)]	0.16 ;0.23;5/13	0.3 ;0.25;13/23	2.3 ;1;12/14
carrot	0.34 ;0.25;12/13	0.49 ;0.25;23/23	0.38 ;0.25;14/14
cbbroth	0.31 ;0.25;10/13	0.35 ;1.2;15/23	0.27 ;0.25;9/14
citrate(tsp citrate)	0.045 ;0.046;12/13	0.062 ;0.062;23/23	0.16 ;0.062;14/14
ctbrothbs	0.11 ;0.18;4/13	0.32 ;0.25;15/23	0.25 ;0.25;8/14
eggo3	0.076 ;0.092;10/13	0.11 ;0.12;21/23	0.089 ;0.12;13/14
garlic	0.1 ;0.25;6/13	0.086 ;0.25;8/23	0.036 ;0.25;2/14
oliveoil(tsp)	0.096 ;0.12;10/13	0.14 ;0.12;18/23	0.04 ;0.12;4/14
salmon	0.018 ;0.18;3/13		0.37 ;1;3/14
shrimp(grams)	3.5 ;6.1;10/13	1.5 ;5;8/23	0.65 ;4;3/14
spinach	0.34 ;0.25;12/13	0.49 ;0.25;23/23	0.38 ;0.25;14/14
tuna(oz)	0.021 ;0.18;2/13	0.17 ;0.5;15/23	0.14 ;0.25;10/14
VITAMIN			
B-1(mg)	12 ;31;6/13	15 ;42;13/23	10 ;31;7/14
B-12(mg)		0.033 ;0.25;3/23	0.062 ;0.25;4/14
B-2(mg)	4.3 ;18;3/13	6.3 ;25;6/23	105 ;100;10/14
B-3(mg)	1.5 ;6.5;3/13	3 ;8.8;8/23	59 ;25;12/14
B-6(mg)	1.4 ;9.2;3/13	3.4 ;16;11/23	4.2 ;12;8/14
B-multi(count)	0.04 ;0.092;5/13	0.049 ;0.12;9/23	0.058 ;0.12;7/14
Cu(mg)	0.44 ;1;5/13	0.67 ;1.2;11/23	0.45 ;1.5;6/14
D-3(iu)	102 ;444;3/13	104 ;600;5/23	61 ;400;3/14
Iodine(mg)[(a)]	7.12e-03 ;0.092;1/13	0.027 ;0.12;5/23	0.018 ;0.12;2/14
K1(mg)	1.6 ;2.2;11/13	2.1 ;2.5;19/23	1.5 ;2.5;11/14
K2(mg)	1.4 ;15;2/13	0.49 ;3.8;3/23	0.4 ;3.8;2/14
Mg(mg)	68 ;100;11/13	95 ;100;22/23	75 ;100;13/14
arginine(mg)	118 ;338;5/13	179 ;375;11/23	134 ;375;6/14
biotin(mg)[(a)]	1.3 ;2.5;8/13	1.9 ;3.8;17/23	1.7 ;2.5;11/14
folate(mg)		0.016 ;0.12;3/23	0.031 ;0.12;4/14
histidinehcl(mg)	26 ;170;1/13	48 ;85;13/23	15 ;85;3/14
isoleucine(mg)	18 ;120;2/13	21 ;162;3/23	17 ;162;2/14
lecithin(mg)	302 ;225;12/13	439 ;225;23/23	338 ;225;14/14
leucine(mg)	144 ;162;12/13	170 ;162;23/23	122 ;162;13/14
lipoicacid(mg)[(a)]	0.28 ;3.7;1/13	0.11 ;2.5;1/23	0.94 ;10;2/14
lysinehcl(mg)	333 ;325;12/13	479 ;325;23/23	377 ;325;14/14
methionine(mg)	38 ;46;10/13	60 ;62;22/23	22 ;62;7/14
pantothenate(mg)[(a)]	27 ;58;6/13	38 ;104;11/23	25 ;78;6/14
phenylalanine(mg)	29 ;125;1/13	97 ;125;18/23	62 ;125;8/14
taurine(mg)	302 ;225;12/13	424 ;225;22/23	338 ;225;14/14
threonine(mg)	334 ;325;12/13	339 ;325;23/23	279 ;325;13/14
tryptophan(mg)	27 ;115;1/13	92 ;153;18/23	66 ;115;11/14
tyrosine(mg)	7.7 ;50;1/13	78 ;100;18/23	50 ;100;8/14
valine(mg)	86 ;180;7/13	156 ;200;18/23	121 ;200;11/14
vitamina(iu)	512 ;1665;4/13	1076 ;2250;11/23	804 ;2250;7/14

