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Medical Nursing Case Challenges Mini Series

Session Three: Chronic Medical Challenges

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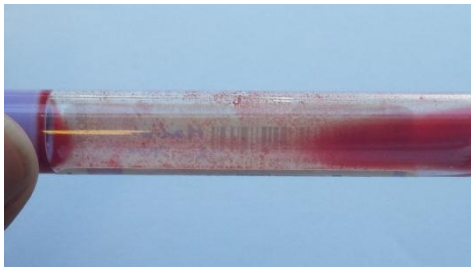

Urinary tract issues may result from a number of different aetiologies including infection, neoplasia, urolithiasis, neurological disorders, anatomic abnormalities and inflammatory conditions. The name Feline lower urinary tract disease (FLUTD) may not be wholly representative of the condition, the role that stress has on the urinary system is starting to become more fully understood. Of the feline patients seen in first opinion practice approximately 7% present with urinary disorders. With increases of the prevalence of risk factors such as obesity there is the potential that there will be more cases being presented.

Urine is a composite of a complex solution of both organic and inorganic ions. Crystals can grow and form when an imbalance occurs in this complex solution. There are several reasons that can cause these imbalances. Diet, decreased water consumption, urine pH alterations or relative lack of inhibitors of crystallisation can cause the solubility of a particular crystal to be exceeded. This result is crystal aggregation and growth. Clinical signs of FIC include haematuria, proteinuria, dysuria, polakiuria and/or urethral obstruction.[1] A full diagnostic work up is recommended in all cases, including blood work and imaging.

It is recommended that all cases are given advice on all aspects of husbandry. Dietary manipulation can aid in reducing the risk factors of uroliths, but there are many other factors that need to be taken in to consideration and addressed.

Nutrition.

Struvite crystals ($MgNH_4PO_4.6H_20$) are commonly seen in cats suffering from FIC. Dietary recommendations for these cats include avoiding excessive dietary protein, avoiding excessive levels of the minerals that are used within the crystals (magnesium and phosphorous), increasing water consumption. Urinary pH needs to be within the recommended urinary pH range, as the crystals form in an alkaline environment. A range of 5.9 to 6.1 is ideal for dissolution, whereas 6.2 to 6.4 is recommended for prevention. The average urinary pH of domestic cat consuming a natural diet (small rodents) is pH6.3. Acidifiers are used to prevent struvite uroliths. Cats receiving long-term dietary acidifiers can suffer from a transient negative potassium balance, with phosphoric acid and

ammonium chloride acidifiers. Long-term potassium depletion will stimulate ammonia synthesis at the same site as chronic metabolic acidosis. Acidifying therapeutic veterinary diets need to have potassium levels in excess of the NRC minimum allowance of 0.6% (DMB).[1] The use of urinary acidifiers alongside an acidifying food is not recommended, as it can lead to metabolic acidosis. The alterations in pH may increase the solubility of some of the solutes within the urine, and in some cases decrease the solubility of other. This complex and competing interplay between nutritional requirements of the management of oxalate and struvite urolithiasis requires a careful selection in the long-term dietary control of FIC.

Excessive levels of protein need to be avoided in cases where struvite crystals and alkaline urine is present. High protein level can influence pH; a prime example of this is the difference in urine pH between cats and dogs. Cats have higher protein consumption than dogs, and therefore an increased urinary pH. Increasing the protein level in the diet also increases urinary calcium excretion, uric acid and oxalate excretion. Excess dietary protein should be avoided by feeding cats a food that contains 30-45% DM protein.[1]

Diets that promote urinary tract health in cats do tend to have a higher fat content. This is due to the increased energy density which overall reduced mineral intake. When metabolised, fat produces the highest metabolic water contribution, which also benefits the animal. Due to the increased fat content some veterinary therapeutic diets are not available in a dry form. Obesity is a major risk factor of FIC, and a diet with a higher fat content may not be the indicated diet in this circumstance.

Cats that suffer from FIC and are overweight need to be placed on an obesity diet. Many of which have higher fibre content. The quantity of calcium being absorbed from the digestive system can be reduced by certain sources of dietary fibre. This can be beneficial with cats suffering from recurrent calcium oxalate urolithiasis.

Struvite precipitates form when the urine becomes supersaturated with magnesium, anionic phosphate and ammonium. Therapeutic diets avoid excess dietary magnesium, but low urinary magnesium concentrations have the potential to increase the risk of the formation of calcium containing uroliths. Highlighting the importance of regular urinalysis, when on a therapeutic urinary diet. The intake of magnesium and calcium also influences urinary phosphate concentrations.

The addition of sodium into the diet is occasionally utilised in order to aid in increased water intake. Increasing the salt content of the diet can aid in diuresis and lowers the urine specific gravity[2].

Water.

Water intake is a vital factor in cats with FIC or a predisposition to FIC. The solute load of the diet influences total water intake by a large factor. Use of a moist diet is preferred, and additional water can also be mixed in if required. Encouragement to increase the consumption of water can also be achieved by increasing access, by placing more bowls of water around the cat's environment. A choice over type and size of water bowls used needs to be considered. Cats can be deterred by the use of fresh tap water due to the chlorine content. Use of bottled, pre-boiled water or water that has been left to stand will have little or no chlorine that can be detected by the cat or dog.

Increases in water consumption will increase the total volume of urine produced. Crystals precipitate out into the urine when supersaturation occurs. Urine becomes saturated when the salt content completely dissolved within the fluid. Any additional salt or decrease in the relative fluid volume will result in precipitation of the salts, hence the requirement for large volumes of more dilute urine. Owners are recommended that the animal's urine should remain dilute and have no strong smell, most cat owners will have difficulty with this as most cats will urinate outside.

Urinalysis should be performed on a regular basis, at least every three to six months. Sediment analysis along with pH and specific gravity are all good indicators of overall health. FIC can result in haematuria and proteinuria. Fresh urine samples should be used when performing urinalysis. Samples obtained via cystocentesis should be used when obtaining samples for bacterial culture and sensitivity. Voided samples and those not examined immediately can have false positives for bacteria and crystalluria. Many owners will need guidance on how to obtain urine samples from their pets.

Feeding a cat with FIC.

The choice of diet is dependent on two factors, the body condition of the animal and results of the urinalysis. Correct identification of the type of crystals present (if any) and the pH of the urine is necessary. Use of a diet that promotes urinary health tends to be aimed to prevent struvite formation. Use of these diets in cats with a predisposition to calcium oxalate uroliths may increase the risk of urolith formation. A full dietary history of the cat is required, including any treats, supplement (especially if containing calcium) and whether or not the owner gives the cat milk. Both treats and processed human food (processed meats) are high in mineral levels, such as phosphorous, and should be avoided.

