OVERVIEW
Veterinarians face multiple questions and challenges in approaching a patient with cancer as pet parents often what to feed ‘cancer’ diets and/or supplements. We need to rely on scientific evidence yet at the same time we cannot overlook the client’s perspective. It has been reported that human oncology patients use nutrition, supplements, and natural products to empower themselves, attempt to take control of their health, and increase quality of life. With the strength of the human animal bond, it is logical to respect these same emotions when an owner is facing cancer in their pet.

Owners are highly motivated to be a part of the health care of their pet with cancer and they are often looking for nutritional recommendations and supplements in hopes it will cure their pet of cancer. It is critical that the veterinarian and health care team addresses this at the time of diagnosis. This is an opportunity for a veterinarian to formalize the veterinarian and health care team-owner-patient bond. We find regardless of final outcome, owners are grateful and more satisfied when their pet with cancer is treated with a plan that integrates thoughtful nutrition and/or supplements with conventional therapies.

UNDERSTANDING CANCER
Four phases of cancer - metabolic and clinical alteration
- Phase 1 or the preclinical “silent” phase is where patients do not exhibit overt signs, but subtle behavior changes are noted
  o Metabolic changes including hyperlactatemia, hyperinsulinemia, and alterations in blood amino acid profiles
- Phase 2-clinical signs including lethargy, weight loss, and/or anorexia
  o Chemotherapy, radiation or other conventional treatment side effects that may alter nutrient intake and use
- Phase 3 or Cancer Cachexia
  o Marked debilitation, weakness and biochemical evidence of negative nitrogen balance such as hypoalbuminemia
  o Owners may report chronic vomiting, diarrhea, weakness, and weight loss
  o Malnutrition increases risk of treatment complications, reduced QOL, and poor outcomes
  o Malnutrition (under nutrition) - state of nutrition in which a deficiency of energy, protein and other nutrients adversely affects body composition, function and clinical outcome
  o Strong evidence supports nutritional intervention to maintain the patients weigh with high energy, high protein diets or texture modification, supplements, and/or enteral feeding
Cancer cachexia - progressive weight loss is in excess of that explained solely by reduced food intake; therefore it is unlikely to be effectively treated by satisfying any deficit in intake alone
  - Cancer cachexia requires a multi-modal approach
- Clinical judgment evaluating weight loss, as there are no precise biochemical cutoffs
  - Phase Four is Recovery where the cancer is eliminated
    - Metabolic alterations persist in some patients despite elimination or control of the cancer. Cancer patients can
    - Develop food aversions in this phase and at any time because of treatment-induced alterations in taste and smell

**Tumor staging**
- Veterinarians can use tumor staging which may correlate with clinical behavior in certain types of cancer and help determine whether a tumor will respond to nutritional management
- Grading the degree of malignancy histologically predicts biologic behavior but direct relationship between tumor grade and nutritional status not established
- Logical to consider aggressive cancers may cause more pronounced systemic effects
- Realize even a benign tumor can significantly affect the nutritional status of a dog
  - Interferes with intake or assimilation
    - Oral tumors such as SSC, melanoma may inhibit food intake

**Cancer metabolism**
- Metabolic concept that cancer cells use “reprogramming of energy metabolism”
- Warburg effect - some cancer cells use glycolytic pathways as it produces ATP more rapidly than oxidative phosphorylation
  - Glycolysis is a less efficient pathway for energy production BUT it is thought the faster rate of ATP production may provide for rapid cell proliferation
- Identifying the different metabolic profiles of different cancers may allow for effective targeting of the predominant energy pathway to produce effective metabolism-target agents and nutrient profiles for cancer diets
  - In conclusion, altered energy metabolism in cancer cells provides a unique opportunity to develop new and more effective anticancer therapies

