Preventing stones and managing them once you get them

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"An ounce of prevention is better than a pound of cure"

If you have had kidney stones, you are at an increased risk of getting them again (50% within 5 years and 90% in your lifetime). It's important to find out why kidney stones have formed so that you can prevent them from happening again.

According to the recent Canadian Urological Association Guidelines, if you have kidney stones, you should have the following tests: stone analysis, urinalysis and blood testing.

You will be asked to strain the urine using filters to catch stones that are passed spontaneously. These stone fragments are analyzed to determine their composition and the type of stone. A small sample of voided urine is also obtained for urinalysis, which is important to determine the pH of the urine or the level of acidity or alkalinity of urine.

Furthermore, red blood cells, white blood cells, glucose, or protein provide a snapshot of your urine at a particular time point – this is a valuable screening tool for urinary tract infections, kidney disease, and other conditions, such as diabetes.

Blood tests are done to measure serum electrolytes, such as sodium, potassium, chloride, bicarbonate, calcium and phosphorus, in addition to serum creatinine and uric acid.

Stone analysis, urinalysis and blood tests form the limited metabolic stone evaluation of all patients who present with kidney stones.

If this is your first experience with kidney stones, your doctor will likely advise you to follow dietary recommendations (listed later).

Your doctor will need to conduct a detailed metabolic stone evaluation if you've had recurrent or multiple bilateral kidney stones, single or abnormally shaped or located kidneys, strong family history of kidney stones, recurrent bone fractures or osteoporosis, recurrent urinary tract infections, renal impairment, and history of gout or inflammatory bowel disease, such as Crohn's or ulcerative colitis, non-calcium containing stone types, such as uric acid and cystine stones.

Moreover, children and pregnant women who form stones need a detailed metabolic evaluation.

Finally, patients in critical occupations, such as airline pilots, firemen, sailors and military personnel, need a detailed metabolic evaluation to identify risk factors and reduce risk of recurrences. In addition to stone analysis, urinalysis and blood tests, the detailed metabolic evaluation also includes two 24-hour urine collections that are used to measure 24-hour urinary excretions of metabolites in the urine that influence kidney stone production. These metabolites may include creatinine, calcium, sodium, oxalate, citrate, uric acid, phosphate, magnesium, and urea nitrogen. Most importantly, the 24-hour urine collections are used to measure the volume to assess whether the patient has adequate urine output per 24-hour. We'll look more into this below.

Why do patients with recurrent stones need 24-hour collections?

As we have talked about, kidney stones have a tendency to come back, unless the underlying cause is identified and treated. This can now be accomplished in most cases with a detailed metabolic evaluation, which includes the 24-hour collections. These preventive measures usually begin with specific dietary changes, with nutritional supplements and medications added to correct the underlying metabolic abnormalities.

Advances in the field of blood and urinary chemical analysis and computerized evaluation of laboratory data can be expected to find at least one correctable or treatable risk factor in over 80% of patients with stone disease. While on therapy, you are less likely to develop new stones and existing stones may take longer to grow and may be more likely to pass spontaneously. Not all stones are easily removed, fragmented or treated; any help in reducing the chance of stone formation would benefit you.

Today, general advice to prevent stones, such as limiting dietary calcium in calcium stone disease, is no longer enough. In fact, eliminating calcium from the diet can actually increase your risk of developing further calcium stones and osteoporosis. Other problems with oxalate, citrate, magnesium, and uric acid go undiagnosed and untreated unless comprehensive chemical studies are performed to identify them. So, correctly identifying any underlying abnormalities will avoid inappropriate treatment and prevent unnecessary complications.

Stone prevention has not always been considered important and some doctors would rather treat new stones as they form rather than stop them from developing in the first place. Some think a metabolic evaluation is too difficult, complicated and expensive. None of these arguments are sound or correct.

National and American bodies (like the Canadian Urological Association [CUA] and the National Institutes of Health) agree that metabolic testing and preventive therapy are best for the patient and that doctors should discuss options with their patients.

The 24-hour urine collections

CUA recommends performing two 24-hour urine collections with the patient on a normal, regular diet. This is done to check for any metabolic abnormalities and to develop a personalized strategy for each patient on how to prevent kidney stones.

A third 24-hour collection may be collected one week later with the patient on a restricted diet for calcium, sodium, and oxalate to better assess if the patient has any problems with excess excretion of calcium in the urine.

For the initial detailed metabolic stone evaluation, you will be asked to stop taking any supplements or medications that may affect the results during the two days that urine is being collected. These supplements/medications include antacids, diuretics and calcium supplements in addition to vitamins C and D. Check with your doctor first before temporarily discontinuing any medications during the urine collection.

How to perform 24-hour urine collections

There is no discomfort with this test. It involves collecting your urine during normal urination.

