Nutritional therapy is considered a cornerstone in the management of dogs and cats with CKD and generally includes reductions in intake of dietary protein, phosphorus, and sodium; modifications in intake of calcium and potassium when necessary; enhancement in the intake of water, water-soluble vitamins, and omega-3 fatty acids; and alkalinization. A number of commercially available diets have been specifically formulated for this purpose; however, some pet owners prefer to use home-prepared diets for a number of reasons, such as a perception of poor quality of commercially available options. Other clients desire to participate in the treatment of an ill pet and wish to deepen the human-animal bond by personally preparing their pet’s meals. Furthermore, some patients will not eat commercially available diets or cannot tolerate them because of concurrent disease (e.g., fat intolerance or adverse food responses).

Clients often seek information about dietary options for their pets from websites or books. In many cases, owners seek information about dietary options for their pets from websites or books. In many

Objectives—To evaluate recipes of diets recommended for animals with chronic kidney disease (CKD), compare nutritional profiles for those recipes to requirements for adult dogs and cats, and assess their appropriateness for the management of CKD.

Design—Evaluation study.

Sample—Recipes of 67 home-prepared diets promoted for use in dogs (n = 39 recipes) and cats (28) with CKD.

Procedures—Recipes were analyzed with computer software to determine calories, macronutrient calorie distribution, and micronutrient concentrations and were assessed for appropriateness for the management of CKD.

Results—Assumptions were required for the analysis of every recipe, and no recipe met all National Research Council nutrient recommended allowances (RA) for adult animals. Compared with RAs, concentrations of crude protein or at least 1 amino acid were low in 30 of 39 (76.9%) canine recipes and 12 of 28 (42.9%) feline recipes. Choline was most commonly below the RA in both canine (37/39 [94.9%]) and feline (23/28 [82.1%]) recipes; selenium (34/39 [87.2%] canine and 9/28 [32.1%] feline recipes), zinc (24/39 [61.5%] canine and 19/28 [67.9%] feline recipes), and calcium (22/39 [56.4%] canine and 7/28 [25.0%] feline recipes) concentrations were also frequently below recommendations. The median phosphorus concentration in canine and feline recipes was 0.58 and 0.69 g/1,000 kcal, respectively.

Conclusions and Clinical Relevance—Many problems with nutritional adequacy were detected, and use of the recipes could result in highly variable and often inappropriate diets. Many recipes would not meet nutritional and clinical needs of individual patients and should be used cautiously for long-term feeding. (J Am Vet Med Assoc 2012;240:532–538)
cases, veterinarians may be asked for home-prepared recipes or to assess a recipe. Veterinarians should understand the information that is available to owners who wish to use home-prepared diets and be able to confidently advise clients on the advantages and disadvantages of the use of home-prepared diets. In other studies, investigators detected major concerns with regard to the nutritional adequacy of home-prepared diets, and the adverse effects of feeding unbalanced diets have been reported. Recipes are readily available in books and websites; however, there is no oversight or standardization, and these recipes may be inappropriate and even potentially harmful.

The nutrient requirements for dogs and cats with CKD have not been established; however, except for a few major minerals (phosphorus, sodium, calcium, and potassium), there are no indications for dietary intakes below those recommended for healthy animals. The NRC has established MR or adequate intake values as well as an RA for all essential nutrients for the various physiologic states of dogs and cats. When supporting data are available, the safe upper limit is also provided. The MR values are based on data from peer-reviewed literature and represent the minimal consistent dietary concentrations of essential nutrients that will support health. An MR has been established for adult dogs for crude protein, all amino acids, calcium, magnesium, sodium, iodine, and riboflavin and for adult cats for crude protein, sulfur-containing amino acids (eg, methionine, methionine plus cystine, and taurine), lysine, calcium, phosphorus, magnesium, sodium, iodine, pyridoxine, pantothenic acid, folic acid, and choline.