TABLE III: Part 1 of 2. Events Summary for Happy from 2022-01-09 to 2022-03-16A summary of most dietary components and events for selected months between 2022-01-09and 2022-03-16. Format is average daily amount ;maximum; days given/ days in interval . Units are arbitrary except where noted. Any superscripts are defined as follows: **a)** SMVT substrate. Biotin, Pantothenate, Lipoic Acid, and Iodine known to compete..**c)** hamburger with varying fat percentages- 7,10,15,20, etc. ..

Name	2022-01 Jan	2022-02 Feb	2022-03 Mar
vitaminc(mg)	3.4 ;15;3/13	7.1 ;25;7/23	3.9 ;20;3/14
zn(mg zn)	1.9 ;8.7;4/13	2.8 ;5.9;11/23	1.9 ;5.9;6/14
MEDICINE			
Ivermectin	0.077 ;1;1/13	0.043 ;1;1/23	
SnAg		0.087 ;1;2/23	3.2 ;1;13/14
sodiumbenzoate(tsp)			0.053 ;0.031;13/14
thgland(capsule)		0.022 ;0.25;2/23	0.018 ;0.25;1/14
wormer	0.077 ;1;1/13		
koil			0.071 ;1;1/14

TABLE IV: Part 2 of 2. Events Summary for Happy from 2022-01-09 to 2022-03-16A summary of most dietary components and events for selected months between 2022-01-09and 2022-03-16. Format is average daily amount ;maximum; days given/ days in interval . Units are arbitrary except where noted. Any superscripts are defined as follows: **a)** SMVT substrate. Biotin, Pantothenate, Lipoic Acid, and Iodine known to compete..**c)** hamburger with varying fat percentages- 7,10,15,20, etc. ..