Use of a moist diet is preferable, as is *ad libitum* feeding. This might not be possible if the cat is overweight with this feeding scenario. When any animal consumes food, gastric acid is secreted and creates a temporary net acid loss from the body, and alkalisation of the urine. This is referred to as the postprandial alkaline tide. The alkaline tide is caused by secretion of bicarbonate into the blood by parietal cells of the stomach. A transient bicarbonisation is produced and increase urinary pH. Acidifiers in the diet will offset this increase in pH. If the diet is offered free choice (*ad libitum*), the cat will eat little and often. These feeding habits result in a smaller but more prolonged alkaline tide. This can reduce the likelihood of struvite precipitate formation.

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Nurse Know How: Urinary Catheter Management

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The need for indwelling urinary catheters varies depending on the patient's needs and requirements from the veterinary surgeon. Indications for urinary catheters can include urinary obstruction, urinary trauma, voiding disorders, urine diversion during or after surgery, and the need to monitor urine production.[1] Guidelines exist for urethral catheterisation in humans[2] and general principles from these have been adapted for urethral catheter management in canines and felines. It is vital that urethral catheters are placed in an aseptic manner, good nursing techniques being utilised, that antibiotics are not used prophylactically and that a closed urinary collection system is used to reduce the incidence of catheter-associated urinary tract infection (CAUTI).[2-4] Alterations in the normal structure of the lower urinary tract can make it easier for bacteria to adhere, grow, and create a probiofilm environment. Any event, such as placement of a urinary catheter, presence of stones or neoplasia, that causes trauma to the mucosal layer of the bladder and erodes the glycosaminoglycan layer can result in a disruption in the natural defences present in the lower urinary tract.[5] Natural mechanisms within the bladder have shown to clear induced urinary tract infections (UTIs) within 2 to 3 days, however, the presence of a surgically placed foreign object in the bladder caused animals to develop chronic urinary tract infections with a concurrent biofilm on the foreign object in less than 24 hours.[6]

Placement and management of urinary catheters therefore needs to be performed using aseptic technique, as introduction of bacteria can potentially occur and result in a nosocomial infection. During the placement of the catheter, all hair needs to be clipped away and the site cleaned with dilute chlorhexidine or iodine, with no application of alcohol. Individual sachets of lubricating gel should be used for the catheter placement, in addition to the use of sterile gloves. If no individual sachets of lubricating gel are available, a new (unbroached) tube of lubricating gel should be used.

Care of Urinary Catheter.

Before handling of the urinary catheter or urinary collection system, hands should always be washed (using the WHO technique) and gloves worn.[7] In dogs, it is also recommended to rinse the prepuce or vulva with warmed antimicrobial solution at the correct dilutions, at least every four hours.[7] The area needs to be completely dried following each rinse. The external catheter and the collection line should also be wiped down at the time. If there is gross contamination (e.g. faeces) the collection line should be replaced.

In male dogs, an abdominal dressing can be used to stop the dog from licking at the area. White or light-coloured dressings (***Figure 1***) should be used to indicate any early evidence of any strike through the bandage. In bitches, the urine collection system can be secured to the hind leg or tail, depending on breed.

In male cats, taping the urine collection system to the tail prevents direct pulling on the prepuce after the catheter has been sutured in place. Though if there has been a tail pull injury this needs to be avoided. In long haired cats reducing the length of the hair on the ventral aspect of the tail can prevent any from getting caught in the connection between the catheter and the collection system, (***Figure 2***). In the female cat, catheterisation is less frequently performed, the catheter can be sutured to the lip of the vulva, or if a Foley catheter used with balloon; with the urine collection system still being secured to the tail (unless a tail pull injury).

It is recommended to always use a closed urine-collection system to help quantify urine output and prevent urine leakage onto the skin or coat. Even when using a closed urine-collection system in cats, a litter tray should always be provided not only for stools that may be passed but also to allow cats to display their natural elimination behavior of burying. Closed urinary collection systems are used in human medicine owing to evidence suggesting that they result in reduced bacteriuria.[8] Although small animal studies directly comparing the use of open urine drainage with closed urinary collection systems are lacking, a 1981 study found that the incidence of bacteriuria in cats with indwelling urethral catheters was 56% in cats maintained with an open indwelling catheter,[9] and a more recent study using closed collection systems found that the probability of CAUTI after 24 h of catheterisation was 16.7% and increased to 33.3% after 48 h.[10] Closed urinary collection systems have the additional benefit that urine is diverted away from the body and contained, thereby preventing discomfort, urine scald and potential distress.

Management Protocol

The urinary catheter should be checked for occlusions and adequate urine output every 4 hours[7]. There is an increased likelihood of blockage in patients passing a large amount of debris in the urine, and therefore more regular checks may be required. This includes palpation of the bladder to ensure good drainage. If the bladder is firm and distended, there is a potential that the catheter is obstructed. The catheter can be slightly repositioned and collection system checked for any kinks.[11] Where there is a possibility for occlusions 0.9% sterile saline solution can be used to flush the catheter (***Figure 3***). It is imperative that aseptic technique is utilised and that the flush is connected directly to the catheter rather than through the collection system as this can introduce bacteria that have colonised in the collection system into the bladder. Likewise, urine should not be collected from the collection bag or urinary catheter for evaluation, as the presence of bacteria in the collection system may not reflect true infection if bacteriuria, culture, and susceptibility of urine should be performed.[7]

If a volume of fluid(s) is required to keep the catheter patent it needs to be subtracted from the volume of urine passed. Cats and dogs should be producing 1 to 2 mLs of urine per kilogram of body weight per hour when in a normovolaemic, normotensive state with adequate kidney function (***Figure 4***). Hands need to be washed and gloves should be worn at all times when attaching and disconnecting the urine-collection system.

As well as being checked for occlusions, animals that have urinary catheters in place need to have their bladder palpated in order to ensure that the organ does not become distended, thus ensuring the catheter is draining properly. Gentle manual compression of the bladder should produce drainage of urine. This can be done at the same time as flushing the catheter.