Because data are not available to support MR values for every nutrient for all life stages of dogs and cats, adequate intake was instead established in those situations. These represent presumed dietary concentrations of nutrients that support a specific life stage as extrapolated from other life stages, other species, or other information. An RA value has been established for all essential nutrients. These values are based on the MR or adequate intake plus a safety factor to account for uncertain bioavailability, which remains undefined for most nutrients of most foods in healthy dogs and cats. The impact of other variable conditions, such as age, disease state, medication interactions, and many other factors, is also unknown. The safety margin inherent in the RA could also be important when developing home-prepared diets because the nutrient concentrations are estimates determined on the basis of ingredient databases and presumed digestibility factors.

We hypothesized that few recipes would provide all essential nutrients at concentrations adequate for adult maintenance as recommended by the NRC9 and that some recipes would not include modifications appropriate for animals with CKD. The objectives of the study reported here were to evaluate recipes for home-prepared diets promoted for use in dogs and cats with CKD, compare the nutritional profiles of those recipes with the NRC’s RAs for dietary intake of essential nutrients for adult dogs and cats, and assess modifications for appropriate use in the management of CKD.10–13

Materials and Methods

Sample—Books (books for a veterinary audience as well as books for pet owners) and websites were searched for recipes of home-prepared diets for dogs and cats. Recipes were included if they were specifically recommended for use in animals with CKD and if the ingredients and preparation instructions were sufficiently detailed to enable computer analysis.

Analysis of recipes—Qualitative analysis of each recipe included an assessment of the specificity of ingredients and preparation instructions as well as the target animal and calorie information. For recipes with allowances for substitutions or ranges in amounts, a mean value was determined for the ingredients (eg, a specification of 2 cups of pasta or rice was analyzed as 1 cup pasta plus 1 cup rice, and a specification of 1 to 2 eggs was analyzed as 1.5 eggs). When specifications for supplement-type products were vague (eg, vitamins for cats or multiple vitamin-mineral tablet), national brand products were used. Common and widely available ingredient types and varieties were used to satisfy vague instructions (eg, regular ground beef was analyzed as ground beef that contained 20% fat). Quantitative analysis was performed by use of diet formulation software and both open-source and proprietary nutrient-analysis databases. One ingredient that was recommended as the source of taurine in several recipes was analyzed at the University of California-Davis Amino Acid Laboratory for determination of taurine concentration by use of an automated analyzer in accordance with a previously described technique. Quantitative analysis of recipes included calculation of total energy, energy density, moisture content, and the proportion of calories contributed by protein, fat, and carbohydrate on an ME basis and determination of concentrations of essential nutrients. Linoleic acid and arachidonic acid were the only fatty acids assessed. Physiologic fuel values (kcal/g metabolized of fat, protein, and carbohydrate) applied to recipe analyses were those used for specific human food types because of the expected higher digestibility of these ingredients, compared with digestibility for commercial pet foods. When possible, the value for the calculated energy provided was compared with the calories specified in the recipe as well as the calculated MER (in kcal/d) of the target animal. For dogs, this was calculated by use of the following equation for inactive pet dogs: kilograms of body weight × 70.75 × 0.75. For cats, this was calculated by use of the following equation for lean domestic cats: kilograms of body weight × 67 × 100. The preceding equations use metabolic body weight (ie, body weight in kilograms raised to the 0.75 and 0.67 power for dogs and cats, respectively). These equations cannot be directly converted to a value for body weight in pounds. Therefore, if the body weight has been recorded in pounds, it must be divided by 2.2 to convert it to kilograms for use in these equations.

Essential nutrient concentrations were assessed on an energy basis to account for differences in energy density of the diets; these were compared with the RA and, when available, MR for adult dogs and cats for maintenance. Iodine, chloride, and vitamin K could not be assessed because of a dearth of analysis data for...
ingredients. For some ingredients, vitamin D concentrations were also not available; other nutrients were defined for all ingredients.

