Emaciation and Dehydration in Mammals

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I. Normal Digestive Physiology

A. Anabolism (body is being built up – positive state)

1. Animal ingests diet of proteins, fats, and carbohydrates supplemented with essential vitamins and minerals.
2. Proteins are broken down into amino acids and used for growth, repair, etc.
3. Fat components are broken down into fatty acids. Excess is stored as adipose tissue (fat).
4. Carbohydrates (CHO) are digested into simple sugars (including glucose) and are the body's first preference for energy. Excess is stored as glycogen in the liver and muscles.
5. Glucose in blood stimulates release of insulin which drives glucose into cells.
6. Dietary components used for energy, repair, immune system (pathogens), wound healing, normal organ function, growth, etc.
7. The brain has the largest requirement for glucose. Red blood cells and the heart muscles also have very large requirements.

B. Intracellular (tissue) versus extracellular (blood)

1. Digestive components can only be used within the cells of the tissue.
2. Insulin not only gets blood glucose into tissue cells, it also allows the body to manufacture glycogen and decreases the excretion of sodium and water through the kidneys.

II. Physiology of Starvation and Dehydration

A. Catabolism (body is being broken down – negative state)

1. Metabolic rate is decreased which decreases the requirement for energy.
2. Stress causes the release of hormones which act against insulin. Therefore, glucose cannot be adequately driven into the tissue cells.
3. Over time, organ function is shut down: kidneys, heart, circulation (decreased ability to carry oxygen), and intestinal digestion/absorption/motility.
4. Electrolytes such as potassium, magnesium and phosphorus shift from the cells of the tissue to the blood to maintain adequate levels.
5. Weight loss occurs along with lethargy, weakness, and disorientation.
6. Immune function is impaired, especially in the intestinal tract, which is the largest immunological organ in the body.

B. Simple Starvation (<24 hrs) = decrease in adequate calories ingested

1. Body shifts into survival mode with the highest priority being the maintenance of blood sugar levels to allow for the continued function of the brain and heart.
2. Glycogen (stored carbohydrate) is mobilized from the liver and muscle reserves.
3. Metabolism slows and the body's energy requirement is reduced.

C. Stressed Starvation (>24 hrs)

1. Critically ill, injured, orphaned
2. 24-48 hrs: Glycogen stores are depleted (depending on age and body condition of animal). Fat reserves (or protein – see section D) are broken down to use for energy.
4. >48-72 hrs: Proteins are mobilized for energy.
    a. Blood hemoglobin is unable to carry oxygen to tissues.
    b. Blood flow slows, causing organs to start shutting down. Blood clots more easily.
    c. Cells of the intestinal lining stop functioning and collapse, preventing digestion and absorption from occurring.
    d. The intestinal immune tissue is compromised in preventing bacteria from crossing into the bloodstream. Bacteria spread through blood to organs to facilitate shutdown.
    e. Compromised immune system causes widespread inflammation as it tries to function.

D. Non-carnivores versus strict carnivores in a stressed starvation state

1. **Non-carnivores** live on grains, meats, plants, etc. – variety of foods.
    a. Initially use stored glycogen for energy.
    b. Start breaking down fats next. Proteins are conserved until fat reserves are depleted.
3. **Strict carnivores** cannot live without meat, e.g. bobcats, mink, weasels, etc.
    a. Higher protein requirement *which does not change in a state of starvation.*
    b. Initially use stored glycogen for energy but unable to efficiently utilize fat reserves.
    c. Begin to break down protein to use for energy instead of conserving it.

III. Recovery

A. "Refeeding Syndrome"

1. Occurs when carbohydrates are suddenly introduced into the body after a period of starvation.
2. The presence of glucose in the blood stimulates the release of insulin and causes potassium, phosphate, and magnesium to shift from the blood into tissue cells, leaving dangerously low blood levels.
3. Low blood levels of electrolytes lead to many adverse effects, including profound weakness, lethargy, retention of fluid and sodium, cardiac arrhythmias, congestive heart failure, respiratory abnormalities, disorientation, seizures, coma, and death.
4. Effects are usually seen 3-7 days after the first feeding.
4. Treatment is very difficult and involves monitoring blood values of electrolytes on a daily basis and administering the proper supplement accordingly. Prevention is preferred.

B. Physical exam

1. Understand the difference between "thin/underweight" and "emaciated".
2. Examine normal animals to know what "normal" is. Become familiar with the sounds of the heart and lungs. You will need to monitor the animal you are treating for emaciation.
3. An animal can be emaciated without being dehydrated. Usually this occurs with older animals who are able to lap water. Don't rely on skin turgor. With moderate to severe emaciation, but little or no dehydration, the skin can remain tented due to loss of fat and protein.
4. Check for sunken eyes and dry or tacky mouth. Always check the weight to see if it is compatible for the species and age of the animal.
5. Determine if the animal is hypothermic (lower than normal body temperature.)