In some cases in which the catheter size might be too small for the size of the urethra, the animal might be able to pass urine around the catheter. It is essential that the catheter is neither too wide, which may exert pressure on the urethral mucosa, or too narrow, which may allow the patient to urinate around it and predispose to urinary leakage and urine scald on the adjacent skin. Of equal importance is the length. Ideally, the tip of the catheter should sit just within the lumen of the bladder. Shorter catheters will sit within the proximal urethra causing irritation and less efficient bladder drainage, whereas excessively long catheters may coil inside the bladder and cause irritation and possibly perforation.[12] The patient's bedding should be inspected for any urine leakage and the patient's coat checked for any dampness, whenever the patient is being checked for urine output every 4 hours.

Patients recovering from urethral obstruction will undergo post-obstructive diuresis. Careful monitoring of the volume of urine produced vs the volume of fluid intake is vital. Use of a fluid pump or burette will ensure that the clinician or nurse can accurately calculate fluids in and out and therefore adjust the volume of fluid administered in to prevent any dehydration. Closed collection systems should be utilised with drainage available through a distal port rather than the catheter connection site.[7] This evacuation port should be wiped down with dilute chlorhexidine before and after each use.

Management of the urinary catheter is an important aspect of nursing care. Prevention of nosocomial infections and urine scalds are exceptionally important; these can be avoided with good nursing management of the patient. Regular assessment balancing the risks and the benefits of keeping the urinary catheter should also be performed.[13]

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Nutritional Management of Canine Urolithiasis.

Abstract.

Urolithiasis in dogs can be a complex multifactorial disorder, and may require different approaches in order to aid in the reoccurrence of crystals and stones. Careful identification of the urolith present is required in order to make the best judgement regarding the type of management, surgical or medical. Medical management is based around the diet for the animal. Each urolith will have optimum management, but as many urolith can be comprised of a combination of different minerals a compromise may be required. Careful monitoring throughout is needed.

Key Words: Urolithiasis, canine, nutritional management, diet

Introduction.

Urolithiasis is considered to be a common disorder of the urinary tract in dogs.[1] With different breeds being more highly represented for certain uroliths than others. Breeds found to be significantly over-represented for calcium oxalate uroliths included the Chihuahua, miniature poodle and Yorkshire terrier. Staffordshire bull terriers and English bulldogs were at increased risk for cystine uroliths.[2]

Clinical signs of urolithiasis may be the first indication of underlying systemic disorder, or defect in the structure or function of the urinary tract. As with feline idiopathic cystitis (FIC), urolithiasis shouldn't be viewed as a single disease process, but rather as a sequel of underlying abnormalities. Examination of the urolith composition will aid in determining the aetiology. A full dietary history is required, along with blood serum biochemistry and urinalysis of the concentration of calculogenic mineral, crystallisation promoters and crystallisation inhibitors. Urinary diets for dogs (and cats) can be divided in to those, which promote dissolution through changing the pH of the urine and those, which act by diluting the concentration of the urine. In all cases, dietary management should only commence once obstruction (if present) has been resolved. The aim of the article is to look at the different nutritional managements that exist for the different canine uroliths that are seen in veterinary practice.

Nutritional Management.

Canine urolithiasis is a disorder that does need close monitoring long term due to the nature of reformation of crystals and stones. Dissolution and prevention of any future stones and crystals is the main aim of long term management, and this can be achieved by several means that can be monitored by veterinary nurses within a clinic setting. The other main aims are to:

- Decrease the amount of calculogenic materials, within the urine.
- Increase water intake, and frequency of urination.
- Promote an optimal pH; this is dependent on the urolith present.
- Help the animal obtain its ideal weight and body condition score (BCS).
- Perform regular urine and blood sampling, and ensure compliance from the owner
- Owner education in preventative measures.

Where dissolution of uroliths is possible with medical management (Table 1), this should be instigated rather than surgical intervention. There are several reasons for this, not all stones and crystals will be removed during a cystotomy and suture material can act as a nidus for further urolith formation. Calcium oxalate uroliths cannot be medically managed and will need surgical intervention.

Clinical Nutrition.

The nutrition recommended can alter slightly depending on the stone or crystal present, and therefore any clinical nutritional recommendations for specific stones are discussed separately. The consumption of water, however, is the same no matter which is present.

<u>Water.</u>

Water intake is a vital factor in dogs with, or those that have a predisposition to, canine urolithiasis. The solute load of the diet influences total water intake by a large factor, the same as with cats. The use of a moist diet can aid in increasing water consumption in some dogs, that don't drink enough. Adding additional water to the diet can be useful in some cases, but can alter the palatability of the diet for some. Encouragement to increase the consumption of water can also be achieved by increasing access, by placing more bowls of water around the dog's environment. Use of bottled, pre-boiled water or water that has been left to stand will have little or no chlorine that

can be detected by the dog. Some dogs will also play with/eat ice cubes, especially useful in the warm weather, or drink flavoured water. Fruit juices can be good, meat/broths can contains minerals and salts their use depends on the type of uroliths present, see Box 1.

Increases in water consumption will increase the total volume of urine produced. Crystals precipitate out into the urine when supersaturation occurs. Urine becomes saturated when the salt content completely dissolves within the fluid. Any additional salt or decrease in the relative fluid volume will result in precipitation of the salts, urine at this stage, is said to be supersaturated. Supersaturation of the urine is the initial stage of crystal urolith formations, (Figure 2). Although urine supersaturation is fundamental for urthogenesis, the whole process is a complex and multifactorial.[1] Veterinary professionals should are recommended that the animal's urine should remain dilute and have no strong smell. Bitch's urine does bleach/kill the grass where urination commonly occurs. This doesn't reflect that crystals or uroliths are present. The use of filtered water in hard water areas can aid in reducing the intake of minerals, such as calcium carbonate which is found in hard water areas. Many small breed dogs will urinate less frequently than larger breed dogs.[3] These breeds do need to be taken out more often to urinate. Access to the garden where the door if left open or a dog flap, may not ensure that the dog is urinating more frequently, and supervising the dog and giving the command to urinate may be more beneficial.[4]

Urate Urolithiasis.

Dalmatians have a high risk factor for recurrent urate uroliths (Figure 3), high enough that prophylactic therapy should be actively considered for this breed. Some texts state that Dalmatians are more susceptible as they lack the enzyme uricase, which converts uric acid to allantoin. Their urine therefore contains higher levels of urates than other breeds.[5] In other texts[6.7] uric acid metabolism is not caused by the absence of hepatic uricase. With uricase enzyme levels being comparable to that in other breeds. The cause has been attributed to the impaired transport of uric acid into the hepatocytes, which may reduce the rate of hepatic oxidation. Another factor can be attributed to the proximal renal tubules of Dalmatians reabsorbing less and secreting more urate than the kidneys of other breeds of dogs.[6]

Nutrition aims of dietary management of urate urolithiasis include:

- Restricting protein level.
- Increasing the source of non-protein calories.
- Promoting an alkaline urine pH.

