

Purina ProPlan HC HydraCare

Feline hydration: from voluntary intake to urine dilution

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ABSTRACT

Water intake is important in health and disease in order to compensate for obligatory water losses. As veterinarians, we can assess hospitalized cats to estimate their hydration status and establish fluid therapy; however, once the patient goes home, the fluid intake depends entirely on the drinking water availability, rate of intake and diet composition. The science behind promoting water intake and in which circumstances it is necessary is discussed herein, focused on the unique metabolism of the cat. ProPlan HydraCare, a nutrient enriched water, can successfully complement dietary and drinking water to increase total daily water intake, promote hydration, and increase urine volume and dilution. Daily water intake, hydration status, and urinalysis should be monitored in each patient to adequately advice on water provision.

Introduction

It is estimated that in general 60% of the cat's body weight consists of water, where it has multitude of functions critical for survival, but can range from 50-70% depending on the level of obesity.^{1,2} Clinical signs of dehydration appear fast and with as little as 5% decrease in body water, and losses of 15% are associated with death.³ Water requirements are directly dependent on losses, in healthy cats these occur mainly through the urine, but also via faeces, saliva and, in much smaller amounts, via evaporation (from skin and respiration) and sweat.^{1,3} In illness, vomiting, diarrhea, hemorrhages account for the most significant loses, but indwelling drains, ascites, effusions, oozing wounds, etc. account for loses or shifts in fluid volumes. Water losses trigger thirst and urinary concentration in order to restore the water balance.¹

During periods of temporary water deprivation, urine concentration helps conserve water. Cats have evolved as desert dwellers that have adapted to periods of scarce water intake with a very high urinary concentration ability^{1,3} (compared to dogs and humans) and reliance on prey to obtain water: average water content of typical feline prey is above 60%.⁴ Cats are considered poor drinkers, since they tend to respond to eating food low in moisture by increasing urine concentration rather than by drinking more. This makes them survive on less water than dogs, but might predispose them to lower urinary tract disease.

Healthy cats with free access to drinking water can maintain a good water balance on a wide range of dietary water

intake, from dry to wet foods.^{1,3,5} However, there are some situations where promotion of water intake can be beneficial, in particular in cats with conditions of increased water losses (kidney disease, diabetes, and those manifested by vomiting and diarrhoea), decreased intake (anorexia), cats with lower urinary tract disease and in obesity prevention and management.

Water requirements: is the cat drinking enough?

Water is an essential nutrient, and requirements vary between individuals depending on their water losses, which are affected by a variety of factors, both intrinsic (diagnoses, life stage, reproductive status, breed coat length, physical activity) and extrinsic (ambient temperature and humidity, diet composition) to the animal.^{1,3} Due to this complexity, there is no one-size fits all recommendation and there are several proposed equations to determine the daily water requirement (in mL per day)¹, which then should be monitored and adjusted for each individual.

The National Research Council³ recommends calculating the energy needs of the animal on kcal per day basis and providing 1 mL water per each 1 kcal. Although lower ratios of 0.6 to 0.8 have been reported in healthy cats, this is only an estimate that will require monitoring and adjustment. In healthy animals, water requirements are rarely estimated since they are perfectly able to self-regulate their water status, and this calculation is usually done in sick patients that might have a lower access to water (due to anorexia, lethargy) or higher losses. Formulas to estimate maintenance energy needs in adult cats are listed in table 1.^{3,6} In

hospitalized patients⁷, energy requirements are determined using 70% or maintenance energy or the resting energy requirements (RER) equation of $70 \times \text{weight (kg)}^{0.67}$.

Sources of water

Without considering parenteral provision, cats have three main sources of water: the two most important are dietary water and drinking water³. The third, and smaller, source is metabolic water. Therefore, when determining the water intake of cats, it is important to consider all sources of water via a good medical and diet history.

Dietary water

This can be extremely important: moisture content of commercial feline diets ranges from <10% to >60% (with some diets providing 70 or even 80%), as mentioned before. The water content of commercial cat food in the European Union (EU) has to be reported if it is higher than 14%. In the case that diet does not cover all water needs, the cat will need to drink water to meet their requirements. Accordingly, European Union legislation, as described in the FEDIAF's "Code of Good Labelling Practice for Pet Food"⁸, requires that the dry food packaging label indicates the need to provide fresh water when feeding dry food to dogs and cats. On the other hand, cats that are fed high moisture diets can sometimes meet their water needs via diet alone and require no additional drinking water^{9,5}.

