

# KIDNEY STONES AND MEDICAL KETOGENIC DIETARY TREATMENT



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Written by  
Val Aldridge

Approved by  
Sue Wood RD  
Dr. L Dabydeen  
and Dr. E. Neal RD

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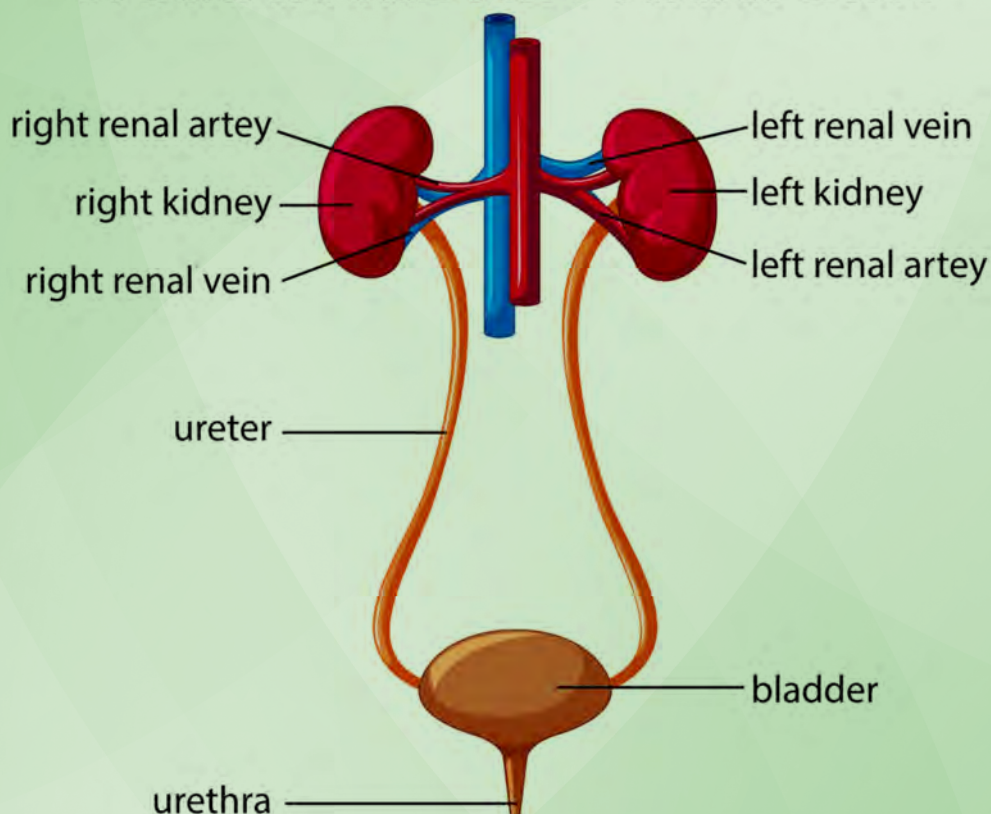
# Introduction

Also known as renal Calculus, renal stones or nephrolithiasis, stones can sit in the kidneys or travel down the ureters into the bladder and pass out via the urethra; they may become lodged at any point but hopefully will pass through into the urine.

The risk to the general population is approximately 12% during a life time. Stones can occur at any age, but more frequently in men age 20 – 49 years (1).

We know that a strict medical ketogenic diet can cause a very mild increase in metabolic acidity which can result in a loss of salts and minerals via the kidneys which are then excreted in the urine. Crystals can build up to make up a stone directly in the kidneys or bladder, or can cause a blockage in the ureters or urethra (2).


## HUMAN KIDNEY ANATOMY





## Risk factors specific to ketogenic dietary therapy (KDT)

There are factors that increase the risk of developing kidney stones, some of which may be particularly relevant to those on a medical KDT.