The urine collections are part of your care and they should be accurate. Important health decisions depend on it. ***The test is valid only if the collection includes ALL the urine you pass in a 24-hour period.*** The test will be inaccurate and may have to be repeated if, for any reason, some of the urine you pass during the 24-hour period is not put into the collection container or if more than 24 hours of urine is collected in one container.

If the tests require different preservatives, you will need to collect urine in separate 24-hour periods. A special container is provided for this purpose, which is returned to the lab after you have finished the urine collection at home. You will be given container(s) for each 24-hour urine collection. These containers come in a variety of shapes and colours, but most are 3-litre (L) capacity and are coloured (to protect light-sensitive preservatives inside the container). When a preservative is required, it should be added to the collection container before the urine collection begins and warning labels should be placed on the container. Be sure to check with the lab to ensure you have the proper containers and preservatives.

How do I prepare for these 24-hour urine collections?

1. You will be given a urine collection container (a urinal for males, a "hat" for females), a urine storage container and a name tag. You may need more than one storage container to collect all of your urine for the 24-hour period.
2. Make sure each storage container has a name tag with your full name and identification number written on it. ***If your container is not labelled properly, you may be asked to repeat the 24-hour collection.***
3. Keep your storage container refrigerated (at 4°C) throughout the 24-hour collection period until you bring it back to the lab. If you do not have access to a fridge, keep your collection on ice or in a cooler.
4. If you need a double container, preservative or if there are special instructions to follow, the lab, your doctor or nurse will tell you.
5. If you are staying at the hospital during your 24-hour urine collection, your nurse will make sure your container is labelled correctly and show you where to keep your storage container.

What is the procedure?

- You should collect every drop of urine during each 24-hour period. It doesn't matter how much or how little there is, as long as every drop is collected.
- Please DO NOT void directly into the 24-hour urine bottle as the container may have a preservative added which may be corrosive and may harm your skin. In case of contact with skin, flush the affected skin with plenty of water.
- On the morning of the first collection, empty your bladder regularly and flush it down the toilet. Note the exact time (e.g., 6:45 am). You will begin the urine collection at this time.
- Collect every drop of urine during the day and night in an empty collection bottle. Store the bottle at room temperature or in the refrigerator.
- If you need to have a bowel movement, any urine passed with the bowel movement should be collected. Try not to include feces with the urine collection. If the sample gets contaminated by feces, don't try to remove the feces from the urine collection bottle.
- Finish by collecting the first urine passed the next morning, adding it to the collection bottle. This should be within 10 minutes before or after the time of the first morning void on the first day (which was flushed). For example, you would try to void between 6:35 and 6:55 am on the second day (based on our example above, with the first urination at 6:45 am).
- If you need to urinate 1 hour before the final collection time, drink a full glass of water so that you can void again at the appropriate time. If you have to urinate 20 minutes before, try to hold the urine until the proper time.
- Note the exact time of the final collection, even if it is not the same time as when collection began on day 1.
- Indicate the date and time started and the date and time you finished. You also need to indicate your weight, which is used for certain calculations.

Date Started:	Time Started:	am
Date Finished:	Time Finished:	am

- Bring the urine to the lab as soon as possible. To prevent leaks, make sure the lid is on tightly, and that the container is transported upright inside a plastic bag. If the weather is warm and you must travel a long distance, transport your urine container on ice or in a cooler.
- If you have questions about the procedure, please ask. The lab, your nurse or doctor should be able to assist you.

What if . . . ?

What if I filled up the container the lab provided, but my 24-hour-collection is not yet complete?

Use a very clean glass or plastic container to continue collecting your urine. Your coloured container protects the collected urine from light, so if you have to use a transparent collection bottle, be sure to guard it from the light along with keeping it chilled. Using an ice chest would be good in this case–if that's not possible, cover the transparent container with a brown paper bag to protect it from the light. When you return your sample to the lab, keep the transparent container in a brown paper bag, or a similar technique to keep it protected from the light.

What if I started the 24-hour-collection, but have to leave the house for several hours?

Take a backpack with you, a plastic bottle with a secure lid, and a large ziplock bag full of ice. This will allow you to carry your collection items discreetly. For ladies, a wide-mouthed plastic container will allow you to urinate and pour the sample into your capped bottle. Your ziplock bag of ice will help keep your sample cool while you are on the go. This may be cumbersome, but necessary to perform the test correctly. *Remember this test will help your doctors come up with a personal strategy to prevent further kidney stones.*

What if I have urinary catheters?

It would be preferable to start your collection with a fresh catheter bag in place–if that's not possible, it would be nice to clean the existing bag, at least remove the bag from the catheter and rinse it out well. *Begin your collection by completely emptying the current catheter bag and flushing the accumulated urine.* Record this as your start time. During the remainder of the 24-hour-collection period, empty the Foley bag into the coloured collection jugs at regular intervals and keep the collection jugs in the refrigerator or in an ice bath just as anyone else would do. At the designated stop time, empty your collection bag for the last time.