**Statistical analysis**—A Shapiro-Wilk test was used to confirm data were nonparametric. Spreadsheet software was used to calculate descriptive statistics (median and range). The denominators used to calculate proportions corresponded to the number of recipes for which data were available for each variable.

**Results**

**Sample**—Thirty-nine recipes intended for the management of CKD in dogs were identified. Of these, 33 were published in books (2 books for a veterinary audience and 8 books for pet owners) and 4 were from online sources. Twenty-eight recipes intended for the management of CKD in cats were identified, of which 26 were published in books (1 book for a veterinary audience and 7 books for pet owners) and 2 of which were from online sources. Recipes were selected from 14 sources; 9 of the sources were written or provided by veterinarians. Many of the recipes from books were also reproduced on numerous websites. Additionally, in 2 cases, recipes from books varied with the edition of the book. In these cases, both versions of the recipe were analyzed. The recipes obtained from 1 online source were removed from that website after they were initially accessed.

**Analysis of recipes**—Assumptions were necessary for base ingredients in 29 of 39 (74.4%) canine and 28 of 28 (100%) feline recipes, including cooking method, specific cut of meat, percentage of fat in ground meats, type of meat (species), type of carbohydrate (ie, grain length of rice or use of peeled potatoes vs potatoes from which the skin was not removed), or type of vegetable oil. Furthermore, many recipes specified volume rather than weight measurements of meat, which necessitated estimations of amounts.

Similarly, specifications for supplement-type products were vague for most recipes, with only 1 canine recipe and no feline recipes providing precise instructions. For example, many recipes included a multivitamin with no quantities or specifics listed. Some recipes included baking soda (sodium bicarbonate) as a source of calcium, which is not. In a few cases, the information for supplement-type products was scattered throughout a book and difficult to locate or the information in a book differed from that provided by the related website. Moreover, some type of assumption was necessary for every recipe.

None of the recipes specified appropriateness for specific types or severity of CKD. Many recipes stated that the information provided was a guideline and should be adjusted with veterinary supervision. Both a specific body weight of the target animal and the amount of calories provided were given for 13 of 39 (33.3%) canine and 1 of 28 (3.6%) feline recipes. Body weight of the target animal was provided for 22 (56.4%) canine and 2 (7.1%) feline recipes, and the amount of calories was provided for 22 (56.4%) canine and 20 (71.4%) feline recipes. Among the canine recipes for which calorie information was provided, 19 of 22 (86.4%) were within 10% of the calories calculated by use of the computer software, but only 5 (22.7%) approximated the MER of the target animal within a margin of 20%. Some sources provided different recipes that varied in energy content by up to 67% for a dog of the same weight. Among the feline recipes for which calorie information was provided, 18 of 20 (90%) were within 10% of the calories calculated by use of the software, and 1 of 2 approximated the MER of the target animal within a margin of 20%.

Although some recipes were intended to provide the daily energy needs of a specific target animal, others included a general guideline. In some cases, sources provided guidance for determining the amount to feed a dog or cat of a particular weight by use of the energy density of the diet and tables with energy requirements of animals of various body weights and life stages. Some recipes stated that the amount fed should be adjusted on the basis of body weight or that the owner should judge the amount to feed; however, guidelines were not listed.

**Quantitative analysis of canine recipes**—The canine recipes provided a median of 845 kcal (range, 573 to 1,729 kcal), energy density of 4,590.6 kcal/kg of DM (2,086.6 kcal/lb of DM) with a range of 4,014 to 5,962 kcal/kg of DM (1,824.3 to 2,710.0 kcal/lb of DM), and moisture content of 71% (range, 32.2% to 81.3%). The energy distribution had a wide range; the proportion of calories (percentage of ME) provided by protein, fat, and carbohydrate ranged from 7.8% to 37%, 13.3% to 60.4%, and 13.9% to 73.3%, respectively. Medians and ranges of crude protein and amino acid concentrations were summarized (Table 1). Adequacy of protein and amino acids was a concern because 30 of 39 (76.9%) recipes were below the RA for crude protein or at least 1 amino acid. Only arginine, isoleucine, and lysine were provided in adequate concentrations in all recipes.