Clinical Nutrition.

Proteins.

The protein levels in a diet designed to aid in urate urolithiasis can have overall restricted levels of proteins, (1.6-2.2g protein/100kcal Metabolisable Energy (ME)).[7] Especially those proteins, which contain larger amounts of nucleic acids, as they contain purines, e.g. protein from muscle or organ tissues. Milk proteins (casein), and eggs provide a suitable source, as they contain a lower amount of purines, but also have a high biological value, which is required when a restriction on protein levels is required in the diet. Box 1 gives a list of different foods that are high, medium and low purine content.

Allopurinol is a xanthine oxidase inhibitor, which reduces the rate of urate excretion into the urine. It decreases the production of uric acid by inhibiting the conversion of hypoxanthine to xanthine, and xanthine to uric acid. Allopurinol does need to be added to the diet when dissolution of urate uroliths is required, though checking the dietary manufacturers' guidelines is recommended. A dose rate of 15mg/kg PO bid should be utilised, though dose rate is dependent on the individual.[1]

Carbohydrates and Fats.

Due to the restriction in protein levels, it is important that there is a sufficient supply of non-protein calories. A higher than normal fat content can arise from this (20% DMB), and care should be given to weight control of the animal. The level of fats also aid in obtaining the preferred urine pH.

Vitamins and Minerals.

As with any disease or disorder which clinical symptoms include polyuria, the water-soluble vitamins should be supplemented. With urolithiasis however, vitamin C should not be supplemented as it is a precursor of oxalate, and can predispose of its formation.

The alkalising agent used in these diets is commonly potassium citrate and calcium carbonate. If the target urinary pH is not reached, then additional potassium citrate can be added to the diet at a starting dose rate of 50-100mg/kg bodyweight (bwt) PO bid, the amount given to effect.[7]

Struvite Uroliths.

Struvite uroliths in dogs, as in cats, are the most commonly occurring urolith in the UK and USA, though its incidence rate is decreasing.[6] Infection induced struvite uroliths are common in dogs and a positive culture result should prompt initiation of antimicrobial therapy alongside nutritional management. The bacteria present tend to be urease-producing *Staphylococci.*

Nutritional aims of dietary management of struvite uroliths include:

- The dissolution of uroliths within the bladder.
- Prevent the formation of reoccurring uroliths or crystals.
- Promote an acidic urine pH.
- Increasing water intake, and encouraging the dog to urinate more frequently.

Clinical Nutrition.

Proteins.

Restricted levels of protein are required (1.47g protein/100kcal ME)[1], but a high biological value is needed. When protein levels are this restricted is not advisable to be feed this diet in the long-term. The urine acidifying substance in diets designed for struvite dissolution is DL-methionine, used at a dose rate of 0.5g/kg of diet[1].

Carbohydrates.

The majority of calories obtained from the diet need to be obtained from a non-protein source. Thus, proportionately the carbohydrate and fat levels of the ME are increased in these diets.

Fats.

Struvite diets can have very high fat levels (~26% Dry Matter (DM)), so much so that in some brands only tinned formulas are available. Feeding diets with this high a fat content to dogs with

hyperlipidaemia, pancreatitis or even at risk groups (such as Schnauzers and Spaniels) is contraindicated.

Vitamins and Minerals.

Decreased amounts of phosphorous (24mg phosphorus/100kcal ME) and magnesium (3.3mg magnesium/100kcal ME) are present in diets designed to aid urinary tract issues, as these are the constituents of the struvite urolith[1]. Sodium levels are often increased in these diets, in order to increase water intake (23.3mg sodium/100kcal ME). The use of the antioxidants vitamin E and beta-carotene are often supplemented, as it helps to reduce oxidative damage, and helps to combat urolithiasis. As an oxalate precursor, vitamin C should not be supplemented when feeding diets designed for struvite dissolution.

Calcium Oxalate Uroliths.

Calcium oxalate uroliths are the second most commonly occurring uroliths in the dog.

Nutritional aims of dietary management include:

- Promoting an alkaline urinary pH.
- Reducing the amounts of calcium, sodium and oxalates within the diet.
- Increase water consumption, and the frequency of urination.

Clinical Nutrition.

Protein.

A low protein diet is required with levels of 1.6-2.2g/100kcal ME have been suggested[7], in cases where calcium oxalate uroliths are present.

Fats and Carbohydrates.

Non-protein calories are required in the diet, in order to prevent protein catabolism. Thus, levels of fats and carbohydrates are higher than normal, for example fat can be as high as 26% DMB, and carbohydrates 60% DMB. Weight management can be a problem in dogs, which are predisposed to weight gain.

Vitamins and Minerals.

Vitamins D and C should not be supplemented into the diet. Vitamin D increases the absorption of calcium from the diet, whereas vitamin C acts as a precursor to oxalates. The levels of calcium in the diet should be restricted, but not reduced, as with levels of sodium. Restricted calcium levels are approximately 0.68% DMB. Sodium increases calcium excretion into the urine, and a dietary level of 0.1-0.2% sodium DMB or 45-55mg sodium /100kcal ME is recommended.[7] The digestibility of the diet and the individual's absorption ability of vitamins and minerals will vary greatly, and thus monitoring of levels may be required.

Cystine Urolithiasis.

Cystine uroliths are uncommon in both cats and dogs, but arise due to a metabolic defect where the reabsorption of filtered cystine in the proximal tube is impaired.[8] Once in the urine cystine is very insoluble, especially in acidic urine.

Nutritional aims in the management of cystine uroliths include:

- Promoting an alkaline urine pH.
- Reducing the amount of cystine produced by the body.
- Increase water consumption and frequency of urination

Clinical Nutrition.

Protein.

A low protein diet is required (9-11% protein DM), as this will aid in the reduction of the total daily excretion of cystine[1].

Carbohydrates and Fats.

Due to the low levels of protein in the diet, calories have to be obtained from these nutrients. Care should be taken with the diet that are high in fats, similarly to that described in diet designed for struvite uroliths.

Vitamins and Minerals.

Low sodium levels are also required as sodium excretion can enhance cystine excretion. Low sodium in combination with low protein levels tends to increase the urine volume, which further decreases the urinary concentration of cystine.[7] In order to create an alkaline urine pH supplementation with potassium citrate (50-100mg /kg bwt PO bid) is required.

