Kidney stones in children

With nephrolithiasis on the rise across all age groups, it's important to know how to manage kidney stones and prevent them from recurring

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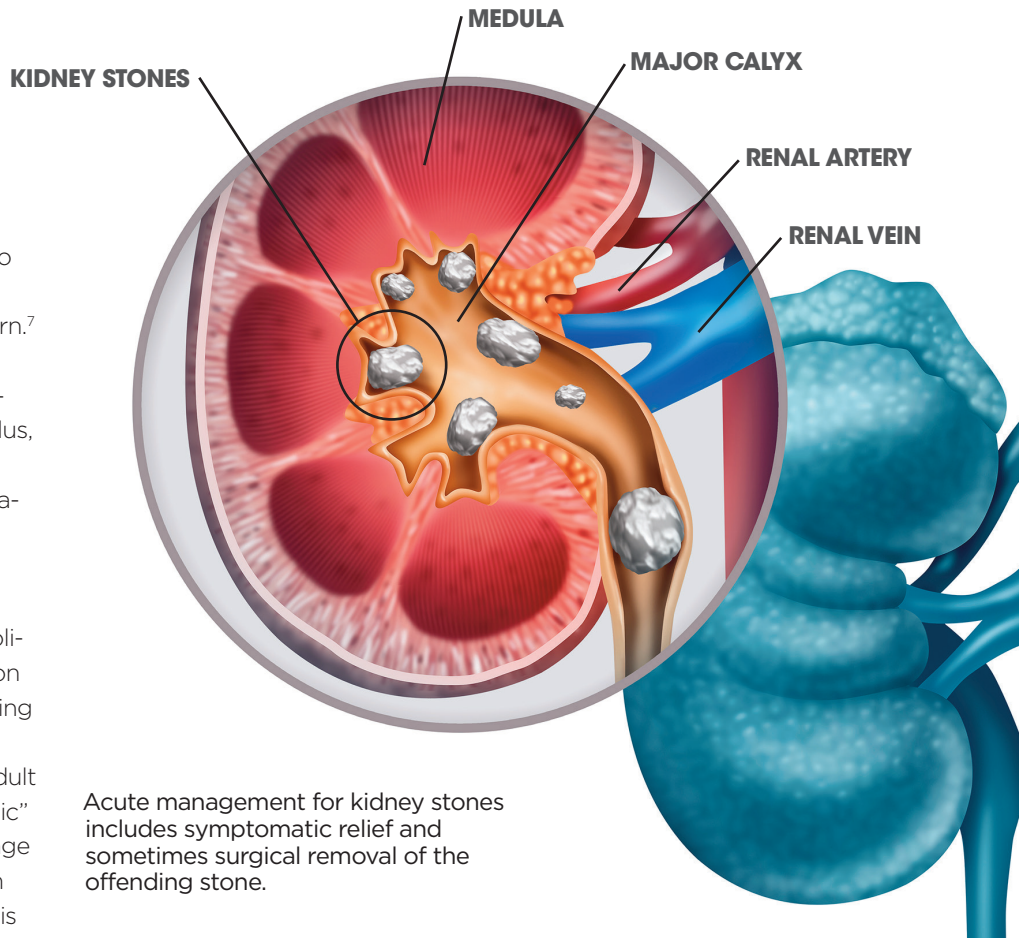
Nephrolithiasis, also known as kidney stones, is the formation of crystalline material in the kidneys or the urinary tract. The incidence of nephrolithiasis has risen rapidly in the pediatric population, driven largely by an increased number of presentations in the adolescent population.[2] Many children will present symptomatically with flank pain, hematuria or urinary tract infections.[6]



Acute management for kidney stones includes symptomatic relief and sometimes surgical removal of the offending stone.

Because 1 in 10 adults will suffer from nephrolithiasis during their lifetime, the signs and symptoms of kidney stones are familiar to many families. Accordingly, the diagnosis of nephrolithiasis will generate significant concern.[7] Acute management for kidney and ureteral calculi includes symptomatic relief and sometimes surgical removal of the offending calculus, while longer-term management focuses on evaluation for underlying causes and preventative strategies.