Drinking water

When the diet is not enough to meet daily water needs, cats will drink, which is why they should always have access to fresh, clean water. Thirst drive is largely enhanced following ingestion of a meal (need reference). Cats drink water using their tongue by licking (when the water container is shallow, and their tongue sweeps the bottom) or lapping (when the tongue does not reach the bottom)¹⁰

There are not many studies that delve into the drinking habits of cats¹¹, but recommendations include separating the food from the water station, use of wider and shallower containers so that the whiskers do not touch the sides. A shallow container also allows a good overview of the surroundings while drinking so no one sneaks up on them, since cats are not only predators but prey. Cats do not seem to follow a circadian rhythm when eating and drinking¹²

Drinking water can be provided by standing water (bowls, rainwater poodles, etc) or running water, such as water fountains, garden ponds or dripping faucets. One survey¹¹ from 549 cat care givers in Germany and Austria found that more than 80% of responders used a water bowl to provide water to their cats with the second most popular option being

a water fountain. In cats with both options, they seemed to prefer the still water to the water fountain. The responders also report smaller bowls (less than 15 cm in diameter) were preferred to larger ones and no preference was reported for the material of the bowl (ceramics, plastic, metal or glass). Half of pet caretakers offered multiple water sources. For these cats, they seemed to prefer the bowl in a different location from the feeding station. Almost half of the cats played with the water.

Metabolic water

During the metabolism of macronutrients to generate energy in the form of ATP, water is also a product of those metabolic reactions. Diet macronutrient composition will affect how much metabolic water is produced, with each gram of protein, fat and carbohydrates providing 0.41, 1.07 and 0.6 grams of water respectively¹. On average the metabolism of 100 kcal will result in 10-16 ml of metabolic water³.

Fluid therapy

Water can be provided parenterally (intravenous, subcutaneous, intraosseous, etc) when oral intake is not possible or is insufficient.^{1,13} In hospitalized patients, intravenous fluid therapy is used to correct dehydration, meet maintenance water needs and compensate for high losses. Careful daily assessment is needed to prevent fluid overload¹.

Conditions that can benefit from extra water intake

Diseases associated with dehydration

Some diseases are associated with high water losses and therefore those patients are at higher risk for dehydration, especially those with diseases associated with polyuria, since urine is the main route for water loss. Clinical signs range from loss of skin elasticity, and reduced saliva production to constipation, lethargy, anorexia, neurological signs and death due to multiple organ failure; depending on the severity of the dehydration.^{1,3} Hydration status assessment requires information from the history, physical examination and labwork^{1,13,15} including history of decreased water intake or high water losses, skin tent/turgor, mucous membrane assessment, position of the eyes in the orbits, heart rate and pulse, PCV/total solids, and urine specific gravity (USG). Using these in conjunction is important because individual parameters can be affected by other factors like age or specific disease processes.

Chronic kidney disease is a common condition in cats, especially in elderly patients¹⁴, that is associated with a loss

of the kidney's urine concentration capacity, polyuria, and compensatory polydipsia as main clinical signs. Dehydration is a concern in these cases, as it can negatively affect renal perfusion and worsen the clinical picture¹³. In fact, parenteral fluids provided at home subcutaneously are often recommended in kidney patients with evidence of dehydration or signs of uremia^{13,14}. Diabetes mellitus is also associated with polyuria and can result in dehydration¹⁶. Patients with non-urinary water losses due to vomiting, diarrhea and hemorrhage can also have problems maintaining their body water status. This can also happen in patients with anorexia, who will have a decreased water input³. In anorectic patients, the use of feeding tubes can be used to provide energy and nutrients but also water¹⁷: the water provided by the food can be calculated and compared to the requirement, and the deficit can be provided during the flushing of the tube or as independent "meals". An increase in water intake is also advisable often in cats with constipation, however, we do not have clinical studies backing up this recommendation. Dehydration can result in harder feces and worsen constipation and should be avoided.