Silicate Uroliths.

These uroliths are more commonly seen in male dogs (96%) than females (4%).[1] Most likely due to females being able to pass smaller uroliths before they can induce clinical signs. Foods, which contain large amounts of plant-derived materials, are thought to be a predisposing factor for silicate uroliths. Another factor being the consumption of soil, as silica in the soil passes through to the plants and is readily absorbed via the intestines.

Dietary management of dogs suffering from silicate uroliths is in the prevention. Change of the diet to one, which, doesn't contain large amounts of plant-derived materials, and increases the volume of urine produced, are the main factors. Debate has arisen to the urinary pH levels; alkalisation of the urine in order to increase the solubility of silica is unknown.[9]

Feeding a Dog With Urolithiasis.

Nearly all diets aimed at dissolution or prevention of uroliths, are potentially high in fat levels, mainly due to the requirement for non-protein calories. Care should be given when transferring a dog over to these diets. Caution should also be given to those dogs, which are likely to gain weight, or those, which are predisposed to hyperlipidaemia or pancreatitis. Diarrhoea can occur when high fat levels are fed, and combination with a high fibre diet, which is aimed at urolith prevention, may be required.

Calculolytic diets are only successful when fed alone. Addition of treats and home-cooked foods can undo the desired effect of the diet. It is equally important that the urolith analysis is correct. Stones, which are of mixed composition, are difficult to dissolve and surgical removal may be the treatment of choice. In dogs suffering from struvite urolithiasis, if you have the suspicion that additional snacks or treats are being fed a blood sample analysis can be useful. In dogs being fed

certain veterinary struvite dissolution diets, a low plasma urea concentration of less than 4mmol/l (BUN 10mg/dl) is found[1]. Above this levels suggests additional feeding.

Monitoring of dogs suffering from urolithiasis is vital, this includes body weight and body condition. A full nutritional assessment should be performed on every pet at every visit (WSAVA Nutritional Assessment Guidelines, 2012). Urinalysis should be performed at least every six months once dissolution has occurred. Preventative measures involve feeding a diet, which promotes the correct urine pH, promotes undersaturation of the urine, provide calories from a non-protein source and is relatively low in salts that are the building blocks for the uroliths that the animal suffers from.

Conclusion.

Dogs that have suffered with any form of urolithiasis needs to have regular urinalysis whilst on the diet, including pH and microscopy performed. Client education can be key in prevention in at risk breeds, and those that are over their ideal BCS. This includes increasing water intake as much as possible in all groups, and the frequency of urination.

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Type of Urolith	Urinary pH during formation	Target urinary pH	Treatment
Struvite	Alkaline	5.9-6.3	Calculolytic diet or surgical removal
Calcium oxalate	Variable but usually acidic	7.1-7.7	Surgical removal
Ammonium urate	Acidic	7.1-7.7	Calculolytic diet and allopurinol
Cystine	Acidic	7.1-7.7	Calculolytic diet or surgical removal
Silicate	Usually acidic	7.1-7.7	Surgical removal

Table 1: Urolith formations and treatments, with urinary pH preferences[2].

Figure 1: Calcium Oxolate stones need to be surgically removed.

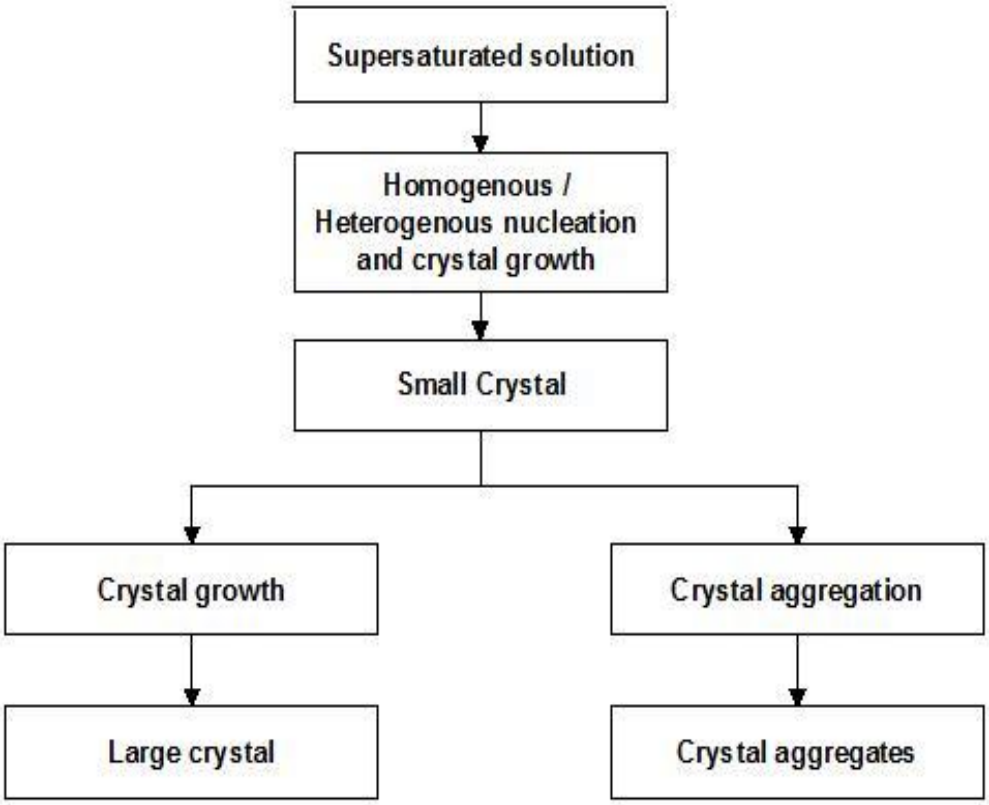

Figure 2: Supersaturation leads to crystal growth and aggregation.

Figure 3: Uric acid stones

Box 1:

The following foods are low in purine.

- Eggs, nuts, and peanut butter
- Low-fat and fat free cheese and ice cream
- Skim or 1% milk
- Soup made without meat extract or broth
- Vegetables that are not on the medium-purine list below
- All fruit and fruit juices
- Bread, pasta, rice, cake, cornbread, and popcorn
- Water, soda, tea, coffee, and cocoa
- Sugar, sweets, and gelatin
- Fat and oil

Medium-purine foods:

- **Meats:** Limit the following to 100-150g (4-6oz) each day.
    - Meat and poultry
    - Crab, lobster, oysters, and shrimp
- **Vegetables:** Limit the following vegetables to ½ cup each day.
    - Asparagus
    - Cauliflower
    - Spinach
    - Mushrooms
    - Green peas

- Beans, peas, and lentils
- Oats and oatmeal
- Wheatgerm and bran

 High-purine foods: Limit or avoid foods high in purine.