What if urine becomes mixed with feces or blood?

Do not empty any urine that has been contaminated by feces or menstrual blood into your collection jug. Make note of the time and stop the collection. Contact your lab or doctor to inform them. In some cases, if enough time has elapsed (12 hours or more), your doctor may give the go-ahead to stop the test early. You may be asked to start all over again.

What if I am incontinent (cannot hold my urine)?

If your doctor did not realize or remember that you struggle with complete or partial incontinence, don't be shy to let your doctor know. Perhaps the 24-hour-test will be impossible because of complete incontinence; perhaps your doctor may recommend a bladder catheter for the test, or perhaps may allow a shorter period of time (12-hours or thereabouts) for the urine collection.

Oops! I didn't collect every voided urine during the 24 hours

If you forget to collect all of your urine, the test results may be inaccurate. Talk to your lab or doctor's office before disposing of all that you've collected. If you have already completed at least 12 hours of the urine collection, mark down the time of the last urination and keep your container on ice or in the refrigerator.

Tell your doctor or the lab about what you *have* been able to collect. They should be able to use your sample and calculate the important information based on the number of hours you have collected–but it's important that they know the correct number of hours when you turn in the sample. You may have to start all over again, but there's a good chance that they can use what you've collected and make adjustments to correctly calculate the results.

Why keep the urine specimen on ice?

The ice bath is just a technique for keeping the urine cool enough so that bacterial growth doesn't overwhelm your specimen. The ice bath should keep your specimen in the 40–45 degree Farenheit (4°C) range as would your refrigerator. Keeping a 24-hour-specimen in the refrigerator can be awkward and inconvenient. Having your specimen container in the bathroom "on ice" can be much easier and more convenient.

If you have other questions, call your doctor's office or lab.

How is this information used?
What are possible results of the 24-hour urine collections?

Suboptimal urine volume

The volume and composition of normal urine vary widely from day to day because of differences in fluid intake and fluid losses. The environment (hot weather) and exercise affect this. The daily urine volume averages 1.5 L (about 1.6 quarts) with a range of 0.5 to 2.5 L. The most common abnormality in 24-hour collections of patients with stone disease is suboptimal production of urine and not drinking enough fluids. Patients with stone disease need to maintain a urine output of 2 L per day. Furthermore, patients with cystine stones are advised to maintain a urine output of 3 L per day.

Simply by looking at the colour of urine, you can tell whether they are drinking sufficiently. When urine is yellow, you are dehydrated and need to drink more. When the urine is clear, you are drinking enough. Normally, the first urine of the day is concentrated because minimal fluids are consumed at night.

Hypercalciuria (excessive urinary calcium excretion)

Hypercalciuria occurs in about 5–10% of the population and is the second most common identifiable cause of calcium kidney stone disease next to dehydration. Hypercalciuria is defined as urinary excretion of more than 6.5 mmol (250 mg) of calcium in the urine per day in women or more than 7.5 mmol (300 mg) of calcium in the urine per day in men while on a regular unrestricted diet.

It can also be defined as the excretion of urinary calcium in excess of 0.1 mmol (4 mg) per kilogram of body weight per day or as a urinary concentration of more than 5 mmol (200 mg) of calcium per litre. An alternate definition of hypercalciuria is daily urinary excretion of more than 0.075 mmol (3 mg) of calcium per kilogram of body weight or more than 5 mmol (200 mg) of calcium per day while on a restricted (400 mg calcium and 100 milliequivalent [mEq] sodium) diet.

There are several causes of hypercalciuria.

Rarely, this is due to excessive production of the parathyroid hormone from the parathyroid glands (four tiny glands in the neck). This condition is associated with elevated levels of blood calcium (hypercalcemia), recurrent kidney stones and osteoporosis (brittle bones). When hypercalcemia and hypercalciuria are present, your doctor will order special nuclear medicine scans and neck ultrasounds to diagnose the condition of primary hyperparathyroidism. If you have this condition, you will be referred to a head and neck surgeon to surgically remove the hyperactive gland(s).

Another cause of hypercalciuria or too much calcium in the urine is excessive absorption of calcium from the intestine (absorptive hypercalciuria).

However, most often the reasons for hypercalciuria are unknown (idiopathic hypercalciuria) and are not due to either of the above two mentioned conditions. Specific dietary and medical treatments for hypercalciuria are discussed below.

Hyperoxaluria

Hyperoxaluria is defined by the presence of excess amounts of oxalate in the urine. This is more precisely defined as urinary excretion of >480 µmol/day of oxalate; or >320 µmol per 24 hours per gram of excreted creatinine. It is relatively common in people who suffer from calcium oxalate renal tract stones, with 20–30% of such patients having some degree of excessive urinary oxalate excretion.

