MONITOR AND ADJUST
Frequent weigh-ins should be scheduled during the early portion of a weight-loss plan to closely monitor progress.

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NUTRITION NOTES

Energy Calculations: Gauging the Proper Caloric Intake for Patients

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Making an appropriate dietary recommendation for a patient can be a difficult conversation to have with the owner. Pet owners typically believe that they are feeding their pet an appropriate amount of an appropriate diet. Suggesting the need to adjust a patient's diet and/or intake can cause the owner to feel as if they have done something wrong when, in reality, they have made the best choices with the information available to them. Having the professional tools to effectively discuss activity and dietary needs can help smooth this delicate conversation.

IMPORTANT CONCEPTS IN DISCUSSING CALORIC INTAKE

Kilocalories and Caloric Density

Pet foods use the kilocalorie (kcal) as the unit of measurement to describe the amount of energy that a diet provides per volume of food. However, the terms "kilocalorie" and "calorie" are interchangeable, and although "kilocalorie" is more scientifically accurate, "calorie" is more familiar to owners.[1] The amount of energy in a diet (often referred to as caloric density or caloric content) is expressed in calories per cup or calories per kilogram.

The caloric density of a diet must be provided by the pet food manufacturer and included on the label. In combination with information about the percentages of calories contributed by fat, carbohydrates, and protein, it can be used to determine the suitability of the food for pets of different ages.[2] The caloric density of a diet must be known to accurately estimate the appropriate feeding volume based on patient energy needs.

While caloric density is an important factor in choosing a particular diet for a patient, it should not be the only consideration. For example, a growing puppy's dietary needs are very different from those of an older, overweight dog or a canine athlete. Dietary recommendations for each patient should therefore be based on several factors, such as life stage, current body condition, and desired body condition, in addition to caloric density.[1]

TABLE 1 Canine Daily Energy Requirement Factors[4-6]

	MULTIPLY RER BY
Neutered adult	1.6
Intact adult	1.8
Inactive/obese prone	1.2–1.4
Weight loss	1
Critical care	1
Weight gain[a]	1.2–1.8
GESTATION	
First 42 days	1.8
Last 21 days	3
LACTATION[b] (NUMBER OF PUPPIES)	
1	3
2	3.5
3–4	4
5–6	5
7–8	5.5
9	≥6
GROWTH	
Weaning to 4 months	3
4 months to adult	2
WORK	
Light work *(physical activity lasting less than 2 minutes)*	2
Moderate work *(physical activity lasting several minutes to a few hours)*	3
Heavy work *(physical activity lasting several hours)*	4–8

[a]RER at ideal weight.
[b]Free choice feeding recommended.
RER=resting energy requirement.

Energy Balance

The concept of energy balance is crucial to understanding how factors such as activity level and life stage affect the caloric intake needed for an individual animal to attain or maintain a healthy weight. Energy balance assumes that the number of calories being consumed is equivalent to the number of calories being expended. If a pet consumes fewer calories than it expends, the result is a negative energy balance. If the patient continues in a negative energy balance for a period of time, it will lose weight. A positive energy balance results when more calories are consumed than expended, resulting in weight gain.

Energy expenditure is affected by many variables. For example, pregnancy, lactation, growth, and work require tremendous amounts of energy to be safely and effectively completed. Intact pets also tend to require more calories than spayed or neutered pets. Geriatric, inactive, or overweight pets require fewer calories than younger, more active pets to ensure appropriate energy balance.

Resting Energy Requirement Versus Daily Energy Requirement

The first step in calculating the caloric intake needed by an individual patient is determining the patient's resting energy requirement (RER). RER is the amount of energy required for essential physiological functions such as digestion, respiration, and cardiac and brain activity.[3] However, RER alone does not account for any variation in growth, activity level, or environmental temperature. Therefore, a more accurate and patient-specific measure of a pet's energy requirement to achieve energy balance is the daily energy requirement (DER), which is calculated based on RER modified by a factor reflecting life stage and activity level.[4] DER factors for dogs and cats are listed in **TABLES 1 AND 2**.