**NUTRIENTS AND CANCER**
- Cancer and Carbohydrate Metabolism Studies
  - Dogs with lymphoma and a wide variety of other malignant diseases have significant alterations in carbohydrate metabolism
  - Dogs with a wide variety of malignant conditions have elevated resting insulin and lactate levels compared with levels in dogs without cancer
- Cancer and Protein Metabolism Studies
  - Human patients with cancer and weight loss have decreased body muscle mass, decreased skeletal protein synthesis, and altered nitrogen balance
  - Accelerated proteolysis via the ubiquitin-proteasome pathway is the principle cause of muscle wasting induced by cancer
  - Dogs with cancer have lower plasma concentrations of threonine, glutamine, glycine, valine, cysteine, and arginine and higher concentrations of isoleucine and phenylalanine
Altered plasma amino acid profiles did not normalize after tumors were removed surgically in dogs
Dietary protein levels for cancer patients should exceed levels normally used for maintenance, assuming adequate renal and liver function

**Cancer and Lipid Metabolism Studies**
- Adipose tissue catabolism is the second major feature of cachexia in cancer
- SOME cancer cells have a limited ability to use fat to meet energy needs compared to soluble carbohydrates and protein
- Omega-3 fatty acids (eicosapentaenoic acid [EPA], docosahexaenoic acid [DHA]) generally have an inhibitory effect on tumor growth
- Omega-6 (n-6) fatty acids (linoleic acid, γ-linolenic acid) enhance metastases
- Omega-3 fatty acids reportedly have anti-cachectic effect and are associated with decreased blood lactate levels
- EPA decreases protein degradation without altering protein synthesis; the net effect is anti-cachectic

**KEY NUTRIENTS OF CONCERN**
- Understanding cancer cell metabolism determines key nutritional factors in cancer patients
- More research is needed in veterinary medicine cancer cell metabolism in the dog to identify other nutritional factors
- Despite limited veterinary studies, we can use critical evaluation of the data combined with known nutritional requirements of dogs and use of translational research and extrapolation from human data to improve the nutritional status of our patients

**WHAT IS THE NUTRIENT PROFILE FOR A CANCER DIET?**
- **Soluble Carbohydrates**
  - Recommended soluble carbohydrate (CHO) diet for canine cancer patients not >25% DMB
- **Protein**
  - Levels in foods should exceed levels normally used for adult maintenance
  - Assumes normal renal and/or liver function
  - Protein levels at 30 to 45% DMB
- **Fats and Fatty Acids**
  - Current published recommendations continue to be focused on diets with increased fat calories (25 to 40% DM fat)
  - Increased levels of dietary omega-3 fatty acids (>5.0% DM) and an N-6: N-3 fatty acid ratio approximating 1:1

**DIET SELECTION FOR THE CANINE CANCER PATIENT**
- Dietary (caloric) intake profoundly affects outcomes in cancer therapies as measured by both survival and QOL
- Because the veterinary oncology patient has a shorter lifespan, the focus on QOL comes to the forefront of a nutritional plan
- All cancer patients should have nutritional evaluation and changes made if the current diet is not optimal
  - And/or if client requests dietary therapy
- Nutrient Profile Diet discussed: Protein 30-45%DMB; Fat 25-40%DMB; CHO <25%DMB
Our Clinical experience
  - We formulate the diet for the patient, not the cancer
  - We believe this approach optimizes nutrition realizing caloric intake is key to longevity and QOL
  - We usually prescribe diets with moderate of lower fat content
    - Recommend therapeutic joint, dermatologic disease, and/or gastrointestinal therapeutic diets due to the higher digestibility of nutrients and specific nutrients (N6:N3s, fiber, antioxidant) for oncology patients
  - Recommend homemade diets alone or concurrent w/therapeutic diet or owner’s preference
    - American College of Veterinary Nutrition: www.acvn.org
    - We use the HM diet to obtain desired nutrient profile i.e N6:N3, moderate fat, etc.

SUMMARY
  - We recommend dietary counseling for owners with pets with cancer to improve nutrition, impact symptoms, improve treatment response, quality of life, and possibly increase survival times
    - Strong evidence that nutrition counseling increases dietary intake, maintains bodyweight, nutritional status and quality of life in cancer patients
  - Understand that caloric intake alone improves survival and QOL
  - Select the best diet for your patient, not for that cancer
    - This is best nutrition for the cancer patient and what we term a “cancer diet”

References upon request