EPIDEMIOLOGY AND ETIOLOGY

Although not as common as in adults, nephrolithiasis has become increasingly more common in the pediatric population, with a near doubling of incidence in the past few decades.[8] A spike in incidence of kidney stones in the adult population has been identified as an "epidemic" by some health professionals. Yet, across all age groups, the adolescent population has shown an even greater rise in new diagnoses over this timeframe.[2] A single unifying cause for this increased incidence has yet to be identified, likely due to the multifactorial nature of kidney stone risk. However, several risk factors for kidney stones are well identified in the pediatric population.

In general, the urine contains a multitude of filtered substrates suspended in supersaturated concentration. As concentrations of stone-forming substances, such as calcium or oxalate, surpass supersaturated concentrations due to either excess substrate within the urine or decreased overall fluid (i.e., low urine volume), these substances will fall out of solution and crystallize. Additionally, low concentrations of inhibitory substances (i.e., urinary citrate) or alterations in the urinary pH will contribute to further crystallization.[9] Thus, the potential to form urinary calculi depends on several aspects of urine concentration, which are in turn influenced by diet, hydration status, genetics and underlying systemic disease.[10] Many children, however, may not present with a single identifying risk factor and further assessment is warranted.

PRESENTATION AND EVALUATION

Renal colic and hematuria are common presenting symptoms of nephrolithiasis, although with the increasing use of general abdominal imaging, incidental presentations may also be seen. Less commonly, children may present with an acute febrile urinary tract infection, which in the setting of an obstructing calculus, is a medical emergency.[6]

Continued on page 10

Kidney stone prevention

These tips can help patients reduce their risk for nephrolithiasis.

INCREASE FLUIDS

Improving fluid intake to dilute the urine is the most effective strategy at minimizing kidney stone risk irrespective of stone type or underlying cause.[1]

WHAT TO DRINK:

Age	Amount per day
1-4 years	1.3 L (about 5 cups)
4-8 years	1.7 L (about 7 cups)
9-13 years	Boys: 2.4 L (about 10 cups)
9-13 years	Girls: 2.1 L (about 9 cups)
14-18 years	Boys: 3.3 L (about 14 cups)
14-18 years	Girls: 2.3 L (about 10 cups)

CHOOSE CITRATE

The addition of citrate, either naturally with lemons or limes, or as a supplement, can reduce kidney stone risk in some individuals.

Although not as potent as specific supplementation, drinking a glass of real lemonade per day, or squeezing 1/4 to 1/2 of a lemon into a glass of water daily, can improve urinary citrate.

In some individuals, targeted medical therapies such as potassium citrate (which supplements urinary stone inhibition) or thiazide-diuretics (which reduce urinary calcium excretion) may be beneficial.[3]

REDUCE SALT

Large randomized controlled studies in adults have shown that low-salt, moderate-calcium diets can reduce risk of future kidney stone events.[4,5]

We recommend limiting salt intake to the recommended daily allowances:

Age	Amount per day
1-3 years	Less than 1.5 g
4-8 years	Less than 1.9 g
9-13 years	Less than 2.2 g
14-18 years	Less than 2.3 g
Older than 18	Less than 2.5 g

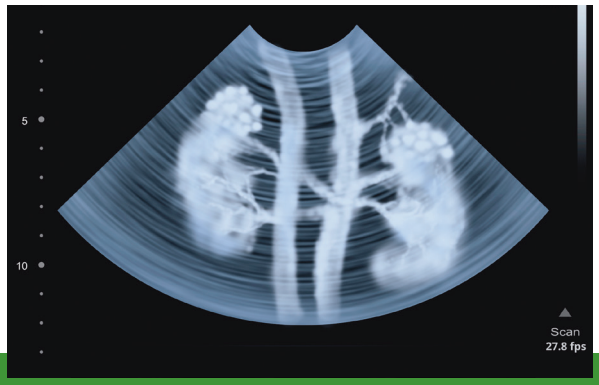
Most children presenting acutely with nephrolithiasis can be managed without hospital admission. Up to 70% of stones within the ureter will pass spontaneously, and adequate nausea and pain control are imperative to allow sufficient time for stone passage. Alpha-blockers, such as tamsulosin, have been shown in limited scenarios to improve stone passage and would be recommended for distal ureteral calculi larger than 5 mm.