Achievement and maintenance of a healthy body weight for patients can be a challenge, particularly for those that are ill and/or hospitalized. Patients that are not feeling well enough to maintain their RER on their own need nutritional support to maintain caloric intake and reduce detrimental effects of negative energy balance and subsequent weight loss. The effects of inadequate nutrition can include decreased immune

TABLE 2 Feline Daily Energy Requirement Factors[4,6]

	MULTIPLY RER BY
Neutered adult	1.2–1.4
Intact adult	1.4–1.6
Senior adult 7–11 years	1.1–1.4
Senior adult >11 years	1.1–1.6
Inactive/obese prone	1
Weight loss	0.8
Critical care	1
Weight gain[a]	1.2–1.8
GESTATION[b]	
At breeding	1.6
Parturition	2
LACTATION[b] (WEEK OF LACTATION)	
1–2	RER + 30%/kitten
3	RER + 45%/kitten
4	RER + 55%/kitten
5	RER + 65%/kitten
6	RER + 90%/kitten
GROWTH[b]	
Weaning to adult	2.5

[a]RER at ideal weight.
[b]Free choice feeding recommended.
RER=resting energy requirement.

system and cellular function, poor drug metabolism and wound healing, loss of lean body mass, and organ dysfunction, all of which contribute to prolonged illness and/or hospitalization.[7] Nutritional support for these pets is typically provided via feeding tube.

Body and Muscle Condition Scoring

While breed is a factor in determining a healthy weight, it can be difficult to accurately estimate a patient's ideal weight based on breed alone, particularly since most pet dogs and cats are mixed breed. Body condition scoring (BCS) and muscle condition scoring (MCS) therefore play important roles in determining ideal body weight for individual animals. These scoring methods use a combination of visual assessment and physical palpation to evaluate body fat and muscle using the BCS and MCS, respectively.

In 2021, the American Animal Hospital Association standardized the 9-point BCS scale (**bit.ly/3koJj0G**).[8] Ideal body condition falls in the center of the scale at 5; however, 4 may be an ideal score for giant-breed dogs. Values below 5 indicate that the patient is slightly underweight (3 to 4) to emaciated (1 to 2). Values above 5 indicate that the patient is overweight (6 to 7) to obese (8 to 9). Each point on the 9-point BCS scale represents approximately 10% body fat. Therefore, a BCS of 6/9 equates to the patient being approximately 10% overweight, a BCS of 7/9 estimates that the patient is 20% overweight, and so on. These same estimations can be applied to underweight patients.

PUTTING IT ALL TOGETHER

Applying all of these concepts in the clinical setting can help quickly identify pets that could benefit from dietary adjustment as well as help create specific recommendations for owners. See "**Case Example: Sophie**" for a step-by-step explanation of how to use BCS and calculate RER and DER in the clinic setting.

Gather an Accurate Diet History

When an owner is asked what they feed their pet, the typical response is often limited to an estimated amount of a purchased diet. For example, an owner may report that they feed their cat a can of wet food in the morning and leave dry food out to be eaten ad lib, or they may feed their dog three-quarters of a cup of dry food twice daily. However, everything a pet consumes is part of its diet, including treats, medications and supplements, and table food.[9] On further questioning, the owner will likely reveal that they also feed their dog Milk-Bone Minis (5 to 10 daily, 5 kcal each), Beggin' Strips (1 daily, 35 kcal each), DentaStix for large dogs (about 3 per week, 84 kcal each) and peanut butter in a Kong (about 1 tablespoon 3 times per week, 90 kcal/tablespoon). The dog also receives the occasional "puppuccino" (about 1 each month, approximately 80 kcal) when in the car during a Starbucks stop and takes twice-daily medications in Pill Pockets (23 kcal each). On average, these extras add an additional 184 to 209 kcal per day!