- Anchovies, sardines, scallops, and mussels
- Tuna, codfish, herring, and haddock

- Wild game meats, like goose and duck
- Organ meats, such as brains, heart, kidney, liver, and sweetbreads
- Gravies and sauces made with meat
- Yeast extracts taken in the form of a supplement

Nutritional Management of Canine Urolithiasis.

Abstract.

Urolithiasis in dogs can be a complex multifactorial disorder, and may require different approaches in order to aid in the reoccurrence of crystals and stones. Careful identification of the urolith present is required in order to make the best judgement regarding the type of management, surgical or medical. Medical management is based around the diet for the animal. Each urolith will have optimum management, but as many urolith can be comprised of a combination of different minerals a compromise may be required. Careful monitoring throughout is needed.

Key Words: Urolithiasis, canine, nutritional management, diet

Introduction.

Urolithiasis is considered to be a common disorder of the urinary tract in dogs.[1] With different breeds being more highly represented for certain uroliths than others. Breeds found to be significantly over-represented for calcium oxalate uroliths included the Chihuahua, miniature poodle and Yorkshire terrier. Staffordshire bull terriers and English bulldogs were at increased risk for cystine uroliths.[2]

Clinical signs of urolithiasis may be the first indication of underlying systemic disorder, or defect in the structure or function of the urinary tract. As with feline idiopathic cystitis (FIC), urolithiasis shouldn't be viewed as a single disease process, but rather as a sequel of underlying abnormalities. Examination of the urolith composition will aid in determining the aetiology. A full dietary history is required, along with blood serum biochemistry and urinalysis of the concentration of calculogenic mineral, crystallisation promoters and crystallisation inhibitors. Urinary diets for dogs (and cats) can be divided in to those, which promote dissolution through changing the pH of the urine and those, which act by diluting the concentration of the urine. In all cases, dietary management should only commence once

obstruction (if present) has been resolved. The aim of the article is to look at the different nutritional managements that exist for the different canine uroliths that are seen in veterinary practice.

Nutritional Management.

Canine urolithiasis is a disorder that does need close monitoring long term due to the nature of reformation of crystals and stones. Dissolution and prevention of any future stones and crystals is the main aim of long term management, and this can be achieved by several means that can be monitored by veterinary nurses within a clinic setting. The other main aims are to:

- Decrease the amount of calculogenic materials, within the urine.
- Increase water intake, and frequency of urination.
- Promote an optimal pH; this is dependent on the urolith present.
- Help the animal obtain its ideal weight and body condition score (BCS).
- Perform regular urine and blood sampling, and ensure compliance from the owner
- Owner education in preventative measures.

Where dissolution of uroliths is possible with medical management (Table 1), this should be instigated rather than surgical intervention. There are several reasons for this, not all stones and crystals will be removed during a cystotomy and suture material can act as a nidus for further urolith formation. Calcium oxalate uroliths cannot be medically managed and will need surgical intervention.

Clinical Nutrition.

The nutrition recommended can alter slightly depending on the stone or crystal present, and therefore any clinical nutritional recommendations for specific stones are discussed separately. The consumption of water, however, is the same no matter which is present.

<u>Water.</u>

Water intake is a vital factor in dogs with, or those that have a predisposition to, canine urolithiasis. The solute load of the diet influences total water intake by a large factor, the same as with cats. The use of a moist diet can aid in increasing water consumption in some dogs, that don't drink enough. Adding additional water to the diet can be useful in some cases, but can alter the palatability of the diet for some. Encouragement to increase the consumption of water can also be

achieved by increasing access, by placing more bowls of water around the dog's environment. Use of bottled, pre-boiled water or water that has been left to stand will have little or no chlorine that can be detected by the dog. Some dogs will also play with/eat ice cubes, especially useful in the warm weather, or drink flavoured water. Fruit juices can be good, meat/broths can contains minerals and salts their use depends on the type of uroliths present, see Box 1.

Increases in water consumption will increase the total volume of urine produced. Crystals precipitate out into the urine when supersaturation occurs. Urine becomes saturated when the salt content completely dissolves within the fluid. Any additional salt or decrease in the relative fluid volume will result in precipitation of the salts, urine at this stage, is said to be supersaturated. Supersaturation of the urine is the initial stage of crystal urolith formations, (Figure 2). Although urine supersaturation is fundamental for urthogenesis, the whole process is a complex and multifactorial.[1] Veterinary professionals should are recommended that the animal's urine should remain dilute and have no strong smell. Bitch's urine does bleach/kill the grass where urination commonly occurs. This doesn't reflect that crystals or uroliths are present. The use of filtered water in hard water areas can aid in reducing the intake of minerals, such as calcium carbonate which is found in hard water areas. Many small breed dogs will urinate less frequently than larger breed dogs.[3] These breeds do need to be taken out more often to urinate. Access to the garden where the door if left open or a dog flap, may not ensure that the dog is urinating more frequently, and supervising the dog and giving the command to urinate may be more beneficial.[4]

Urate Urolithiasis.

Dalmatians have a high risk factor for recurrent urate uroliths (Figure 3), high enough that prophylactic therapy should be actively considered for this breed. Some texts state that Dalmatians are more susceptible as they lack the enzyme uricase, which converts uric acid to allantoin. Their urine therefore contains higher levels of urates than other breeds.[5] In other texts[6.7] uric acid metabolism is not caused by the absence of hepatic uricase. With uricase enzyme levels being comparable to that in other breeds. The cause has been attributed to the impaired transport of uric acid into the hepatocytes, which may reduce the rate of hepatic oxidation. Another factor can be attributed to the

proximal renal tubules of Dalmatians reabsorbing less and secreting more urate than the kidneys of other breeds of dogs.[6]

Nutrition aims of dietary management of urate urolithiasis include:

- Restricting protein level.
- Increasing the source of non-protein calories.
- Promoting an alkaline urine pH.

Clinical Nutrition.

Proteins.

The protein levels in a diet designed to aid in urate urolithiasis can have overall restricted levels of proteins, (1.6-2.2g protein/100kcal Metabolisable Energy (ME)).[7] Especially those proteins, which contain larger amounts of nucleic acids, as they contain purines, e.g. protein from muscle or organ tissues. Milk proteins (casein), and eggs provide a suitable source, as they contain a lower amount of purines, but also have a high biological value, which is required when a restriction on protein levels is required in the diet. Box 1 gives a list of different foods that are high, medium and low purine content.