All canine recipes were adequate in crude fat content. Five (12.8%) canine recipes were below the RA for linoleic acid. Only 4 (10.3%) canine recipes included a specific dose of fish oil as a source of long-chain omega-3 fatty acids; however, some sources included a recommendation for an omega-3 fatty acid nutritional product as a general guideline.

Mineral and vitamin concentrations provided by canine recipes were often inadequate (Table 2). Calcium concentration was below the RA in 22 (56.4%) recipes, and calcium was provided at more than twice the RA in 7 (17.9%) recipes and at >3 times the RA in 1 (2.6%) recipe. Although there is no MR for adult dogs, the phosphorous concentration was below the RA in 27 of 39 (69.2%) recipes and at or above the RA in 12 (30.8%) recipes. Twenty (51.3%) recipes provided a calcium-to-phosphorous ratio <1:1, and 5 (12.8%) recipes provided a ratio >3:1. Some ingredients did not define a value for vitamin D concentration but would have been expected to provide this nutrient via products such as raw ground chicken, cooked ground beef (10% fat),

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*JAVMA, Vol 240, No. 5, March 1, 2012*
and some cuts of lamb. Of 36 recipes for which vitamin D content, 15 (41.7%) were below the NRC's RA below RA NA = Not applicable.

Table 1—Median and range values for concentrations of crude protein and amino acids in 39 canine and 28 feline recipes of home-prepared diets for the management of CKD.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Canine (1,000 kcal)*</th>
<th>Median (1,000 kcal)</th>
<th>Range (1,000 kcal)</th>
<th>No. (%) below RA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NRC’s RA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude protein (g)</td>
<td>25.00</td>
<td>33.60</td>
<td>18.00–88.20</td>
<td>6 (15.4)</td>
</tr>
<tr>
<td>Arginine (g)</td>
<td>0.88</td>
<td>1.97</td>
<td>1.08–5.04</td>
<td>0</td>
</tr>
<tr>
<td>Histidine (g)</td>
<td>0.48</td>
<td>0.92</td>
<td>0.48–2.33</td>
<td>1 (2.6)</td>
</tr>
<tr>
<td>Isoleucine (g)</td>
<td>0.95</td>
<td>1.51</td>
<td>0.97–4.25</td>
<td>0</td>
</tr>
<tr>
<td>Methionine and cystine (g)</td>
<td>1.63</td>
<td>1.19</td>
<td>0.74–3.07</td>
<td>28 (71.8)</td>
</tr>
<tr>
<td>Leucine (g)</td>
<td>1.70</td>
<td>2.51</td>
<td>1.63–7.19</td>
<td>3 (7.7)</td>
</tr>
<tr>
<td>Lysine (g)</td>
<td>0.68</td>
<td>2.34</td>
<td>1.05–6.20</td>
<td>0</td>
</tr>
<tr>
<td>Phenylalanine and tyrosine (g)</td>
<td>1.85</td>
<td>2.70</td>
<td>1.51–7.57</td>
<td>1 (2.6)</td>
</tr>
<tr>
<td>Threonine (g)</td>
<td>1.08</td>
<td>1.34</td>
<td>0.73–3.29</td>
<td>9 (23.1)</td>
</tr>
<tr>
<td>Tryptophan (g)</td>
<td>0.35</td>
<td>0.92</td>
<td>0.13–161.21</td>
<td>22 (58.4)</td>
</tr>
<tr>
<td>Valine (g)</td>
<td>1.23</td>
<td>1.83</td>
<td>1.07–4.65</td>
<td>0</td>
</tr>
<tr>
<td>Taurine (g)†</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2—Median and range values for concentrations of selected vitamins and minerals in 39 canine and 28 feline recipes of home-prepared diets for the management of CKD.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Canine (1,000 kcal)*</th>
<th>Median (1,000 kcal)</th>
<th>Range (1,000 kcal)</th>
<th>No. (%) below RA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NRC’s RA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (g)</td>
<td>1.00</td>
<td>0.90</td>
<td>0.09–3.22</td>
<td>22 (56.4)</td>
</tr>
<tr>
<td>Phosphorus (g)</td>
<td>0.75</td>
<td>0.58</td>
<td>0.20–1.26</td>
<td>27 (69.2)</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>150.00</td>
<td>0.20</td>
<td>0.07–0.45</td>
<td>13 (33.3)</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>200.00</td>
<td>0.34</td>
<td>0.02–2.36</td>
<td>27 (69.2)</td>
</tr>
<tr>
<td>Potassium (g)</td>
<td>1.00</td>
<td>1.65</td>
<td>0.29–4.86</td>
<td>16 (41.0)</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>7.50</td>
<td>16.74</td>
<td>3.64–44.46</td>
<td>7 (17.9)</td>
</tr>
<tr>
<td>Copper (mg)</td>
<td>1.50</td>
<td>1.34</td>
<td>0.25–4.99</td>
<td>20 (51.3)</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>15.00</td>
<td>12.51</td>
<td>3.07–97.17</td>
<td>24 (61.5)</td>
</tr>
<tr>
<td>Manganese (mg)</td>
<td>1.20</td>
<td>3.13</td>
<td>0.08–16.66</td>
<td>4 (10.3)</td>
</tr>
<tr>
<td>Selenium (µg)</td>
<td>87.50</td>
<td>0.05</td>
<td>0.02–0.19</td>
<td>34 (87.2)</td>
</tr>
</tbody>
</table>

Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Canine (1,000 kcal)*</th>
<th>Median (1,000 kcal)</th>
<th>Range (1,000 kcal)</th>
<th>No. (%) below RA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NRC’s RA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A (µg)</td>
<td>379.00</td>
<td>437.78</td>
<td>4.23–7,963.20</td>
<td>17 (43.6)</td>
</tr>
<tr>
<td>Vitamin E (µg)</td>
<td>7.50</td>
<td>26.49</td>
<td>3.61–120.20</td>
<td>3 (7.7)</td>
</tr>
<tr>
<td>Thiamine (mg)</td>
<td>0.56</td>
<td>2.08</td>
<td>0.18–18.31</td>
<td>3 (7.7)</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>1.30</td>
<td>2.04</td>
<td>0.23–18.21</td>
<td>11 (28.2)</td>
</tr>
<tr>
<td>Pyridoxine (mg)</td>
<td>0.38</td>
<td>2.98</td>
<td>0.66–17.84</td>
<td>0</td>
</tr>
<tr>
<td>Nicacin (mg)</td>
<td>4.25</td>
<td>21.10</td>
<td>11.75–51.43</td>
<td>2 (5.1)</td>
</tr>
<tr>
<td>Pantothenate (mg)</td>
<td>3.75</td>
<td>9.23</td>
<td>1.47–20.49</td>
<td>7 (17.9)</td>
</tr>
<tr>
<td>Cobalamin (µg)</td>
<td>8.75</td>
<td>0.01</td>
<td>0.40–40.00</td>
<td>22 (56.4)</td>
</tr>
<tr>
<td>Folate (µg)</td>
<td>67.50</td>
<td>356.60</td>
<td>21.50–1,128.40</td>
<td>3 (7.7)</td>
</tr>
<tr>
<td>Biotin (µg)†</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
</tr>
<tr>
<td>Choline (mg)</td>
<td>425.00</td>
<td>169.05</td>
<td>11.26–488.61</td>
<td>37 (94.9)</td>
</tr>
</tbody>
</table>