When taking a dietary history from an owner, it is essential to question them about other calorie sources, such as treats, snacks used for medications or enrichment (e.g., peanut butter Kong, rawhides), and table food. Such items should account for a maximum of 10% of the pet's total daily calories when the DER is calculated.[9]

Calculate Energy Requirements

Many tables and calculators are available for determining DER and RER for a given patient (**BOX 1**), though manually calculating these values is quite simple.

For dogs and cats of any size,[4] **RER (kcal/day) = 70 × body weight (BW [kg])$^{0.75}$**

BOX 1

Web-Based Calculators[a]

Web-based calculators, such as those below, allow owners and the veterinary healthcare team to easily and quickly adjust dietary variables (body condition score, reproductive status, caloric density of food, etc.) to help determine the most ideal weight-loss plan for a pet.

Pet Nutrition Alliance
Calorie Calculator for Dogs
petnutritionalliance.org/dog.php

Pet Nutrition Alliance
Calorie Calculator for Cats
petnutritionalliance.org/cat.php

[a]The Pet Nutrition Alliance calculators are not designed for pets that are underweight.

In today's age of smartphones, simply changing the orientation of most phones enhances the standard calculator to a scientific one. However, this equation can be calculated on a standard calculator with a simple hack: multiply the body weight in kilograms (BW kg) by itself twice (BW kg × BW kg × BW kg), then press the square root key twice (√, √) and multiply the result by 70.[10]

Make a Diet Recommendation

Just as with human foods, the calorie content of pet foods varies tremendously among diets. This can be helpful in explaining recommendations to owners. For example, 2 different spaghetti recipes can differ not only in their nutrient profiles but also in caloric density (sometimes drastically). One may include meat in the sauce, which will increase the protein content as well as the fat content, depending on the type of meat used. As a result, the same-size serving of each will have a different caloric density. The same drastic variance is found when comparing commercially prepared diets for pets and patients. Even minor adjustments to the formulation of a diet can have a significant impact on the diet's nutrient profile and caloric density.

When choosing a diet, several factors should play a role. First, the diet should be appropriate for the age of the animal. Puppies and kittens have a tremendously higher caloric requirement than adults and senior pets. The activity level and reproductive status of the animal must also be considered—pregnant, lactating, and working animals have a higher DER than sedentary ones. If the pet has a medical condition that can be (at

Case Example: Sophie

Sophie is a 2-year-old female spayed Belgian Malinois. At presentation, she weighs 19 kg and has a body condition score (BCS) of 3/9.

Based on her BCS, Sophie is approximately 20% underweight. Using this estimation, it can be assumed that at a healthy body condition, Sophie would weigh approximately 22.8 kg.

Diet History and Activity
Sophie is currently being fed Purina Pro Plan Adult Large Breed Chicken & Rice Dry Formula (407 kcal/cup). She is given 1 scoop in the morning. The scoop is from the pet store and is not marked with any type of measurement. After appropriate measurement, the scoop is found to hold approximately 2½ cups when full (level with the edge of the scoop). Her owner estimates that she gets 1 or 2 large Milk-Bones each afternoon (125 kcal each) but is not given table foods or other treats. As she is currently being fed, Sophie's caloric intake is approximately 1206 kcal/day.

Maintaining energy balance requires consideration of not only caloric intake, but also energy expenditure. Sophie's owner is an avid hiker, and Sophie frequently joins a few times each week. Typical hikes are approximately 2 to 4 hours long with varying levels of incline through rocky and wooded areas.

Energy Calculations
To create a dietary recommendation for Sophie, her resting energy requirement (RER) and daily energy requirement (DER) need to be calculated.

RER
RER = 70 × body weight (kg)$^{0.75}$

RER = 70(19)$^{0.75}$

RER = 70(9.1)

RER = 637 kcal/day

DER
DER = RER × appropriate factor

Sophie's level of activity can be considered moderate work (**TABLE 1**).

The canine DER for moderate work is 3 (**TABLE 1**). Therefore, Sophie's DER is 637 × 3 = 1911 kcal/day.

Feeding Plan
Purina Pro Plan Adult Large Breed Chicken & Rice Dry Formula has 407 kcal/cup.