C. Normalize the body temperature

1. An animal's metabolism cannot function properly if the body temperature is too low.
2. Increasing the body temperature will increase metabolism and the need for glucose. Do not overheat.
2. Give 1-2 drops of a sugar source on the gums. This small amount provides needed energy for the brain but does not usually otherwise cause a problem. Glucose administration may need to be repeated. Amount and whether to repeat is subjective.

D. Rehydrate the animal

1. With simple starvation (<24 hrs), rehydration can take place as you normally would using 4-5% of the body weight and warmed oral fluids such as Pedialyte®. SQ fluids should not be needed.
2. With moderate emaciation and dehydration, the circulation has slowed, blood vessels may have collapsed, and the kidney is not functioning at peak efficiency to remove excess fluid from the body. Do not overload.
3. With severe emaciation the electrolyte imbalances must be corrected *before introducing food.*
4. Warmed fluids such as Normosol-R® and Lactated Ringer's® are used which do not contain glucose or other sugars.
5. If administering orally, give 1-2% of the body weight every 2-3 hours. This is subjective depending on the condition of the animal.
6. Subcutaneous (SQ) fluids are not recommended for severe dehydration or emaciation as it is easy to overload the body.
7. SQ fluids may need to be given if the animal is comatose or otherwise unable to swallow. Give 2-3% of the body weight and monitor to determine how quickly the fluids are absorbed and if there are any adverse effects.
8. Frequently monitor the heart and lungs with all treatment given.

E. Refeeding

1. Calculating the amount to feed
    a. Treatment for moderate to severe emaciation consists of very small amounts given very frequently.
    b. The goal is primarily to <u>maintain</u> weight until the gut starts working normally again.
    b. Using an "illness" factor to calculate nutritional needs is outdated. Use the Resting Energy Requirement
        RER = Number of **kilocalories** required **per day** when the animal is at rest (BW = body weight)
            if < 2kg BW: RER = 70 x $(BW_{kg})^{0.75}$ more accurate for small animals
            if > 2kg BW: RER = (30 x BW_{kg}) + 70 more accurate for larger animals
    c. Select dietary product and divide the RER by the number of Kcal/ml in the product to determine the number of mls to feed per day (ml = cc). Divide this number by the number of feedings during the day.
2. Microenteral nutrition (MN)
    d. MN guidelines recommend feeding 0.1-0.4ml/kg BW every 2 hours.
    e. This method is especially good for the most critical animals and can be also used for rehydration
    c. Feed 25% of the RER the first day (divided into several small feedings).
    d. Increase by 1/8 – 1/4 each day over the next several days until the total RER is reached.
3. KISS Method:
    a. Feed 1-2% of the animal's body weight every 1 ½ - 2 hrs.
    b. While this method is oftentimes effective with moderately emaciated animals, one doesn't always know whether the animal is getting too much or too little nutrition with every feeding.
4. When to feed
    a. For weaned animals, feeding can usually begin in 24-36 hrs (subjective) after rehydrating fluids are given.
    b. Infants normally on formula need to ingest calories sooner. Evaluate for feeding 8-12 hrs after partial rehydration. Remember, diluted formula will also rehydrate.
5. Initially, the diet will have a high water content so rehydration will continue to occur. After the first several days, when the animal is improving, the diet can be gradually changed to a more normal diet, even if water is still added. GO SLOW. With weaned animals, give fresh water free choice after they are rehydrated.

IV. Selecting the Diet

A. Read the labels
1. Percentage of fats, proteins, carbohydrates – consider liquid vs. canned
2. Kilocalories/unit
3. Vitamins and minerals – especially potassium, phosphate, and magnesium
4. Compare the levels of nutrients with the requirements of the species with which you are working.