Factor	Challenges	Prevention advice
Poor fluid intake (3)	<ul style="list-style-type: none"> <li>• Poor drinker before starting KDT</li> <li>• Changes in what drinks are available once on KDT</li> <li>• Unable to tolerate volume of fluids</li> </ul>	<ul style="list-style-type: none"> <li>• Follow your dietitian's guidance on target amounts of daily fluids</li> <li>• Try different ideas to boost fluid intake, e.g. water may be improved with lemon juice or low carbohydrate squash, fruit teas, coffee with cream, low carbohydrate milks such as Alpro soya or Almond light, sugar free fizzy drinks</li> <li>• Special cups and sports bottles are worth a try Matthew's Friends cups are also available!</li> <li>• Try drinking bottles with times</li> <li>• For those taking fluids orally, remember fluid will also be provided from foods like jelly, ice cream, ice pops/lollies, soups, and sauces</li> <li>• For those who are fed via a gastrostomy, try very small water increases, e.g. 10mls extra in a flush or between feeds; this can be built up gradually if needed. A slow pump feed can be tried, but always be guided by your dietitian on this</li> </ul> 
Immobility (4)	<ul style="list-style-type: none"> <li>• Disability</li> <li>• Lack of exercise</li> </ul>	<ul style="list-style-type: none"> <li>• Use of standing frames, physiotherapy, passive exercises, swimming or hydrotherapy pools, rebound therapy</li> <li>• Encourage to find an exercise that suits and is enjoyable!</li> </ul>
Medications (5) Carbonic anhydrase inhibitors (6) Laxatives	<ul style="list-style-type: none"> <li>• Some anti-seizure medication such as carbonic anhydrase inhibitors can increase acidity levels. These include Topiramate, Zonisamide and (occasionally used) Acetazolamide</li> <li>• Constipation is a common side effect of KDT and may also be a pre-existing problem before starting the diet</li> </ul>	<ul style="list-style-type: none"> <li>• Follow prevention guidance on fluids and mobility</li> <li>• Although increased risk has not been conclusive in studies it is something to be aware of</li> <li>• Renal ultrasound recommended before starting KDT and may be needed during follow-up</li> <li>• See Matthew's Friends advice sheet on constipation and KDT</li> <li>• Follow guidance on laxative use</li> </ul>
Vitamin C Supplements (7)	<ul style="list-style-type: none"> <li>• Some adults may be taking vitamin C supplements extra to a general multivitamin</li> </ul>	<ul style="list-style-type: none"> <li>• Additional Vitamin C may increase the risk of renal stones (guidance from dietitian needed)</li> </ul>

Factor	Challenges	Prevention advice
Calcium & mineral Supplements (8)	<ul style="list-style-type: none"> <li>• Often essential, particularly with growing children</li> </ul>	<ul style="list-style-type: none"> <li>• In adults or older children supplements may be avoided if nutritional intake is adequate (Guidance from dietitian needed)</li> </ul>
Length of time on diet	<ul style="list-style-type: none"> <li>• A mild increase in metabolic acidity over a long period of time</li> </ul>	<ul style="list-style-type: none"> <li>• Consider whether an individual KDT can be less restrictive or consider gradual weaning</li> </ul>
Age & Gender - (1)	<ul style="list-style-type: none"> <li>• General prevalence, especially in adult males</li> </ul>	<ul style="list-style-type: none"> <li>• Follow prevention guidance on fluids and mobility</li> <li>• Use of urine alkalising agents, e.g. potassium citrate</li> </ul>
Family history (9)	<ul style="list-style-type: none"> <li>• Known increased risk</li> </ul>	<ul style="list-style-type: none"> <li>• Follow prevention guidance on fluids and mobility</li> <li>• Consider renal ultrasound before starting KDT and during follow-up</li> <li>• Use of urine alkalising agents, e.g. potassium citrate</li> </ul>

## Symptoms to look out for which may indicate kidney stones

Some of the symptoms below may be completely unrelated to kidney stones but once obvious causes have been ruled out, they are worth considering especially if the risk factors exist:

- Kidney stones can cause extreme pain, especially if they start to move. This may be felt in the back, groin and sometimes abdomen.
- Blood in the urine (haematuria), blood or gravel in nappies.
- Inability to pass urine (dysuria).
- Increased seizures.
- Irritability.
- Vomiting or nausea.
- Signs of infection such as cloudy or smelly urine.
- Raised temperature.
- Ketone levels may be affected, usually decreasing.
- Glucose levels may increase.



## How do we monitor for signs of kidney stones?

Tests will vary from centre to centre but are likely to include the following:

### 1. Urine multistick dip stick test (10)

Specific Findings	Obvious signs or risk of stones
Haematuria - Blood (frank or trace)	Damage from stones
Gravel/sand	Passed stones or fragments
Protein	May indicate kidney disease
PH	Acidity level
Specific gravity	Dehydration
Leucocytes and Nitrites	Infection
Colour	Dark urine could indicate dehydration
Clarity	Infection
Odour	Infection
High Ketones	Could be linked to high acidity or dehydration

When sending urine samples, in general use the white top containers. Please use red top containers if infection is suspected and store in a fridge if samples are not sent off to a lab immediately (red top containers contain boric acid, a preservative to maintain the quality of a sample, thus reducing false positive cultures).

Catching urine samples can be very difficult and, in some cases, cause a great deal of stress. Conveen may be helpful or cotton wool placed in nappies, then put into a syringe to squeeze the urine out with the plunger. If it is not possible to obtain a sample, then other indicators such as blood results will be looked at and a renal ultrasound may be required on a more regular basis.