1. Eliminating treats from Sophie's diet entirely would provide calories only in kibble form:

   1911 kcal/day ÷ 407 kcal/cup = 4.69 cups kibble/day (approx. 4.75 cups kibble/day)

2. To continue to allow Sophie to have 1 Milk-Bone per day would add an additional 125 kcal/day. These additional calories need to be accounted for as part of her daily intake:
   - 1911 kcal/day - 125 kcal/day (Milk-Bone) = 1786 kcal/day (kibble)
   - 1786 kcal/day ÷ 407 kcal/cup = 4.38 cups/day (approximately 4.375 cups/day)
   - **1911 kcal/day = 1 Milk-Bone + 4.375 cups kibble/day**

Inclusion of 2 large Milk-Bones/day (250 kcal/day) into Sophie's diet would exceed the recommended limit of 10% daily calories from treats by providing 13% of her daily calories in treat form.

least partially) managed with diet manipulation, such as chronic kidney disease, diabetes, or uroliths, the diet should also cater to that particular need.

The formulation of the diet is another factor to consider. A diet in kibble form will have a different caloric density than the same diet in a canned formulation. It is common to also find variations in formulations such as flavor (seafood, poultry, beef) and texture (pâté, stew, gravy). It is important to remember that the caloric density of even the most similar of diets is likely very different. For many pets, even small adjustments to caloric intake can cause a significant change in body condition.

Appropriate Measurement Is Key

When providing feeding instructions to an owner, it is crucial to be specific. Coach owners in the importance of using true measuring devices (such as a measuring cup or gram scale) instead of a mug from the kitchen or an unlabeled scoop from the pet store. Even though pet foods are required to include feeding instructions on their label, the method used to determine these recommendations can differ by company[9] and is not on the label. Therefore, despite an owner's strict adherence to the feeding instructions on a diet's packaging, a pet's body condition may not be ideal when evaluated at a veterinary visit. Without specific instruction and explanation to the owner when a diet recommendation is made, these types of weight management discrepancies can lead to distrust in the veterinary staff.

Be specific about the number and type of treats allowable in the feeding plan. Table scraps and additional treats unaccounted for in the feeding plan are not allowed while a weight management plan is in effect. The addition of extra snacks not only jeopardizes the outcome of the feeding plan, but also creates the potential for nutrient imbalance. This typically occurs