Imaging choice is a major consideration for children with recurrent nephrolithiasis, especially given the high risk of ionizing radiation exposure for initial and follow-up imaging assessments as well as surgical intervention.[11-13] Ultrasound is the recommended first-line imaging strategy but, due to a lower sensitivity, may result in non-diagnostic findings where the clinical suspicion remains quite high. Dose-modification strategies can reduce ionizing radiation of computed tomography without compromising diagnostic quality and are preferable in situations where ultrasound was insufficient.[14] Imaging not only can help with the diagnosis, but reveal size and location of the calculus, which will help determine further management options.

EVALUATION OF RISK

Up to 50% of children with an incident stone event will develop a recurrence within three years.[3] Thus, identification of any modifiable risks and counseling regarding stone-prevention strategies are imperative following diagnosis.

Urinary stone risk may be assessed with urine studies evaluating for both stone promoters (i.e., calcium, oxalate) and stone inhibitors, serum studies to assess for calcium homeostasis and renal function, and select genetic evaluations. Although cumbersome to perform, 24-hour urine studies are most informative and should be offered to interested individuals.[20] Children who are not yet toilet-



Step-wise evaluation of suspected symptomatic nephrolithiasis

1. History and Physical: A personal history of nephrolithiasis, nausea or vomiting with renal colic, or flank pain on physical examination all increase the positive predictive likelihood of nephrolithiasis.[15]
2. Urinalysis: Microscopic hematuria > 2 red blood cells/high-powered field increases the likelihood of a kidney stone.[15] Meanwhile, presence of infection in the setting of a kidney stone should prompt urgent urological consultation.
3. Imaging: Renal-bladder ultrasound is the first-line recommended imaging strategy for children with a suspected kidney stone, reserving CT for indeterminate cases where clinical suspicion remains high.[16]
4. Pain Management: Oral non-steroidal inflammatory agents are safe and effective in renal colic. [17,18]
5. Follow-up: Urologic follow-up within 1-2 weeks of diagnosis is advisable for symptomatic (i.e., painful) kidney stones and all ureteral calculi.[19]

trained can submit spot urine studies for analysis as an alternative.[6] Serum studies are lower-yield, but should be considered in higher-risk children, such as those with recurrent nephrolithiasis, a family history of stone disease, large or multiple kidney stones, or hypercalcuria on urinary evaluation.[21] Genetic evaluations are typically limited to higher-risk populations, as well, where the yield of a monogenic cause of nephrolithiasis may be has high as 17%.[22] However, because the implications of an abnormal genetic screen for nephrolithiasis are not well defined, it is advisable to undertake such endeavors with support from a genetics specialist.

FOLLOW-UP

Routine follow-up can serve several purposes. These visits serve as an opportunity to reassess adherence to fluid and dietary recommendations and discuss strategies to overcome barriers to achieving these goals. Imaging with renal ultrasound can aid in identification of new, asymptomatic kidney stones. Finally, children with rare monogenic kidney stone diseases, such as cystinuria or primary hyperoxaluria, assessments of renal function and ensuring lifelong kidney stone management strategies are paramount.

At Children's Hospital of Wisconsin, families are offered a comprehensive risk assessment and provided guidance for preventative measures. Higher-risk individuals are offered genetic evaluation through collaboration with our genetics team. Follow-up strategies are tailored to the individual, and we are typically able to triage acute stone events in established patients through our specialist nursing team in order to ensure timely assessment and intervention while minimizing additional emergency department visits.

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