Oxalate is produced by plants (found particularly in leaves, fruit and nuts), ingested in the diet and absorbed from the gut, mainly the colon. More is absorbed in the summer months, perhaps related to seasonal changes in diet. The concentration in particular plants is unpredictable as it is greatly affected by growing conditions. It is important in the normal metabolic functions of fungi and bacteria, but appears to be only a metabolic by-product with no particular role in humans. It has great affinity to bind calcium and the combination of calcium and oxalate become crystallized in urine. Urinary oxalate is one of the most important causes of kidney stone formation, and is approximately ten times more important than excess levels of calcium in the urine. High concentrations lead to formation of calcium oxalate crystals and ultimately to kidney stones.

Primary hyperoxaluria is extremely rare. It happens when there is an overproduction of oxalate, which is deposited as calcium oxalate in various organs especially kidneys. Elevated urinary oxalate excretion can also be seen in patients with excess intake of oxalate (dietary hyperoxaluria), or in patients with increased intestinal oxalate absorption due to small bowel diseases (enteric hyperoxaluria), or in patients with short-gut syndrome and inflammatory bowel disease. A dietary questionnaire may detect those with excessive oxalate consumption (for example, spinach, rhubarb, cranberry, and nuts), excessive vitamin C consumption (more than 1000 mg/day), and high meat protein consumption.

Hypocitraturia

Hypocitraturia, or a low amount of citrate in the urine, is an important risk factor for kidney stone formation. Citrate in the urine has long been recognized as an inhibitor of calcium crystallization in the urine. The mean urinary citrate excretion is 1.6- 4.5 mmol/day in healthy individuals. Hypocitraturia usually is defined as citrate excretion of less than 1.6 mmol (320 mg) per day.

Hyperuricosuria:

Uric acid is a by-product of protein metabolism in humans. Hyperuricosuria means excessive excretion of uric acid in the urine, greater than 4.4 mmol (800 mg)/day. Uric acid is relatively insoluble in water and about two-thirds of uric acid is produced by the body and the remaining one third comes from protein in the diet. About 70% of the uric acid produced daily is excreted by the kidneys, while the rest is eliminated by the intestines.

High levels of uric acid in the urine may result from an abnormality in the mechanism of eliminating bodily protein waste resulting in the formation of solid, hard, uric acid stones in the kidneys and bladder. When the pH of urine becomes more acidic and drops below 5.5, the urine becomes saturated and uric acid crystals start to form stones. Uric acid stones are more common in people who consume large amounts of protein, such as that found in red meat or poultry. People with gout (elevated serum uric acid and joint pain) or diabetes are also known to form uric acid stones. Furthermore, uric acid stones may still develop in people with normal urinary and serum levels of uric acid.

Patients with high levels of uric acid in the urine may develop calcium oxalate stones and uric acid stones as well. A dietary history of patients with uric acid calculi may reveal that they have a diet high in animal protein. The key treatment of hyperuricosuria is to maintain good hydration status through drinking ample amount of fluids together with increasing the urine pH (making it less acidic or more alkaline); therefore, the excreted uric acid will dissolve and decrease the chance that it will become a stone.

Dietary modification to prevent and reduce stone formation

How do I know if I am eating the wrong things? What should I change?

Dietary assessment

Ideally, if you have kidney stones, you will be referred to a dietitian or clinical nutritionist for a full dietary assessment. This includes fluid intake, in addition to intake of salt, animal proteins and foods containing high amounts of oxalate. This baseline evaluation together with the results of the detailed metabolic evaluation will guide the dietitian in recommending dietary modifications.

You will be requested to keep a 24-hour dietary record to identify your dietary patterns. Sources of dietary sodium (salt) are often not obvious, but can be hidden in foods that we least expect. For example, you may consume a nightly bag of microwave popcorn and bottled sports drinks after exercising; both of these are high in sodium, but only the popcorn is typically recognized as being salty and often bottled sports drinks go unrecognized as a high source of salt.

While diet alone can't always control the disease, it can help supplement other therapies, and for some patients it may be the primary tool for stone prevention. As a component of the medical management for stone disease, the goal of therapy should be to reduce the chance of forming stones. It is also advisable to follow-up with a dietitian to make sure that recommended diet changes have been implemented.

1. Increase fluid intake: "More is better"

As we already discussed, increasing urine volume is crucial to diluting the crystals in the urine that may form kidney stones, and is widely known to prevent stone formation.

Try this at home:

Try to dissolve sugar in water

A tablespoon of sugar is readily dissolved in a glass of water, but 10 tablespoons of sugar in that same glass will not completely dissolve, resulting in the accumulation of crystals at the bottom of the glass.

The water is saturated with sugar so that the water can no longer dissolve the sugar – so it is called "supersaturated." It is clear that to prevent stones, you need to increase your water (solvent) intake and decrease your sugar (solute) intake – these are 2 principles for your dietary changes. By diluting the calcium and oxalate crystals by drinking more water, you will decrease your chances of developing stones.