In summary, any disease process associated with reduced water intake and/or increased water losses can benefit from strategies to stimulate water consumption.

Feline Lower Urinary Tract Disease (FLUTD)

Increasing water intake can increase urine volume and decrease urine concentration, which can be of interest for management of urolithiasis and feline idiopathic cystitis (FIC). Even though conclusive clinical efficacy data is still lacking, this strategy is widely recommended, for example, by the ACVIM consensus statement on the management of urolithiasis¹⁸. The rationale for this is that an increased water intake will promote a more dilute urine and, in turn, reduce the concentration of stone precursors and inflammatory mediators.^{18,19} Moreover, a higher water intake and urine volume will also result in increased frequency of urination, therefore reducing the time urolith precursors and other substances reside in the lower urinary tract. The recommendation in cats is to achieve a consistently low USG of 1.030 or below.

Regarding urolithiasis, this is a complex condition where many diets can affect urolith formation and treatment outcome, including target urinary pH, concentration of precursors and inhibitors, and moisture. There are no clinical studies that have looked at outcome in patients with urolithiasis with diets that only varied in water content. Therefore, it is difficult to establish the relative importance of each modification, including promotion of diuresis. However, one epidemiological study²⁰ found that diets high in moisture were associated to a decreased risk of calcium oxalate stone formation in cats. One study²¹ in healthy cats

found that a diet with 73.3% moisture (achieved by adding water to a dry diet) resulted in increased water intake (30 ml/kg BW/day) and urine volume, decreased USG, and decreased relative super saturation (RSS) for calcium oxalate compared to the same diet but with 6.3% moisture. RSS assesses the urinary environment in animals fed a diet for several days and has been proposed as an indicator of stone formation risk (the lower the better). One small study²² in stone former cats for calcium oxalate switched these cats from their original diet to a high moisture urinary diet, and the activity product ratios (APR, similar to RSS measure of the effect of urinary environment on stone formation) was reduced. This study suggests a positive role of increasing water intake, but only used 10 cats, the diets had also other modifications and we do not have long term recurrence information. It is noteworthy, that a lower RSS for both struvite and calcium oxalate can also be achieved in cats fed dry diets.²³

Regarding FIC, two studies have supported the use of high moisture canned diets for the long-term management of this disease as part of the multimodal approach, even though there are no studies comparing the effect of water intake alone on the clinical outcome of this disease. One study recruited cats with FIC and put them into two dietary treatments, consisting of a dry or a wet urinary diet. Both were acidifying and had controlled mineral concentrations, but the diets different in nutrient composition, besides dietary moisture. After one year, 17 of 28 cats (61%) eating the dry food had not experienced a recurred condition, compared to 16 out of 18 (89%) for the wet food. In this case, some cats responded positively to both diets but the rate of recurrence was lower for the canned fed cats, at least for 12 months. In another study with duration of 6 months in cats with FIC, the average clinical score improved, but was likely due to 36 out of 40 cat owners incorporating the feeding of more canned food.

However, two recent studies have not found a difference between using a wet or a dry diet for the management of FIC. Kruger and collaborators²⁶ recruited 31 cases for a randomized, controlled masked clinical trial, where cats received either a control diet or a diet formulated for the management of FIC and urolithiasis (differing from the control in calcium, phosphorus and magnesium concentrations, and also differing in antioxidants and fatty acid profile). Cat owners could choose using a wet or a dry variety of their control/treatment diets. After one year, cats fed the prevention food showed lower mean incidence rates for recurrent episodes of multiple-sign days and fewer required analgesics compared to the control. In this study, the researchers did not observe a difference in the results between the cats fed the dry, wet or a combination of foods. Another study²⁷, this one only of 5 week duration, and non-randomized, tested a urinary diet (dry or wet or both, owners could choose) vs a control diet and reported lower rates of recurrence with the test food, with no differences between

cats fed dry, wet or a combination. The limitations include low sample size, low duration, and the fact that the control diets were a variety of non-urinary diets, not a single diet. Results are, therefore, difficult to interpret, since these study were not designed to test water intake alone as a strategy and the sample size is small, but it shows that multiple dietary strategies can be playing a role in the management of this disease.

