Urinary Lithiasis

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EPIDEMIOLOGY OF RENAL CALCULI

- The lifetime prevalence of kidney stone disease is estimated at 1% to 15%, varying according to age, gender, race, and geographic location.

Gender

- **Historically, stone disease affected adult men more commonly than adult women. By a variety of indicators, including inpatient admissions, outpatient office visits, and emergency department visits, men were affected two to three times more often than women .**

Race and Ethnicity

- **Among US men, found the highest prevalence of stone disease in whites, followed by Hispanics, Asians, and African-Americans, who had prevalences of 70%, 63%, and 44% of whites .**

- **The gender distribution of stone disease varies according to race. noted a male-to-female ratio among whites of 2.3 and among African-Americans of 0.65.**

Age

- Historically it was relatively uncommon for stones to occur in individuals under age 20. However, over the last few decades stone disease has been increasing at a rate of 5% to 10% annually in the pediatric population .

- **In adults, the incidence of kidney stones peaks in the fourth to sixth decades of life .**

Geography

- The geographic distribution of stone disease tends to roughly follow environmental risk factors; **a higher prevalence of stone disease is found in hot, arid, or dry climates such as the mountains, desert, or tropical areas.**

- **the highest rates of hospital discharges for patients with calcium oxalate stones in the Southeast and for uric acid stones in the East, among the veteran patient population .**

- **found increasing age-adjusted prevalence rates in men and women going from north to south and west to east, with the highest prevalence observed in the Southeast.**

Climate

- Seasonal variation in stone disease is likely related to temperature by way of fluid losses from perspiration and perhaps by sunlight-induced increases in vitamin D noted the highest incidence of stone disease in the summer months .

Occupation

- Heat exposure and dehydration constitute occupational risk factors for stone disease as well. Cooks and engineering room personnel, who are exposed to high temperatures, were found to have the highest rates of stone formation .

- Individuals with sedentary occupations such as those in managerial or professional positions have been found to carry an increased risk of stone formation for unclear reasons .

Obesity, Diabetes, and Metabolic Syndrome

- **the prevalence and incident risk of stone disease directly correlated with weight and body mass index (BMI) in both sexes, although the magnitude of the association was greater in women than in men .**

- The constellation of visceral obesity along with hyperlipidemia, hypertriglyceridemia, hyperglycemia, and/or hypertension, known as metabolic syndrome, has been linked to an increased risk for kidney stones.

- **Subjects with higher BMI excreted more urinary oxalate, uric acid, sodium, and phosphorus than those with lower BMI. Furthermore, similar to other studies, urinary supersaturation of uric acid increased with BMI.**

- **It has been suggested that the association of obesity with calcium oxalate stone formation is primarily due to increased excretion of promoters of stone formation .**

- **In contrast, the association of obesity and uric acid stone formation is primarily influenced by urinary pH.**

Cardiovascular Disease

- A number of investigators have explored the association between hypertension and kidney stones.

- the factors responsible for the association between nephrolithiasis and cardiovascular disease have yet to be elucidated, dyslipidemia (high total cholesterol, high triglycerides, and low high-density lipoprotein [HDL]) has been associated with alterations in urine chemistry that can predispose to kidney stone formation .

Chronic Kidney Disease

- Epidemiologic studies have demonstrated a link between nephrolithiasis and development of chronic kidney disease (CKD).

Water

- The beneficial effect of a high fluid intake on stone prevention has long been recognized.

- several investigators reported a lower incidence of stone disease in geographic regions with a “hard” water supply compared with a “soft” water .

- water “hardness” is determined by content of calcium carbonate others found no difference. found no association between water hardness and incidence of stone episodes .

Classification of Nephrolithiasis

STONE COMPOSITION	OCCURRENCE (%)
CALCIUM-CONTAINING STONES	
Calcium oxalate	60
Hydroxyapatite	20
Brushite	2
NON–CALCIUM-CONTAINING STONES	
Uric acid	7
Struvite	7
Cystine	1–3
Triamterene	<1
Silica	<1
2,8-Dihydroxyadenine	<1

Absorptive hypercalciuria	Increased gastrointestinal calcium absorption
Renal phosphate leak	Impaired renal phosphorus absorption
Renal hypercalciuria	Impaired renal calcium reabsorption
Resorptive hypercalciuria	Primary hyperparathyroidism
Hyperuricosuric calcium nephrolithiasis	Dietary purine excess, uric acid overproduction