You are advised to maintain at least 2 L per day of urine output. Patients with cystinuria should aim for at least 3 L of urine per day. A key point is that the dilution of urine is necessary all day, every day. A patient who urinates the recommended 2 L a day between 7:00 am and 9:00 pm, but only 300 mL during the remaining 10 hours of the day will have saturated urine overnight, with the possibility of crystals and stones forming during the sleeping hours. Patients must accept the possibility of getting up once or twice at night to urinate, and should consume more water each time they get up.

Understand that *it is not the quantity of fluid consumed that is important, but the fluid voided that should be measured.* If you live in hot or dry conditions, or you exercise and perspire significantly, you will need to drink even more liquid to maintain adequate urine output.

Water is the best fluid to drink because it is non-caloric, non-caffeinated, and contains insignificant amounts of solutes. Furthermore, it is not the quality of water that is important, but the quantity. Since we live in a country with free access to safe potable water, tap water is sufficient, so you can avoid expensive bottled water. For those with excessive urinary oxalates, black teas should be reduced or eliminated because black tea is a high-oxalate beverage. Stone formers should also avoid excess caffeine, grapefruit and apple juice.

To begin increasing your fluid intake, drink whatever you can in large quantities. However, there are side effects with any sugared and caffeinated beverages in large quantities. There is no clear agreement on whether the mineral content in drinking water affects stone formation; "hard water" may not be problematic for most patients. Again, water in large quantities should be the focus of prevention. Lemonade is often recommended, as it supplies dietary citrate, a stone inhibitor and pH buffer when excreted later in the urine.

Stay well-hydrated and reduce alcohol consumption to relieve hyperuricosuria and prevent attacks of gout

Carry water with you at all times, and strive for pale, clear urine throughout the day and night. Some patients describe an initial physiologic resistance to increased fluid intake; this eases as their bodies and minds learn the new habit of extra fluid intake and output. High urine volumes should be the goal of all stone-formers. Most patients find that after forcing fluids for a couple of months, their bodies crave fluids and their habit is to drink more.

2. Consume adequate calcium

High calcium excretion in urine may be associated with osteoporosis and the formation of kidney stones. Sufficient calcium intake is required for the growth and maintenance of the skeleton in children and adults.

Reducing urine calcium should be a goal for stone formers, but not via dietary restriction. While reduced dietary calcium can decrease urine calcium, calcium restriction is no longer advisable for patients who form calcium kidney stones as this may lead to osteoporosis. Adequate calcium is required for the ongoing rebuilding of bone material. Recently, it was shown that adequate calcium intake is associated with decreased stone formation. Moreover, adequate calcium plus decreased sodium and protein intake protect against stones than decreased calcium intake alone.

Patients with the highest dietary calcium levels also had the lowest rates of new calcium stone formation. Apparently, dietary calcium acts as a scavenger in the digestive tract and prevents absorption of intestinal oxalate. Any modest increase in risk of stone formation from additional calcium absorption is more than compensated for by the reduction in oxalate excretion in urine.

A modest reduction in dietary calcium, with optimal levels at about 1000–1200 mg of calcium per day in most hypercalciuric patients, is currently recommended. This should be divided into two doses and taken with meals. Taking more than 2000 mg of calcium per day generally results in hypercalciuria and/or hypercalcemia in calcium stone formers.

Your body (and your digestive system) will adapt with long-term, consistent calcium intake. This means that patients with persistently low dietary calcium increase their intestinal calcium absorption and those with a high calcium intake show a corresponding decrease in intestinal absorption.

Fractional calcium absorption decreases with larger calcium loads, probably due to saturation of active absorption pathways. It plateaus at about 500 mg of calcium for most people. This means that an oral calcium dose is absorbed better if administered in small, divided portions rather than in a single large calcium bolus. In general, each additional 100 mg of daily dietary calcium ingestion increases urinary calcium levels by 0.2 mmol (8 mg) per day in a healthy population, but raises urinary calcium levels by 0.5 mmol (20 mg) per day in hypercalciuric patients.

Hypercalciuria can be caused by several other dietary factors besides calcium, such as animal protein, sodium (salt), alcohol, caffeine, refined carbohydrates, fiber, oxalate, and fluids. Excessive animal protein (>1.7 g/kg of body weight) increases the body's acid load. This additional acid load is buffered or neutralized in part by the bony skeleton, which then releases calcium into the general circulation. This extra serum calcium is eventually excreted by the kidneys into the urine, exacerbating any hypercalciuria. Acid loading also directly inhibits renal calcium reabsorption, resulting in an increase in urinary calcium excretion.

Animal protein also contributes a large purine load. Purines are the precursors of uric acid, which can form uric acid stones, lower the urinary pH, increase the overall acid load, contribute to gouty diatheses (a condition involving both stone disease and elevated uric acid levels), and generally increase urinary calcium excretion and stone formation.