To summarize, promotion of water intake, especially the use of diets with more than 70% moisture, can be helpful in the management of urolithiasis and FIC in cats when used in combination with other strategies.

Obesity prevention and management

Water provides bulk but not calories, which results in wet diets having lower energy density than dry on a fresh matter (or “as fed”) basis. Energy density of wet food ranges from 0.6 to 1.5 kcal/gram, whereas dry food is generally higher than 3 kcal/g.

Energy intake

There are some studies looking at the effect of high moisture diets vs dry diets on energy intake. Even though some studies suggest that cats can compensate by eating more when fed low calorie wet foods⁵, some studies show potentially helpful results. One study²⁸ used adult neutered cats with ideal body condition score (BCS) were offered their individual energy requirements using the same dry diet, either as is (6% water) or hydrated to 40 or 80% total moisture content for baseline and later, for 4 weeks, twice as many calories. After 4 weeks of being fed in excess, cats fed the 6% moisture diet had increased their energy intake and gained weight and body fat, whereas the cats fed the hydrated diets did not increase their intake and their body weight and body fat remained the same as the start of the trial. **These results suggest that using diets high in moisture to achieve calorie dilution can help prevent undesired weight gain.**

Wei and collaborators²⁹ used lean young adult cats and fed them on a cross-over design the same canned diet, either as is (80% moisture) or freeze-dried (10% moisture) for three weeks. The diets were free fed and food intake and body weight were assessed. The voluntary energy intake was 25% lower in the cats fed the canned diet vs the freeze dried and the cats lost weight in a small, but statistically significant amount, after 3 weeks on the wet diet. It would be interesting to see how overweight cats behave, but these results suggest that using wet diets in obese prone and obese cats could potentially help keep them satiated and improve compliance.

Further supporting the positive effect of high moisture diets in weight management, one study³⁰ fed *ad libitum* the same dry diet as is or with 40% water added in cats that had undergone a weight loss plan. Despite finding no differences

in average energy intake, the cats fed the higher moisture diet gained less weight, suggesting that using **wet diets in the post-weight loss period could help reduce weight regain.**

Physical activity

Two of the above studies that found a positive effect of high moisture diets in weight trends also noted improvement in physical activity: the study from Alexander and collaborators²⁸, using accelerometers in the collars of the cats, found that cats fed the 80% moisture diet had higher activity counts vs the 6 and 40% diet at baseline and during the energy excess phase. The study from Cameron also identified higher activity (measured with activity monitors in the collars) in cats fed the 40% hydrated diet vs the non-hydrated diet.

A third study³¹ compared the effect of meal numbers (1, 2, 4 or a random number of meals per day) on lean neutered adult cats fed the same dry diet with a Latin Square design, and found that feeding one meal per day was associated to lower activity counts. When comparing the same diet as is or hydrated to 70% moisture, **daily activity level tended to be higher in cats fed the high moisture diet vs the dry food, especially at night.**

However, in a study of De Godoy³² and collaborators, while feeding 4 meals per day instead of 1, increased activity counts, especially during the day, and increased food anticipatory activity in the afternoon were observed but no differences in activity with increased water content. Another study³³, cats fed one of four diets: canned (82% moisture as is) or freeze dried (4% moisture) and dry diet as is (3% moisture) or with added water (70% moisture) did not show any difference in activity, but cats fed dry food had a higher day to night activity ratio.

Taken together, the studies support a potentially positive effect of high moisture diets on weight management, especially if fed multiple times a day, due to calorie dilution and potentially an effect on satiation. Moreover, some studies suggest that high moisture diets could increase physical activity and change activity patterns in cats, but this needs to be further elucidated.

Strategies to increase water intake in cats

Clinicians have to assess each situation to recommend the best method to promote water intake. Several strategies exist, discussed below, with the goal of providing adequate hydration status and/or a more dilute urine. Some of these methods can be combined if the goal not met with a single strategy.

Dietary modifications

Use of wet diets or adding water to dry food

The easiest way to promote water intake in cats is to use a wet diet. The moisture content is above 60%, and it can be as high as > 80%. This information is available on the label of wet foods⁸ (moisture is not always reported in dry foods). The very high moisture convalescence liquid diets indicated for tube feeding also help meet water requirements and not only provide nutrients and calories needed for recovery.