B. Partial listing
1. Electramine®
2. Vital HN®
3. Travasol®
4. CliniCare®
5. Ensure®
6. Formula V® HLP
7. Formula V® MLP
8. Hill's a/d®
9. Eukanuba Max-Cal™
10. Purina Veterinary Diets® EN – NEW – canned feline formula – added B vitamins, high omega-3 fatty acids specifically formulated for gastrointestinal problems in the cat which is considered a carnivore

V. Supplements

A. Components recommended

1. glutamine – used by rapidly dividing cells of gut, unstable – add immediately prior to feeding
2. glycine
3. arginine
4. omega-3 fatty acids – fat metabolism and inflammation
5. thiamine – carbohydrate and energy metabolism
6. glycine – improves gut mucosa
7. Vitamins A, C, E, B-complex
8. Other antioxidants
9. carnitine for carnivores

B. Partial Listing

1. Missing Link®
2. Liquid avian vitamin supplement
3. Separate components – check health food stores, check for quality
4. Complete pet vitamin/mineral tablet – for older animals who will chew solid food

VI. Miscellaneous Notes

1. With self-feeding adults, don't allow uncontrolled feeding for 7-10 days for moderate emaciation or 10-14 days with severe emaciation (subjective). Researchers have shown that in adult animals, it may take up to 2 weeks for the intestinal tract to function normally.
2. Some diarrhea is common initially. Don't be too concerned about treating it. Get the animal stabilized first.
3. Products with H_2 blockers, such as Pepto-Bismol and antacids may facilitate bacterial overload. Use products such as kaolin and sucralfate for diarrhea.
4. Keep activity to a minimum to lower energy usage and avoid increasing the metabolic rate.
5. Wound treatment is imperative as healing and the prevention of infection is compromised.

VII. Squirrels, Chipmunks, Woodchucks

A. Differences

1. Squirrels and chipmunks, are different from most other species in ways that affect the treatment of emaciation. We have found groundhogs also do well with slight modifications.
2. While all have a relatively shorter intestinal tract, the tract of squirrels is considered very short.
3. In addition, the metabolic rate of these species tends to be much higher than many other species.
4. What these differences mean is that food ingested is digested and the nutrients absorbed much faster.
5. With emaciated animals, nutrients must be supplied much quicker than in other animals. This is true whether the animal is an infant or an adult.
6. The first 48 hours are the most critical and the most intensive.

B. Rehydration

1. The animal is initially warmed up and a few drops of a sugar source applied to the gums as described above.
2. Depending on the size of the animal, 0.5-1.5ml of a rehydrating fluid are given orally every hour for squirrels and chipmunks. Woodchucks are given 2% BW every 1-2 hours.
3. If the animal is more emaciated than dehydrated, the volume of fluid given at one time can be increased with a longer interval between administrations. This is a subjective call and depends on continued evaluation of the vital signs.
4. Squirrels and chipmunks are frequently hydrated enough that feedings can begin within 8 hrs. Woodchucks are usually ready by 12 hrs.

C. Feeding squirrels

1. Either Ensure® or Esbilac® can be used for feeding. What to use and how to dilute it is a subjective call and depends on your experience, the degree of emaciation, and the percentage of dehydration.
2. In general, Ensure® is the diet of choice, especially with squirrels over 6 weeks of age. Ensure® is more concentrated in required nutrients and easier to digest than Esbilac®
3. If there is a higher degree of dehydration, the Ensure® is diluted: 1 tbsp Ensure® + ½ tsp water (As Ensure® is already a liquid, it doesn't need much dilution.)
4. Start feeding by giving small amounts every 1-2 hrs as was done with the rehydrating fluids.
5. Once the squirrel is taking the Ensure® well (frequently by 24 hrs), start blending in Esbilac® which has been diluted 1:3. Mix in 25% initially, and then increase by 25% every 1-2 feedings until the animal is completely switched over to formula. Continue to monitor the heart and lungs.
6. With squirrels less than 6 weeks of age which are significantly dehydrated, Esbilac® at a 1:3 dilution is given initially.
7. The interval between feedings can be lengthened after the first 24 hours.
8. If the animal appears to have no adverse effects from the formula, the concentration can be gradually increased to a normal 1: 1 ½ dilution over the next 1-2 days.
9. After about four days, if an older animal is eliminating properly, has good activity, and the heart and lungs sound normal, it can be given access to solid food and gradually weaned off formula according to its age.

D. Chipmunks and Woodchucks

1. Chipmunks are fed the same as a squirrel.
3. With woodchucks, most of the rehydration can be accomplished by 12 hrs instead of 8.
4. If the admitted woodchuck is unable to swallow, subcutaneous fluids are administered using 1-2% BW initially until it is determined how quickly the fluids are absorbed and whether any adverse effects are present.
5. Diluted or undiluted Ensure® is used for refeeding (depending on the degree of dehydration) when the animal is able to swallow normally.
6. The difference with woodchucks versus squirrels, is that the change to formula and then solid food occurs over a longer period of time. It is recommended that greens and monkey chow not be given until 7 days after initiation of treatment and then only if the animal is active and all vital signs are good.