Sodium or salt intake is another significant dietary risk factor for kidney stone disease and hypercalciuria. High dietary sodium is associated with increased calcium release from bone, further contributing to any existing hypercalciuria. It also causes an increase in urinary calcium excretion through a direct effect on the kidneys and reduces or eliminates the hypocalciuric effect of thiazide therapy in hypercalciuria. Each 100–mEq increase in daily sodium intake raises urinary calcium excretion by about 1.25 mmol (50 mg) per day.

Alcohol intake should be limited, because ethanol reduces osteoblastic (bone formation) activity, lowers parathyroid hormone levels, and contributes to osteoporosis. It also indirectly accelerates osteoclastic (bone lyses) activity, increases urinary calcium excretion, and contributes to bone loss.

Caffeine intake also should be limited, because caffeine increases urinary calcium excretion. Drinking 34 ounces of caffeine causes a loss of 1.6 mmol of total calcium, contributing to both hypercalciuria and osteoporosis.

Another dietary factor that affects calcium excretion is refined carbohydrates, which increase intestinal calcium absorption. Restricting dietary oxalate is necessary whenever calcium intake is limited in order to avoid a reactive absorptive hyperoxaluria caused by the decrease of intestinal oxalate-binding sites (calcium). High dietary fiber binds to free intestinal calcium, reducing its absorption. Increasing fluid (water) intake lowers urinary calcium concentrations without affecting total calcium excretion.

Vitamin D increases small bowel absorption of calcium and phosphate, enhances renal filtration, decreases parathyroid hormone (PTH) levels, and reduces renal tubular calcium absorption, which ultimately leads to hypercalciuria. Serum vitamin D determinations can be helpful in determining the etiology of hypercalciuria in difficult or resistant cases, but these tests are probably unnecessary in most hypercalciuric patients except as part of a research study or other standardized protocol. Vitamin D is stored in fat, and, in some cases, the vitamin D intoxication may persist for weeks after vitamin D ingestion has ceased.

Dietary changes have long been the mainstay of initial therapy for hypercalciuria. Although dietary changes alone may not always be successful or enough, dietary excesses possibly can undermine or defeat even optimal medical treatments.

If you are able to normalize your urinary calcium excretion with dietary changes alone, you may still benefit from thiazides or other treatments to avoid or treat bone demineralization and osteoporosis or osteopenia. Reducing intestinal calcium inadvertently may increase oxalate absorption and contribute to hyperoxaluria, resulting in a net increase in stone formation risk rather than a reduction. This is why dietary oxalate is limited whenever calcium intake is reduced.

Dietary changes involving reasonable restrictions of dietary calcium, oxalate, meat (purines) and sodium, have been useful in reducing the urinary super saturation of calcium oxalate. This effect is more pronounced in hypercalciuric calcium oxalate stone formers than in calcium nephrolithiasis patients who have normal urinary calcium excretion. Urinary calcium was found to decrease by 29% when reasonable dietary changes alone were used.

Calcium-rich food

Low-fat dairy products, green leafy vegetables, broccoli, fortified foods, and almonds are excellent sources. Patients should avoid calcium supplements in favour of calcium-rich foods; a patient with intolerance to dairy products may supplement, but should not exceed the recommended dose.

Putting it all together – here are some diet changes for hypercalciuria:

- Maintain a moderate calcium intake to 1000–1200 mg/day unless otherwise instructed.
- Limit dietary oxalate, especially when calcium intake is reduced. High oxalate levels are found in strong teas, nuts, chocolate, coffee, colas, green leafy vegetables (e.g., spinach), and other plant and vegetable products.
- Take calcium with oxalate-containing foods so that they bind together in the gut and are excreted in the feces rather than absorbed into the body and kidney where it can form kidney stones.
- Avoid excessive purines and animal protein (< 1.7 g/kg of body weight).
- Reduce sodium (salt) and refined sugar to the minimum possible.
- Increase dietary fiber (12–24 g/day).
- Limit alcohol and caffeine intake.
- Increase fluid intake, especially water (enough to produce at least 2 L of urine per day).
- If diet changes do not help you, you will likely be treated with thiazide diuretics, which can be associated with the following side effects: fatigue, dizziness, erectile dysfunction, gout, glucose intolerance, hypokalemia, hyperuricemia and dyslipidemia.

3. Limit Dietary Oxalates

Oxalate is found in many foods and there is much variation in the absorption of oxalate among different individuals. This makes adequate calcium intake critically important. The highest levels of oxalate are found in chocolate, nuts, beans (including soybeans), rhubarb, spinach, beets, and black tea. Reduction of high oxalate foods is the goal for typical stone formers rather than strict avoidance of all oxalate-containing foods (which would be very difficult). Follow-up 24-hour urine studies will show the effectiveness of the oxalate restriction.