However, feeding wet diets is not always an option: not all cats like wet food and it can be very expensive for some clients. Some patients may require a specific diet for a comorbidity that only comes in dry. In these cases, adding water to the dry food is also an efficient option.

Using such diets does help in increasing water intake and decreasing USG, even though there is a high individual variation since water losses and water intake are affected by a variety of factors. Older study where diets varied in moisture but also other aspects did not see difference in water intake⁵. A controlled study offered the same dry diet, but with increasing water content, 6, 25.4, 56.2 and 73.3%²¹ found that total water intake was higher in the 73.3%, which also resulted in higher urine volume and lower USG. One of the studies that assessed the effect of dietary water on activity³³ found that the 82% moisture diet had higher total water intake, higher urine volume, and lower USG; with the diet with 70% water in second place. The only diet that gave an average USG below 1.030 was the one at 82% moisture. The dry diet resulted in the lowest water intake, urine volume and highest USG. The study from Deng and collaborators³¹ compared fecal water, urine volume and USG between cats fed the same diet as is (dry) or hydrated to 70% and found that the cats fed the hydrated diet had higher fecal and urinary outputs of water, and a lower USG (1.032 vs 1.053).

Therefore, if we are aiming to use water intake to promote a USG at or below 1.030, it is recommended to use a high moisture diet, either all canned (maybe with added water) or dry food plus water, at least one and a half cups of water per each cup of dry food, added very slowly over days to help with acceptance¹⁹. The amount of water added can be adjusted according to the target USG. In these cases, mixed feeding alone using dry and wet food will not be enough to get the USG where we want it. On the other hand, when the goal of increased water intake is to help with weight management, positive results have been reported with 40% dietary moisture, so a mixed feeding approach here can work.

Changing dietary composition

There are several dietary factors that affect urine volume and USG, besides water content of the diet, such as protein content and mineral type and concentration.^{3,5} Particularly, increased dietary sodium (>2.5 grams per 1000 kcal) has

been proposed to promote thirst and subsequent water intake and diuresis, although this strategy possible achieves less dilution compared to the addition of water to the diet and might be more limited in time.^{18,19} One short term study³⁴ fed 4 different diets with increasing amounts of salt (from 0.7 to 3.4 grams sodium per 1000 kcal) for one week and looked at RSS of struvite and calcium oxalate in healthy dogs and cats, and they observed an increase in water intake and urine volume with increasing dietary sodium, and also a lower RSS for both uroliths. Long term studies, the effect of such diets on RSS of stone former patients, and the effect of their use on clinical outcomes and recurrence is necessary to clarify the importance of this strategy on the management of urolithiasis in cats.

The use of sodium enriched diets is controversial. One study³⁵ found an increase in creatinine (that was reversible) in 4 aged cats fed a diet with 2.9 grams of sodium per 1000 kcal. These cats might have had some underlying renal impairment. However, longer term studies have not found adverse effects of such diets. One 6 month study³⁶ compared two diets differing in salt (1.4 vs 2.9 grams sodium per 1000 kcal) to mature cats (mean 7 years old) and did not see any differences in food intake, body weight, bone mineral content, hydration status, blood pressure, or markers of renal function.

Sodium enriched diets can be potentially helpful to promote water intake and urine dilution in patients with urolithiasis. Out of caution, this strategy should be avoided in patients with salt sensitive diseases like heart or kidney disease or hypertension. There is no data on the use of sodium enriched diets on weight management variables (energy intake or activity level). A study, of 2 years duration, also with healthy older cats, separated the cats into two groups only differing in salt content (1 vs 3.1 grams per 1000 kcal of sodium) and extensively investigated renal³⁷ and cardiovascular³⁸ health. There were no reported differences between the diets in the assessment of both systems, including in glomerular filtration rate and blood pressure.