Quantitative analysis of feline recipes—The feline recipes provided a median of 396 kcal (range: 259 to 1,667 kcal), energy density of 5,171 kcal/kg of DM (2,330.5 kcal/lb of DM) with a range of 4,372.6 to 6,584.1 kcal/kg of DM (1,987.5 to 2,992.8 kcal/lb of DM), and moisture content of 63.4% (range, 57.3% to 71.6%). The energy distribution had a wide range; the proportion of calories (percentage of ME) provided by protein, fat, and carbohydrate ranged from 11.4% to 28%, 31.2% to 73.4%, and 0.7% to 57.4%, respectively. Medians and ranges of crude protein and amino acid concentrations were summarized (Table 1). Adequacy of protein and amino acids was a concern because 12 of 28 (42.9%) feline recipes were below the RA for crude protein or at least 1 amino acid.

All feline recipes were adequate in crude fat, arachidonic acid, and linoleic acid content. No recipes included a specific dose of fish oil as a source of long-chain omega-3 fatty acids; however, some sources in-

*Information obtained from an NRC publication. †Taurine is not a required nutrient for canine maintenance, according to the NRC.
cluded a recommendation for an omega-3 fatty acid nutritional product as a general guideline.

Mineral and vitamin concentrations provided by feline recipes were often inadequate (Table 2). Calcium concentration was below the RA in 7 (25%) recipes, and calcium was provided at more than twice the RA in 11 (39.3%) recipes and at >3 times the RA in 3 (10.7%) recipes. All recipes provided phosphorus at concentrations above the MR for adult cats, with 12 of 28 (42.9%) recipes below the RA and 16 of 28 (57.1%) above the RA. Seven (25%) recipes provided a calcium-to-phosphorus ratio <1:1, and 6 (21.4%) recipes provided a ratio >3:1. Of 21 recipes for which vitamin D was defined for all ingredients expected to contribute to the vitamin D content, only 1 (3.6%) was below the RA; none exceeded the safe upper limit. Even when disregarding phosphorus concentrations, none of the feline recipes provided all essential nutrients at or above the RA for adult maintenance of a target animal.

**Discussion**

To our knowledge, the study reported here was the first in which recipes for home-prepared diets intended for the management of CKD were assessed. An objective of the study was to compare the nutritional profiles of readily accessible recipes with established RAs for essential nutrients of adult dogs and cats. Despite the fact that most of the recipes in this study were written or provided by veterinarians, the results indicated that many recipes for home-prepared diets that owners may use for dogs and cats with CKD may be inappropriate.

Although recipes for home-prepared diets for pets with CKD are readily available to pet owners through books and websites, these recipes differ widely with regard to the nutritional profile. Also, regardless of the training and credentials of the individual formulating the recipe, vague specifications for ingredients and instructions for diet preparation may result in a highly variable end product when the recipe is prepared by different pet owners. It was necessary to make 1 or more assumptions to analyze every recipe in this study. Although attempts were made to approximate a realistic outcome by use of ingredients that were widely available and typically found in grocery stores, inherent variability and regional differences in the commonality of some items will influence the reproducibility of the analyses. The tools and resources used to formulate the recipes will also have a substantial impact on the nutritional analysis; however, most sources did not cite the reference requirements, software, or nutritional databases used in the process.

A recipe for a useful home-prepared diet for pets with any disease should be specific enough to reduce variability in ingredient selection and diet preparation so that the intended nutritional profile of the final diet would be as constant as possible regardless of who obtains the ingredients and prepares the meals. A customized approach that would account for the energy requirements and the particular type and stage of disease of a specific pet would also be beneficial because owners may lack the ability to make appropriate adjustments to a general recipe; this approach has been advocated by veterinary nutritionists. Many of the recipes assessed in the study reported here did not provide calorie information or target animal body weight. Although the data for most recipes that provided calorie information were consistent with that calculated by use of the software, few approximated the MER of the target animal when that information was provided. Because few sources provided the equation used to estimate energy requirements, this discrepancy may have reflected differences in energy calculations. The equation for the calculation of energy needs of neutered, less active pets was used in this study; compared with those determinations, many recipes overestimated the energy requirement of a target animal. Moreover, although it is known that energy requirements are not linear with body size, several sources included a recommendation to double the recipe amounts for animals twice the size of a target animal. Additionally, some sources provided recipes that differed widely in caloric content for target animals of the same body weight.