Allopurinol is a xanthine oxidase inhibitor, which reduces the rate of urate excretion into the urine. It decreases the production of uric acid by inhibiting the conversion of hypoxanthine to xanthine, and xanthine to uric acid. Allopurinol does need to be added to the diet when dissolution of urate uroliths is required, though checking the dietary manufacturers' guidelines is recommended. A dose rate of 15mg/kg PO bid should be utilised, though dose rate is dependent on the individual.[1]

Carbohydrates and Fats.

Due to the restriction in protein levels, it is important that there is a sufficient supply of non-protein calories. A higher than normal fat content can arise from this (20% DMB), and care should be given to weight control of the animal. The level of fats also aid in obtaining the preferred urine pH.

Vitamins and Minerals.

As with any disease or disorder which clinical symptoms include polyuria, the water-soluble vitamins should be supplemented. With urolithiasis however, vitamin C should not be supplemented as it is a precursor of oxalate, and can predispose of its formation.

The alkalising agent used in these diets is commonly potassium citrate and calcium carbonate. If the target urinary pH is not reached, then additional potassium citrate can be added to the diet at a starting dose rate of 50-100mg/kg bodyweight (bwt) PO bid, the amount given to effect.[7]

Struvite Uroliths.

Struvite uroliths in dogs, as in cats, are the most commonly occurring urolith in the UK and USA, though its incidence rate is decreasing.[6] Infection induced struvite uroliths are common in dogs and a positive culture result should prompt initiation of antimicrobial therapy alongside nutritional management. The bacteria present tend to be urease-producing *Staphylococci.*

Nutritional aims of dietary management of struvite uroliths include:

- The dissolution of uroliths within the bladder.
- Prevent the formation of reoccurring uroliths or crystals.
- Promote an acidic urine pH.
- Increasing water intake, and encouraging the dog to urinate more frequently.

Clinical Nutrition.

Proteins.

Restricted levels of protein are required (1.47g protein/100kcal ME)[1], but a high biological value is needed. When protein levels are this restricted is not advisable to be feed this diet in the long-term. The urine acidifying substance in diets designed for struvite dissolution is DL-methionine, used at a dose rate of 0.5g/kg of diet[1].

Carbohydrates.

The majority of calories obtained from the diet need to be obtained from a non-protein source. Thus, proportionately the carbohydrate and fat levels of the ME are increased in these diets.

Fats.

Struvite diets can have very high fat levels (~26% Dry Matter (DM)), so much so that in some brands only tinned formulas are available. Feeding diets with this high a fat content to dogs with hyperlipidaemia, pancreatitis or even at risk groups (such as Schnauzers and Spaniels) is contraindicated.

Vitamins and Minerals.

Decreased amounts of phosphorous (24mg phosphorus/100kcal ME) and magnesium (3.3mg magnesium/100kcal ME) are present in diets designed to aid urinary tract issues, as these are the constituents of the struvite urolith[1]. Sodium levels are often increased in these diets, in order to increase water intake (23.3mg sodium/100kcal ME). The use of the antioxidants vitamin E and beta-carotene are often supplemented, as it helps to reduce oxidative damage, and helps to combat urolithiasis. As an oxalate precursor, vitamin C should not be supplemented when feeding diets designed for struvite dissolution.

Calcium Oxalate Uroliths.

Calcium oxalate uroliths are the second most commonly occurring uroliths in the dog.

Nutritional aims of dietary management include:

- Promoting an alkaline urinary pH.
- Reducing the amounts of calcium, sodium and oxalates within the diet.
- Increase water consumption, and the frequency of urination.

Clinical Nutrition.

Protein.

A low protein diet is required with levels of 1.6-2.2g/100kcal ME have been suggested[7], in cases where calcium oxalate uroliths are present.

Fats and Carbohydrates.

Non-protein calories are required in the diet, in order to prevent protein catabolism. Thus, levels of fats and carbohydrates are higher than normal, for example fat can be as high as 26% DMB, and carbohydrates 60% DMB. Weight management can be a problem in dogs, which are predisposed to weight gain.

Vitamins and Minerals.

Vitamins D and C should not be supplemented into the diet. Vitamin D increases the absorption of calcium from the diet, whereas vitamin C acts as a precursor to oxalates. The levels of calcium in the diet should be restricted, but not reduced, as with levels of sodium. Restricted calcium levels are approximately 0.68% DMB. Sodium increases calcium excretion into the urine, and a dietary level of 0.1-0.2% sodium DMB or 45-55mg sodium /100kcal ME is recommended.[7] The digestibility of the diet and the individual's absorption ability of vitamins and minerals will vary greatly, and thus monitoring of levels may be required.

Cystine Urolithiasis.

Cystine uroliths are uncommon in both cats and dogs, but arise due to a metabolic defect where the reabsorption of filtered cystine in the proximal tube is impaired.[8] Once in the urine cystine is very insoluble, especially in acidic urine.

Nutritional aims in the management of cystine uroliths include:

- Promoting an alkaline urine pH.
- Reducing the amount of cystine produced by the body.
- Increase water consumption and frequency of urination

Clinical Nutrition.

Protein.

A low protein diet is required (9-11% protein DM), as this will aid in the reduction of the total daily excretion of cystine[1].

Carbohydrates and Fats.

Due to the low levels of protein in the diet, calories have to be obtained from these nutrients. Care should be taken with the diet that are high in fats, similarly to that described in diet designed for struvite uroliths.

Vitamins and Minerals.

Low sodium levels are also required as sodium excretion can enhance cystine excretion. Low sodium in combination with low protein levels tends to increase the urine volume, which further decreases the urinary concentration of cystine.[7] In order to create an alkaline urine pH supplementation with potassium citrate (50-100mg /kg bwt PO bid) is required.

Silicate Uroliths.

These uroliths are more commonly seen in male dogs (96%) than females (4%).[1] Most likely due to females being able to pass smaller uroliths before they can induce clinical signs. Foods, which contain large amounts of plant-derived materials, are thought to be a predisposing factor for silicate uroliths. Another factor being the consumption of soil, as silica in the soil passes through to the plants and is readily absorbed via the intestines.