Stimulation of drinking water intake

Water enriched diets stimulate water intake by increasing consumption via diet. Another way to increase total water intake is to act on the drinking water part of the equation. This can be done, as mentioned above, by modifying diet composition by increasing salt content, which will promote thirst, increased water intake but also by using different strategies to encourage cats to drink. The evidence we have on many of these strategies is lacking, but they are safe to implement and potentially can help. This is especially important in those cases where using high moisture diets is not resulting in the results we expect, especially regarding USG or prevention of dehydration. Offering nutrient enriched water⁴¹ may have similar effect on satiation, energy

intake and activity as what is seen in the studies done with water enriched diet, compared to increasing drinking water consumption.

Whatever the choice of water delivery system, care should be taken to ensure that the water is always fresh and clean, with regular cleaning and disinfection of the containers. A smaller, shallow container might be preferred. The water station should be in a different location from both food and litterboxes, in a quiet, odorless place. If the household has multiple cats, ensure all have access to water without having to compete for it.

Use of circulating water

It has been suggested that the use of flowing water might be preferred to still water in cats and suggesting a water fountain or similar device is common advice for cats where we want to promote water intake. However, two short term studies with a small number of animals did not see differences in drinking water intake comparing the use of fountains vs still water in client owned³⁹ or research cats⁴⁰, but cats may have individual preferences, so it is worth offering both options. In one survey of cat care givers¹¹, the humans perceived that the cat preferred the bowl to the fountain when both options were offered. Fountain filter needs to be changed regularly. Also, cat care givers must be cautious of electric connections in proximity to water.

Flavored water

The use of chicken broth (without garlic or onion) or tuna “water” could be added to the drinking water. Some cat owners also use lactose free milk or convalescence support liquids (or cow milk diluted in water). Unfortunately, published research is lacking on the effect and safety of adding such products to the water and the individual variability can be very high.

Nutrient enriched water

There are three published studies^{41,42,43} on the use of nutrient enriched water in healthy cats fed the same dry food. The initial study⁴¹ used 18 kennel-housed cats offered tap water for a week (baseline), and then separated into two groups, one fed tap water and the other a nutrient enriched water for 10 days. Afterwards, for additional 45 days, the treatment group was offered both tap and the nutrient enriched water

in separate bowls. The treatment cats had a higher liquid consumption when offered the nutrient enriched water, which was associated with higher mean urine output and lower USG and osmolality.

Additionally, an internal Nestlé study⁴⁴, based on a very similar protocol, demonstrate as well an increase of the total water intake and a decrease of the urinary osmolality when feeding a nutrient enriched water supplement to 22 healthy adult cats during 27 days.

These are very encouraging results and it will be very interesting to assess further research on this product in cats prone to dehydration or with FLUTD. This product provides some calories, even if a small amount, so adjustments should be made to the main diet to prevent undesirable weight gain.

ProPlan HC HydraCare

Purina® ProPlan® HC Hydracare™ is a complementary pet food, created based on the studies above, that offers additional water as a palatable soft textured liquid supplement. The idea is that served on its own, as an extra third bowl, will engage cats to lick the palatable formula to promote hydration and urine dilution. This new supplement has been demonstrated to significantly increase (p=0.03) the total water intake by 27% (in mL/d) than when water is offered alone, and to increase urine dilution⁴⁴.

1.1. Conclusion

Healthy cats are able to maintain an adequate hydration status within a wide range of water intake. However, in some cases, using strategies to promote water intake can be very helpful, such as in patients prone to dehydration, where high water losses result in higher water needs or in cases with impaired water intake like in anorectic patients. Growing evidence supports that promotion of water intake is also desirable in patients with lower urinary tract disease, such as urolithiasis and feline idiopathic cystitis and can also help with weight management. Promotion of water intake is especially important in cats, which are usually poor drinkers that tend to form a highly concentrated urine.

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Table 1: Maintenance energy requirements in adult cats in kcal per kilogram of metabolic body weight per day according to the National Research Council (NRC)² and the European Federation of Pet Food Manufacturers (FEDIAF)⁵

	NRC		FEDIAF
Lean cats	100 x Weight(kg) ^{0.67}	Neutered and/or indoor cats	52 – 75 x Weight(kg) ^{0.67}
Obese cats	130 x Weight(kg) ^{0.4}	Active cats	100 x Weight(kg) ^{0.67}

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EXTRA References

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