### 2. Urine Calcium/creatinine ratio

A normal reference interval for the urine calcium (mg/dL): urine creatinine (mg/dL) ratio is less than 0.14. Values exceeding 0.20 are found in patients with hypercalciuria and so indicate risk of stone formation (11) In children, the calcium: creatinine ratio decreases steadily with time until approximately six years of age.

**3. Blood Urea and Electrolytes** – to see how the kidneys are functioning

**4. Bicarbonate** – an indication of acidity

**5. Bone profile** – to exclude hypercalcaemia (high calcium levels) - may cause stones

**6. Renal (kidney) Ultrasound Scan** – This may be recommended before starting KDT if taking carbonic anhydrase inhibitors or there is a family history of kidney stones. This will be repeated if stones are suspected during KDT and for those on long term KDT with other risk factors.

## Prevention and Treatment of kidney stones

### 1. Potassium Citrate

Studies have shown that use of potassium citrate appears to be a safe and effective way of alkalinising urine without impacting the efficacy of KDT in seizure control, although long-term use in KDT has not been researched (2, 12, 13, 14, 15).

Long term use in a study of 500 people, not following KDT, on potassium citrate (the longest 14 years) showed continued efficacy in prevention of recurrent stone formation (16). Some centres prescribe potassium citrate as a routine preventative measure. Others use this only when risk factors are high or when symptoms are present.

Potassium effercitrate tablets are used for children over 6 years and adults (contain saccharin)  
Effercitrate: 1 x tablet = 1.5g.

- Children over six years of age: one tablet TDS
- Adults: two tablets TDS

A liquid formulation is recommended for children under the age of 6 years. The dose is 5mls TDS 300mg/ml, which contains approximately 1g of carbohydrate per 5ml.



For some children on KDT with a generous carbohydrate allowance this can be incorporated into the daily allowance. The dose should be taken alongside meals.

**2. Lithotripsy** (Uses sound waves to break up stones so that they can be passed in the urine)

**3. Surgery** - Keyhole surgical stone removal

## Dietary adjustments

Making dietary changes to treat kidney stones can be difficult with an already restricted diet and would need individual assessment as to the benefits. Types of stones differ and how they are made will depend on which foods need to be avoided (17).

The palatability of potassium citrate can be a problem and further research is needed into more palatable, non-medical and cheaper ways to alkalinise urine. Lemon juice and vinegar, both cheap and easily accessible, have been studied and found to be effective substitutes for potassium citrate. Comparing the use of lemon juice, potassium citrate, and dietary manipulation, 85mls lemon juice daily (= 1.3g CHO) was found to reduce urine calcium levels as effectively as potassium citrate (18). Vinegar used on a daily basis showed similar effect (19).

The PH of natural water has been mentioned in a paper looking at the gut microbiota and its link with renal stone formation (20). The PH of water varies depending on its source so water can vary depending on where we live! In the UK water PH is usually between 6.5 and 8.5 (21).

More research is needed, especially in children, to assess the minimal amounts of these everyday food items that would be required to effect change and whether a combination would in fact be more palatable. Further study is also needed into their potential for safe use in P.E.G. fed patients, who often have multiple risk factors for kidney stones.



## Practicalities of dietary adjustments

Food	Concerns/challenges	Ways to incorporate daily
Lemon juice	Sour and acidic to tooth enamel	<ul style="list-style-type: none"> <li>• Try small amount, e.g. 5 -10mls in water, hot or cold, sparkling, diet lemonade? Have alongside a meal. Use in cooking?</li> <li>• Rinse mouth or clean teeth afterwards.</li> </ul>
Vinegar	Sour and acidic to tooth enamel	<ul style="list-style-type: none"> <li>• Use daily on salads (side dish of cucumber in vinegar?) or in dressings mixed with oil. On vegetables?</li> <li>• In sauces for cooking?</li> </ul>



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 **Post:**  
Matthew's Friends  
St. Piers Lane  
Lingfield  
Surrey RH7 6PW

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 **Telephone (Office):**  
01342 836571

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 **Support-line Number:**  
0788 4054811

---

 **Website address:**  
[www.matthewsfriends.org](http://www.matthewsfriends.org)

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 **General E-mail:**  
[enq@matthewsfriends.org](mailto:enq@matthewsfriends.org)

 **Post:**  
Matthew's Friends Clinics Ltd  
St. Piers Lane  
Lingfield  
Surrey RH7 6PW

---

 **Telephone (Office):**  
01342 836571

---

 **Support-line Number:**  
0788 4054811

---

 **Website address:**  
[www.mfclinics.com](http://www.mfclinics.com)

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 **Email**  
[info@mfclinics.com](mailto:info@mfclinics.com)



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