There is much less oxalate than calcium in the urine; therefore, urinary oxalate concentration is much more critical to the formation of calcium oxalate crystals than urinary calcium concentration. Reducing urine oxalates may have a more powerful effect on stone formation than reducing urine calcium.

If you have calcium oxalate stones, particularly if you have increased urinary oxalate, you should avoid foods high in oxalates. Vitamin C is a precursor to endogenous production of oxalates, so some clinicians recommend avoiding vitamin C more than 1000 mg/day.

Patients with enteric hyperoxaluria should:

- Maintain high fluid intake to produce at least 2L/day of urine.
- Restrict dietary oxalate and avoid foods, such as spinach, rhubarb, nuts, beetroot, chocolate, wheat bran, tea and excessive meat intake, which increase oxalate absorption. See Resources section for more information.
- Avoid eating a high-fat diet and increase their dietary fiber.
- Avoid excessive vitamin C intake (more than 1000 mg/day).
- Take a calcium citrate supplement since the calcium binds the free oxalate from food and prevents the absorption of oxalate in the intestine. In addition, citrate is an inhibitor of stone formation.
- Possibly take potassium citrate to increase urinary pH and citrate, which reduce stone formation.
- Possibly take organic marine colloid to help bind oxalate in the gut and reduce urinary excretion.
- Make sure you treat any underlying intestinal causes.
- Possibly try other experimental treatments for hyperoxaluria, including pyridoxine (Vitamin B6) supplementation if you develop oxalobacter formigenes bacteria.

4. Limit sodium intake

Although you may never “salt your food,” you are likely getting salt from hidden sources in your diet. Sodium is a common preservative in canned and frozen foods, in pickled food and in restaurant foods. Excess sodium intake is associated with greater calcium excretion in the urine. Carefully check food labels so that you can reduce sodium in your diet.

The goal of therapy should be a "no-added-salt diet" or the equivalent of 2300 mg per day or less of dietary sodium. Reduction of dietary sodium is difficult and disappointing to patients. They may believe they have made significant reductions, while their urine sodium remains high. Consult a registered dietician who will be able to help you achieve the specific goal of a recommended sodium intake.

5. Limit animal protein

Uric acid, a by-product of animal protein (purine) degradation, is excreted in large quantities in the urine. With excessive protein intake, the urine will become supersaturated with uric acid and will have a low pH, both necessary for formation of uric acid stones. There is no inhibitor of uric acid crystal formation. So, diet changes should focus on reducing uric acid and increasing urine volume.

You should restrict animal protein to no more than 2 meals daily, with less than 6 to 8 ounces per day. Protein from plant sources, as beans and legumes, can be substituted as a dietary alternative without negative consequences. Calcium oxalate stone formers reducing their animal protein should note the oxalate content of substitute proteins.

High dietary protein is associated with increased urinary calcium. There is a link between meat consumption and both uric acid and calcium stone formation. In fact, the rate of stone formation in vegetarians is lower by one third than those eating a mixed diet. A study of 18 hypercalciuric stone formers found that a 15-day protein restriction was associated with a significant decrease in urine calcium, uric acid, phosphate and oxalate. Nevertheless, a beneficial increase in urinary citrate was observed. Citrate inhibits the formation of calcium oxalate crystals and increases pH, which can prevent uric acid stones. Thus, animal protein restriction has many preventive advantages in stone-formers.

6. Increase citrate intake:

Citrate plays several important roles in the mechanism of urinary stone formation.

First, citrate inhibits the crystallization and precipitation of calcium salts.

Second, citrate binds calcium ions in the urine and reduces calcium ion activity, which results in lowering the urinary supersaturation of calcium phosphate and calcium oxalate. This process is pH-dependent; increases in urinary pH levels appear to be more important in the formation of this complex than are increases in available citrate. In addition, urinary citrate excretion can increase urinary pH, which is a factor in uric acid crystallization and uric acid stone formation, as well as in the calcium-citrate-phosphate complex formation described above.

Therefore, hypocitraturia enhances urine calcium salt super saturation and reduces calcium crystallization inhibition, which increases the risk of calcium nephrolithiasis. It also may play a role in uric acid solubility and uric acid stone formation.

Patients with hypocitraturia are advised to increase their intake of citrate-rich fluids, such as lemonade and orange juice. It is important to note that the orange peel is high in oxalate. It is preferable to freshly squeeze lemon or orange rather than processed juices which contain the peel in addition to processed carbohydrates and sodium. If you are unable to increase your urinary pH or citrate through diet, then you will need to take sodium bicarbonate (baking soda) or potassium citrate.

Stone disease and the metabolic syndrome

Patients suffering from the metabolic syndrome (a cluster of conditions including high blood pressure, diabetes, obesity, and high cholesterol that increases the risk for heart disease, stroke and diabetes) also have a propensity to develop highly acidic urine, which increases the risk of developing kidney stones especially uric acid.