Quantitative analysis revealed large variations in the calories provided and the macronutrient profile of the recipes. Deficits in crude protein and many amino acids, vitamins, and minerals were common in both canine and feline recipes. Furthermore, although many recipes provided essential nutrients at concentrations below the MR for maintenance, even more provided concentrations between the MR and the RA. Whether these nutrients would be provided to any particular animal in sufficient quantities would be highly dependent on energy intake as well as digestibility and bioavailability of the nutrients. Accuracy of the ingredient database as well as the cooking and preparation methods will also influence the actual concentration of any nutrient in the final diet.

The goals for management of CKD in dogs and cats are to delay progression of disease and reduce the impact of clinical signs of disease. Generally accepted strategies for the nutritional management of CKD patients include reduced intake of protein, phosphorus, and sodium; modified intake of calcium and potassium, when necessary; and enhanced intake of water, water-soluble vitamins, and omega-3 fatty acids. Additionally, systemic alkalization is promoted through protein restriction and the use of sodium bicarbonate, potassium citrate, or calcium carbonate. Several studies have been conducted to evaluate the effect of commercially available therapeutic diets formulated for the management of CKD in dogs and cats. However, there is a lack of data on the effects of any 1 strategy or of modifying specific dietary variables on the basis of stage and manifestation of the disease.

Many of the recipes were low in protein. Although the requirements of dogs and cats with CKD for protein and other essential nutrients are unknown, there is no reason to assume these are less than the requirements for adult maintenance of dogs and cats. Currently, all commercially available veterinary therapeutic diets for use in managing CKD provide protein in concentrations that meet or exceed the NRC’s RAs (23 and 30 g of crude protein/1,000 kcal for dogs and cats, respectively). However, in the recipes analyzed in the present study, there was a wide range of crude protein concen-
trations provided, with several recipes containing crude protein concentrations below the RA for adult dogs and many others that had or even exceeded a crude protein concentration twice the RA for adult dogs. Although there is a lack of research on the optimal protein intake for dogs and cats with CKD, clinical experience supports the belief that a customized approach can accommodate different stages and types of disease. Animals with early stages of CKD are unlikely to develop adverse effects from consumption of diets with protein concentrations that exceed the RA, whereas animals with more advanced disease may benefit (a reduction in clinical signs associated with uremia) from dietary protein concentrations that are closer to the RA. Furthermore, investigators in 1 study found that a dietary protein concentration of approximately 33 g/1,000 kcal (similar to the concentration in many therapeutic diets formulated for dogs with CKD) reduced proteinuria in dogs with glomerular nephropathy; compared with results for dogs fed dietary protein at concentrations of 72 g/1,000 kcal. This finding supports the belief that adjustment of dietary protein intake for renal proteinuria independent of stage of CKD is an important consideration in affected dogs. Finally, it is clear that despite adequate crude protein intake, adequacy of essential amino acids is important for any animal. The inadequacy of the amino acid profile provided by the recipes assessed here was a major concern, especially for canine recipes.