Appendix D: MUQED Daily Output

```
cat /home/scripts/script_data/cases/out/dog_daily.txt | grep Happy | tail -n 10
19061 2022-03-10 Happy KCl 0.21875 tsp KibbleAmJrLaPo 0.075 - lecithin 450 mg taurine 450 mg biotin 2.5 mg
    SnAg 5.4 - K1 2.5 mg phenylalanine 125 mg sodiumbenzoate 0.090625 tsp b20ngnc 0.4 - tyrosine 100 mg
    leucine 162.5 mg lysinehcl 325 mg threonine 325 mg eggo3 0.125 - B-multi 0.125 count KibbleLogic 0.05 -
     tryptophan 115 mg arginine 375 mg Mg 100 mg valine 200 mg Cu 0.625 mg D-3 400 iu ctbrothbs 0.625 - B-2
     100 mg B-3 65 mg B-6 6.25 mg b7ngnc 5.625 - spinach 0.5 - tuna 0.25 oz carrot 0.5 - citrate 0.21875
    tsp
19062 2022-03-11 Happy KCl 0.1875 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg cbbroth 0.45 -
    B-1 12.5 mg biotin 1.25 mg SnAg 4.2 - vitamina 1125 iu zn 2.92969 mg K1 1.25 mg phenylalanine 62.5 mg
    sodiumbenzoate 0.06875 tsp b20ngnc 4.575 - tyrosine 50 mg leucine 81.25 mg lysinehcl 405 mg threonine
    162.5 mg eggo3 0.0625 - KibbleLogic 0.05 - tryptophan 57.5 mg Mg 50 mg valine 100 mg pantothenate
    39.0625 mg ctbrothbs 0.125 - B-2 162.5 mg B-3 53.75 mg B-6 3.125 mg spinach 0.25 - tuna 0.125 oz carrot
     0.25 - citrate 0.1875 tsp
19063 2022-03-12 Happy KCl 0.0625 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg cbbroth 0.375 -
     B-12 0.125 mg biotin 1.25 mg SnAg 4.2 - vitamina 1125 iu sodiumbenzoate 0.06875 tsp b20ngnc 4.575 -
    leucine 81.25 mg lysinehcl 162.5 mg threonine 162.5 mg methionine 31.25 mg eggo3 0.0625 - B-multi
    0.0625 count folate 0.0625 mg KibbleLogic 0.05 - tryptophan 57.5 mg vitaminc 15 mg arginine 187.5 mg Mg
     50 mg valine 100 mg Cu 0.625 mg B-2 362.5 mg B-3 75 mg B-6 6.25 mg spinach 0.25 - tuna 0.125 oz K2
    1.875 mg carrot 0.25 - citrate 0.0625 tsp
19064 2022-03-13 Happy KCl 0.0625 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg cbbroth 0.375 -
     SnAg 4.2 - zn 2.92969 mg K1 1.25 mg sodiumbenzoate 0.06875 tsp b20ngnc 4.125 - leucine 81.25 mg
    lysinehcl 325 mg threonine 162.5 mg methionine 31.25 mg eggo3 0.0625 - KibbleLogic 0.05 - tryptophan
    57.5 mg Mg 50 mg valine 100 mg pantothenate 39.0625 mg D-3 250 iu B-2 225 mg B-3 84.375 mg B-6 12.5 mg
    Iodine 0.125 mg b7ngnc 0.45 - spinach 0.25 - tuna 0.125 oz carrot 0.25 - citrate 0.0625 tsp
19065 2022-03-14 Happy KCl 0.19375 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg cbbroth 0.375
    - B-1 12.5 mg biotin 1.25 mg SnAg 4.2 - vitamina 1125 iu K1 1.25 mg phenylalanine 62.5 mg
    sodiumbenzoate 0.06875 tsp b20ngnc 1 - tyrosine 50 mg lysinehcl 162.5 mg threonine 162.5 mg eggo3
    0.0625 - B-multi 0.125 count KibbleLogic 0.05 - tryptophan 57.5 mg arginine 187.5 mg Mg 50 mg valine
    100 mg Cu 0.625 mg lipoicacid 10 mg B-2 205 mg B-3 86.375 mg b7ngnc 3.575 - spinach 0.25 - tuna 0.125
    oz carrot 0.25 - citrate 0.19375 tsp
19066 2022-03-15 Happy KCl 0.19375 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg cbbroth 0.1875
     - B-1 15.625 mg B-12 0.25 mg SnAg 4.2 - vitamina 1125 iu K1 1.25 mg sodiumbenzoate 0.06875 tsp leucine
     81.25 mg lysinehcl 325 mg histidinehcl 42.5 mg threonine 162.5 mg methionine 31.25 mg eggo3 0.0625 -
    folate 0.125 mg KibbleLogic 0.05 - tryptophan 57.5 mg valine 100 mg Cu 0.625 mg pantothenate 39.0625 mg
     lipoicacid 3.125 mg ctbrothbs 0.1875 - B-2 225 mg B-3 91.375 mg B-6 12.5 mg shrimp 2.49226 grams
    b7ngnc 4.475 - oliveoil 0.0625 tsp spinach 0.25 - carrot 0.25 - citrate 0.19375 tsp
```

```
19067 2022-03-16 Happy KCl 0.19375 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg weight 16.2
    lbs B-1 25 mg biotin 1.875 mg SnAg 4.2 - zn 2.92969 mg K1 1.25 mg sodiumbenzoate 0.06875 tsp leucine
    81.25 mg lysinehcl 325 mg histidinehcl 85 mg threonine 162.5 mg methionine 31.25 mg eggo3 0.0625 - B-
    multi 0.125 count KibbleLogic 0.05 - tryptophan 57.5 mg Mg 50 mg lipoicacid 24 mg isoleucine 81.25 mg
    ctbrothbs 0.375 - B-2 231.875 mg B-3 100.375 mg shrimp 2.49226 grams b7ngnc 4.575 - spinach 0.25 -
    carrot 0.25 - citrate 0.19375 tsp
19068 2022-03-17 Happy KCl 0.2 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg biotin 1.25 mg
    SnAg 4.2 - vitamina 1500 iu K1 1.25 mg sodiumbenzoate 0.06875 tsp leucine 81.25 mg lysinehcl 162.5 mg
    threonine 162.5 mg methionine 31.25 mg eggo3 0.0625 - KibbleLogic 0.05 - tryptophan 115 mg arginine
    187.5 mg Mg 50 mg valine 100 mg Cu 0.625 mg pantothenate 39.0625 mg ctbrothbs 0.375 - B-2 216.25 mg B-3
     67.375 mg B-6 25 mg shrimp 2.49226 grams b7ngnc 4.575 - spinach 0.25 - carrot 0.25 - citrate 0.2 tsp
19069 2022-03-18 Happy KCl 0.19375 tsp KibbleAmJrLaPo 0.075 - lecithin 225 mg taurine 225 mg B-12 0.25 mg
    SnAg 4.2 - zn 2.92969 mg K1 1.25 mg phenylalanine 62.5 mg sodiumbenzoate 0.06875 tsp tyrosine 50 mg
    leucine 81.25 mg lysinehcl 325 mg histidinehcl 85 mg threonine 162.5 mg eggo3 0.0625 - B-multi 0.0625
    count folate 0.125 mg KibbleLogic 0.05 - tryptophan 115 mg Mg 50 mg valine 100 mg lipoicacid 3.75 mg D
    -3 200 iu ctbrothbs 0.375 - B-2 210 mg B-3 63.6 mg B-6 12.5 mg b7ngnc 4.575 - spinach 0.25 - tuna 0.125
     oz carrot 0.25 - citrate 0.19375 tsp
19070 2022-03-19 Happy KCl 0.0625 tsp lecithin 112.5 mg taurine 112.5 mg SnAg 1 - vitamina 2250 iu
    sodiumbenzoate 0.03125 tsp leucine 81.25 mg lysinehcl 162.5 mg threonine 162.5 mg methionine 31.25 mg
    eggo3 0.0625 - tryptophan 115 mg vitaminc 18.75 mg Cu 0.625 mg pantothenate 39.0625 mg ctbrothbs 0.125
    - B-2 75 mg B-3 24.375 mg B-6 12.5 mg b7ngnc 1.125 - spinach 0.125 - carrot 0.125 - citrate 0.0625 tsp
```