The detailed mechanisms responsible for the association of metabolic syndrome with kidney stone development are unclear.

A relationship between weight, body mass index and risk of calcium oxalate stone formation has been established. The prevalence of stone disease history and the incidence of stone disease were directly associated with weight and body mass index especially among women. The value of weight loss for stone prevention has not been proven, but given the benefits of weight loss for general health and reducing metabolic syndrome, it is certainly worthwhile for overweight patients.

Read on:

1- To read about diet in stone formers, visit the National Kidney & Urologic Diseases Information Clearinghouse website: **http://kidney.niddk.nih.gov/kudiseases/pubs/kidneystonediet/**

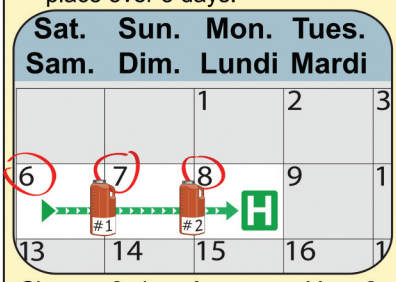
2- If you want nutritional information: **www.nutritiondata.com**

3- A thorough oxalate list can be found on the Oxalosis and Hyperoxaluria Foundation website: **http://www.ohf.org/diet.html**

How to do a 48-Hour Urine Collection

You have 2 bottles for your 48 hour urine sample collection. Once you have completed the collection, please go to the hospital for a blood test, to drop off your two bottles, and to do one more fasting urine test. **Use this form to help you plan how to do this.**

1 Your 48-hr collection will take place over 3 days.



Choose 3 days **in a row**. Your **3rd day** must be **a weekday** so that you can go to the hospital **Blood Center** and **Urology Center** when you are done.

For your 3rd day, avoid the following hospital holidays:

One Monday in February: _____
Good Friday
Easter Monday
Victoria Day
Jean Baptist Day
Canada Day
1st Monday in August
Labour Day
Thanksgiving Day,
December 23rd to January 3rd.

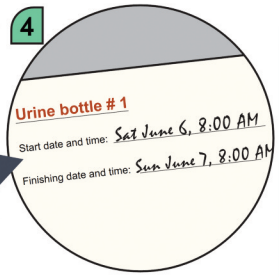
2

Empty your bladder & discard your urine at the beginning of the first day you decide to collect your urine for bottle #1

3

Note the time. This is your urine collection **bottle #1 start time**. You will stop collecting 24 hours after this start time (in other words, the next day at the same time).

4



Record your urine collection **bottle #1 start** and **end dates** and **times** on the hospital form.

5

You may now begin collecting urine. Use bottle #1 to collect ALL your urine for the next 24hrs.

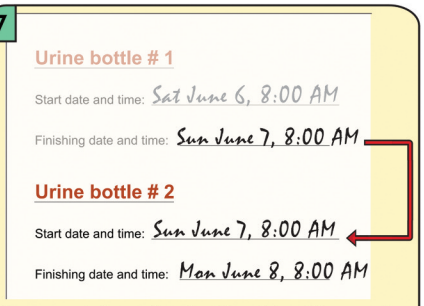
If the bottle is not big enough, use another leak-proof bottle that you have at home for the rest of your collection.

6

When you reach your end time, urinate one last time into the bottle and then close the lid.

Your urine collection for bottle #1 is now complete. Do not refridgerate.

7



Your end time for bottle #1 will now be your start time for bottle #2. Record your urine collection **bottle #2 start** and **end dates** and **times** on the hospital form.

How to do a 48-Hour Urine Collection

8

You may now begin collecting urine. Use bottle #2 to collect ALL your urine for the next 24hrs.

9

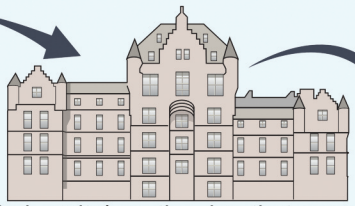
You will need to start fasting after midnight for your blood and urine test the next day. You may still drink water. Continue to urinate in bottle #2.

10

When you reach your **bottle #2 end time**, urinate one last time into the bottle and then close the lid.

Your urine collection for bottle #2 is now complete.

11



Bring the 2 bottles and hospital form to the Royal Victoria hospital on the day that your collections are complete.

12 First, go to the Blood Center (room E2.45).

It opens at 8AM. You will have a blood test.

BLOOD CENTER

13 **UROLOGY CENTER**

Go to the Urology Center (room S6.41). Give the nurse your 2 urine bottles and the completed hospital form.

14 At the Urology Center, you will be asked to provide one last fasting urine sample.

You are now done and may eat and drink normally again.

Developed by: McGill Molson Medical Informatics