Dietary management of dogs suffering from silicate uroliths is in the prevention. Change of the diet to one, which, doesn't contain large amounts of plant-derived materials, and increases the volume of urine produced, are the main factors. Debate has arisen to the urinary pH levels; alkalisation of the urine in order to increase the solubility of silica is unknown.[9]

Feeding a Dog With Urolithiasis.

Nearly all diets aimed at dissolution or prevention of uroliths, are potentially high in fat levels, mainly due to the requirement for non-protein calories. Care should be given when transferring a dog over to

these diets. Caution should also be given to those dogs, which are likely to gain weight, or those, which are predisposed to hyperlipidaemia or pancreatitis. Diarrhoea can occur when high fat levels are fed, and combination with a high fibre diet, which is aimed at urolith prevention, may be required.

Calculolytic diets are only successful when fed alone. Addition of treats and home-cooked foods can undo the desired effect of the diet. It is equally important that the urolith analysis is correct. Stones, which are of mixed composition, are difficult to dissolve and surgical removal may be the treatment of choice. In dogs suffering from struvite urolithiasis, if you have the suspicion that additional snacks or treats are being fed a blood sample analysis can be useful. In dogs being fed certain veterinary struvite dissolution diets, a low plasma urea concentration of less than 4mmol/l (BUN 10mg/dl) is found[1]. Above this levels suggests additional feeding.

Monitoring of dogs suffering from urolithiasis is vital, this includes body weight and body condition. A full nutritional assessment should be performed on every pet at every visit (WSAVA Nutritional Assessment Guidelines, 2012). Urinalysis should be performed at least every six months once dissolution has occurred. Preventative measures involve feeding a diet, which promotes the correct urine pH, promotes undersaturation of the urine, provide calories from a non-protein source and is relatively low in salts that are the building blocks for the uroliths that the animal suffers from.

Conclusion.

Dogs that have suffered with any form of urolithiasis needs to have regular urinalysis whilst on the diet, including pH and microscopy performed. Client education can be key in prevention in at risk breeds, and those that are over their ideal BCS. This includes increasing water intake as much as possible in all groups, and the frequency of urination

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Cystine	Acidic	7.1-7.7	Calculolytic diet or surgical removal
Silicate	Usually acidic	7.1-7.7	Surgical removal

Table 1: Urolith formations and treatments, with urinary pH preferences[2].

Figure 1: Calcium Oxolate stones need to be surgically removed.

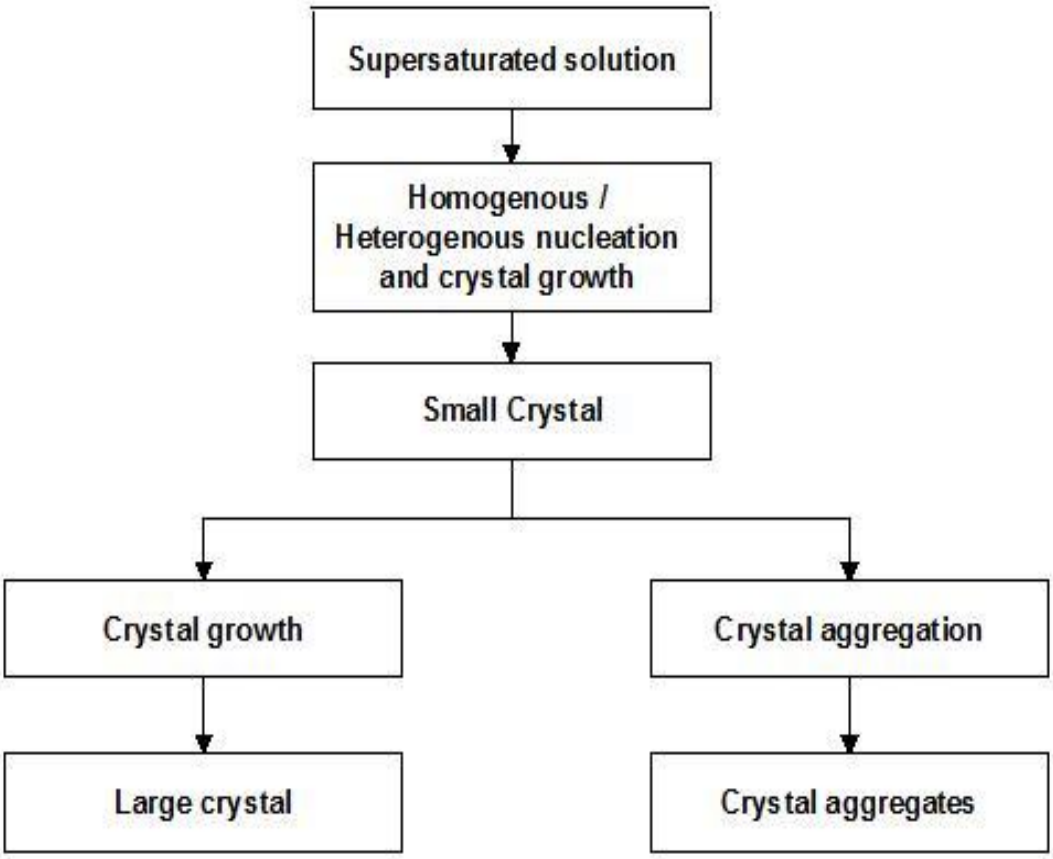

Figure 2: Supersaturation leads to crystal growth and aggregation.

Figure 3: Uric acid stones

Box 1:

The following foods are low in purine.

- Eggs, nuts, and peanut butter
- Low-fat and fat free cheese and ice cream
- Skim or 1% milk
- Soup made without meat extract or broth
- Vegetables that are not on the medium-purine list below
- All fruit and fruit juices
- Bread, pasta, rice, cake, cornbread, and popcorn
- Water, soda, tea, coffee, and cocoa
- Sugar, sweets, and gelatin
- Fat and oil

Medium-purine foods:

- **Meats:** Limit the following to 100-150g (4-6oz) each day.
    - Meat and poultry
    - Crab, lobster, oysters, and shrimp
- **Vegetables:** Limit the following vegetables to ½ cup each day.
    - Asparagus
    - Cauliflower
    - Spinach
    - Mushrooms
    - Green peas

- Beans, peas, and lentils
- Oats and oatmeal
- Wheatgerm and bran

 High-purine foods: Limit or avoid foods high in purine.

- Anchovies, sardines, scallops, and mussels
- Tuna, codfish, herring, and haddock

- Wild game meats, like goose and duck
- Organ meats, such as brains, heart, kidney, liver, and sweetbreads
- Gravies and sauces made with meat
- Yeast extracts taken in the form of a supplement