Appendix E: Symbols, Abbreviations and Colloquialisms

TERM	definition and meaning
AAFCO	American Association of Feed Control Officials
DCM	Dilated Cardiomyopathy
FAD	Flavin Adenine Dinucleotide
FDA	US Food and Drug Administration
FMN	Flavin NonoNucleotide
MUQED	Multi-Use Quantitative Event Diary [46]
RER	Resting Energy Requirement
SnAg	A mixture of arginine HCl and Tin-Silver dissolution products

Appendix F: General caveats and disclaimer

This document was created in the hope it will be interesting to someone including me by providing information about some topic that may include personal experience or a literature review or description of a speculative theory or idea. There is no assurance that the content of this work will be useful for any paricular purpose.

All statements in this document were true to the best of my knowledge at the time they were made and every attempt is made to assure they are not misleading or confusing. However, information provided by others and observations that can be manipulated by unknown causes ("gaslighting") may be misleading. Any use of this information should be preceded by validation including replication where feasible. Errors may enter into the final work at every step from conception and research to final editing.

Documents labelled "NOTES" or "not public" contain substantial informal or speculative content that may be terse and poorly edited or even sarcastic or profane. Documents labelled as "public" have generally been edited to be more coherent but probably have not been reviewed or proof read.

Generally non-public documents are labelled as such to avoid confusion and embarassment and should be read with that understanding.

Appendix G: Citing this as a tech report or white paper

Note: This is mostly manually entered and not assured to be error free.

This is tech report MJM-2022-009.

Version	Date	Comments
0.01	2022-03-12	Create from empty.tex template
0.5	2022-03-27	Draft, good enough for now
-	March 27, 2022	version 0.50 MJM-2022-009
1.0	20xx-xx-xx	First revision for distribution

Released versions,
build script needs to include empty releases.tex

Version	Date	URL
0.5	2022-30-27	

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author =”Mike J Marchywka ” ,
type =”techreport” ,
name =”marchywka-MJM-2022-009-0.50 ” ,
number =”MJM-2022-009” ,
version =”0.50 ” ,
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contact =”marchywka@hotmail.com” ,
author1id =”orcid.org/0000-0001-9237-455X” ,
pages =” 17”
}

Supporting files. Note that some dates,sizes, and md5's will change as this is rebuilt.
This really needs to include the data analysis code but right now it is auto generated picking up things from prior build in many cases

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175592 Mar 27 15:43 happyagain.bib af2a29bc97046171d7f96113adeafccf
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