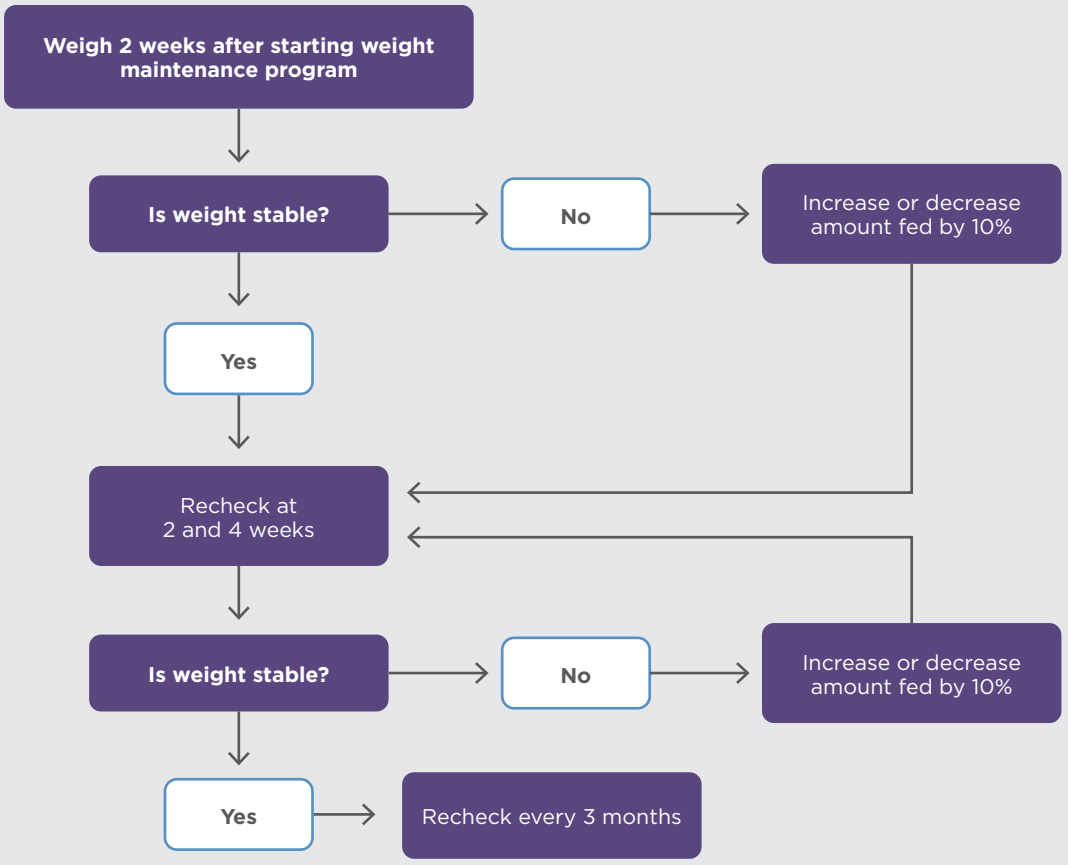

FIGURE 1. Algorithm for stabilizing body weight.[11]

when an intake of more than 10% of the pet's total daily calories is from sources that are not complete and balanced, such as treats and table foods.

Monitor and Adjust

Even with the most precise instructions, it is critical to understand that creation of a feeding plan is only a starting point. Just like people, every pet is an individual with calorie needs that are dictated by factors that cannot be completely calculated, such as age, activity level, and genetics.[9] The Ohio State University found that real-world calorie needs for a given pet can vary by as much as 50% from calculated values.[3] Monitoring the effect of a dietary plan over time is therefore essential. According to Tufts University's veterinary website Petfoodology, "one of the most useful things you can do is learn how to assess [a] pet's body condition score and adjust the amount [to] feed accordingly."[9]

Dietary plans, particularly those designed for weight management or ingredient sensitivity, can be long and challenging for both the pet and the owner. Weight loss should be gradual, not drastic; recommended rates of average weight loss are 1% to 2% of the obese body weight per week for dogs and 0.5% to 1% per week for cats.[11] Weight loss of greater than 2% body weight per week for dogs or 1% body weight per week for cats increases concern for loss of lean body mass as opposed to obese body weight alone.

At a minimum, weigh-ins should be planned every 2 weeks for weight gain or weekly for weight loss during the first few months to safely monitor response to the dietary recommendations. Feeding amounts should be adjusted, as needed, in increments of approximately 10% based on the patient's weight response over time. As the patient's weight begins to stabilize while nearing ideal BCS, the time between weigh-ins can be slowly lengthened (**FIGURE 1**).

CONCLUSION

Maintaining an ideal body condition for pets and patients can be a challenge. Collecting a detailed diet and activity history helps guide the veterinary staff in their recommendations for a weight management plan. The appropriate diet choice can help owners meet weight goals for their pets without having to rely on adjusting food volume alone. Body condition and body weight should be closely monitored to track progress and guide plan adjustments, even after ideal body condition is achieved. TVN

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Mallory joined the Oakland Veterinary Referral Services (OVRS) emergency team in 2007 and worked as a veterinary assistant in the emergency department while completing the veterinary technician program at Macomb Community College in southeast Michigan. She earned her veterinary technician license in 2010 and went on to complete her VTS in emergency and critical care in 2014. In 2015, Mallory joined the OVRS critical care department, where she developed a passion for nutrition with a focus on critically ill patients. She earned her VTS in nutrition in 2018. Her interests include assisted feeding (feeding tubes and intravenous nutrition), transfusion medicine, and toxicology. Mallory and her family share their home with 4 cats (Kora, Uno, Ursula, and Earl) and a terrier mix named Ranger.

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