The role of phosphorus in CKD is fairly clearly defined, and reduction of dietary intake to near or below the NRC’s RAs has long been the mainstay of CKD treatment. The objectives of this dietary modification are to control hyperparathyroidism and delay disease progression. Only 2 canine recipes were below the RA for phosphorus (there is no MR for phosphorus for adult dogs). Although many feline recipes were between the RA and the MR, none were below the MR. However, many recipes exceeded the RA, with 2 canine and 2 feline recipes providing > 150% of the RA for phosphorus. Similarly, commercially available therapeutic diets marketed for CKD provide phosphorus at concentrations that range from 50% to 160% and 125% to 200% of the RA for dogs and cats, respectively. The impact of consuming any diet with concentrations of phosphorus that markedly exceed the RA cannot be predicted for any particular patient but likely depends on CKD stage and other specific underlying physiologic processes.

The role of dietary intake of sodium in animals with CKD has not been fully characterized. Because of the increased incidence of hypertension in patients with CKD, there have been concerns regarding a potential lower sodium tolerance and worsening of hypertension in some patients. Studies of dogs and cats with experimentally induced CKD have not indicated an association between sodium intake and hypertension or progression of renal dysfunction. In 1 study of 36 cats (6 of which had naturally occurring CKD), there was no effect of a high-sodium diet, compared with the effects of a low-sodium diet, on blood pressure variables, although increases in serum concentrations of creatinine, phosphorus, and SUN were reported for all cats; however, data for the group with CKD were not reported separately and glomerular filtration rate was not assessed. Perhaps of more concern is the adverse effect of inadequate intake of sodium. Activation of the renin-angiotensin-aldosterone system and resultant hypokalemia in cats consuming low-sodium diets have been reported, and progressive renal injury from hypokalemic nephropathy is a concern. Although nearly one-fourth of the feline recipes were below the RA for sodium intake, none exceeded 50% of the concentration associated with increases in relevant biochemical variables reported in another study.

With regard to other nutrients that may be required at modified concentrations in diets formulated for CKD, many of the canine and feline recipes assessed in the present study provided deficient or excessive concentrations of calcium, potassium, and water-soluble vitamins. Clearly, this is not ideal for healthy pets and is likely even of more concern for dogs and cats with CKD. Because not all animals require the same degree and type of modifications, it is recommended that clinicians consider individualized clinical data for each patient. For example, although hypokalemia is sometimes detected in animals with polyuria secondary to CKD, hyperkalemia is also found in a portion of the patient population. Finally, a few canine recipes and no feline recipes included a specific recommendation for supplementation with omega-3 fatty acids, which has been found to reduce inflammation and systemic blood pressure as well as preserve renal function in dogs with experimentally induced CKD. To our knowledge, similar investigations in cats with CKD have not been reported.

None of the recipes assessed in the study reported here provided adequate concentrations of all essential nutrients, compared with the NRC’s RAs for adult dogs and cats. Furthermore, many recipes did not accommodate currently accepted nutritional strategies for managing CKD, and none provided guidelines for use at any particular stage or type of disease. Recipes of home-prepared diets that are intended for the management of CKD should be used under appropriate veterinary supervision and monitoring. Consideration should be given to collaborating with a board-certified veterinary nutritionist to develop a comprehensive and customized nutritional management plan including follow-up and adjustments as needed.


Centrum multivitamin/multimineral supplement, Pfizer Inc, Kings Mountain, NC.

Centrum Kids multivitamin/multimineral supplement, Pfizer Inc, Kings Mountain, NC.

One-a-Day Maximum multivitamin/multimineral supplement, Bayer HealthCare LLC, Morristown, NJ.

Vetri-Science Nu-Cat tablets, FoodScience Corp, Essex Junction, Vt.

Vetri-Science Canine Plus tablets, FoodScience Corp, Essex Junction, Vt.

Virbac Pet-Tabs, Virbac Corp, Fort Worth, Tex.

Vital Vites for Dogs, Deserving Pets, Clearwater, Fla.

Vital Vites for Cats, Deserving Pets, Clearwater, Fla.

Balance IT, Davis Veterinary Medical Consulting Inc, Davis, Calif.


Davis Veterinary Medical Consulting Inc, Davis, Calif.
References