Hypocitraturic calcium nephrolithiasis	
Isolated	Idiopathic
Chronic diarrheal syndrome	Gastrointestinal alkali loss
Distal renal tubular acidosis	Impaired renal acid excretion
Thiazide-induced	Hypokalemia

Hyperoxaluric calcium nephrolithiasis	
Primary hyperoxaluria	Oxalate overproduction
Dietary hyperoxaluria	Increased dietary oxalate
Enteric hyperoxaluria	Increased intestinal oxalate absorption

Hypomagnesiuric calcium nephrolithiasis	Decreased intestinal magnesium absorption
Idiopathic low urine pH	Low urinary pH
Cystinuria	Impaired renal cystine reabsorption
Infection stones	Infection with urease-producing bacteria
Low urine volume	Inadequate fluid intake

Ureteropelvic Junction Obstruction

Horseshoe Kidneys

Caliceal Diverticula

Medullary Sponge Kidney

Stones in Pregnancy

Symptomatic stones during pregnancy occur at a rate of 1 in 250 to 1 in 3000 pregnant women.

- A number of physiologic changes occur during pregnancy. Physiologic hydronephrosis occurs in up to 90% of pregnant women and persists up to 4 to 6 weeks postpartum .

- Although hydronephrosis may be in part due to the effects of progesterone, compression of the ureters by the gravid uterus is at least a contributory, if not the primary, factor .

- Dilation is typically greater in the right ureter as a result of the engorged uterine vein and derotation of the enlarged uterus .

- The physiologic dilation may promote crystallization as a result of urinary stasis and the increased renal pelvic pressure has been suggested to increase the likelihood of stone movement and symptoms.

- **Important physiologic changes in the kidney occur during pregnancy and modulate urinary stone risk factors. Renal blood flow increases, leading to a 30% to 50% rise in glomerular filtration rate, which subsequently increases the filtered loads of calcium, sodium, and uric acid .**

- Despite increases in a number of stone-inducing analytes, pregnant women have been shown to excrete increased amounts of inhibitors such as citrate, magnesium, and glycoproteins .

- Therefore the overall risk of stone formation has been reported to be similar in gravid and nongravid women.

EVALUATION OF URINARY LITHIASIS

IMAGING FOR URINARY LITHIASIS

- **Noncontrast computed tomography (CT) imaging is the gold standard in terms of diagnostic accuracy for stones, with a reported sensitivity of 98% and a specificity of 97% .**

METABOLIC EVALUATION

Recurrent stone formers
Strong family history of stones
Intestinal disease (particularly chronic diarrhea)
Pathologic skeletal fractures
Osteoporosis
History of urinary tract infection with calculi
Personal history of gout
Infirm health (unable to tolerate repeat stone episodes)
Solitary kidney
Anatomic abnormalities
Renal insufficiency
Stones composed of cystine, uric acid, struvite

- **In addition, the overwhelming consensus is that all children should undergo a full metabolic evaluation because they have been found to have a significant risk for underlying metabolic disturbances .**

- **African-Americans, Asians, and Hispanics appear to have a surprisingly similar incidence of underlying metabolic disturbances when compared with white stone formers. These results suggest that dietary and environmental factors may be as important as ethnicity in the cause of stone disease .**

- All first-time stone formers should undergo a detailed medical and dietary history.

- High-risk stone formers include those with GI disease, obesity, metabolic syndrome, diabetes mellitus, primary hyperparathyroidism, renal tubular acidosis, sarcoidosis, gout, and family history of nephrolithiasis.

- Children should generally be evaluated because of concerns about renal damage and long-term sequelae of stone recurrence.

History

- Underlying predisposing conditions (see Box 92.1)
- Medications (calcium, vitamin C, vitamin D, acetazolamide, steroids)
- Dietary excesses, inadequate fluid intake, excessive fluid loss

Multichannel Blood Screen

- Basic metabolic panel (sodium, potassium, chloride, carbon dioxide, blood urea nitrogen, creatinine)
- Calcium
- Intact parathyroid hormone
- Uric acid

Urine

- Urinalysis
  pH >7.5: infection lithiasis
  pH <5.5: uric acid lithiasis
  Sediment for crystalluria
- Urine culture
  Urea-splitting organisms: suggestive of infection lithiasis
- Qualitative cystine

Radiography

- Radiopaque stones: calcium oxalate, calcium phosphate, magnesium ammonium phosphate (struvite), cystine.
- Radiolucent stones: uric acid, xanthine, triamterene
- Intravenous pyelogram: radiolucent stones, anatomic abnormalities

Stone Analysis

24-Hour Urine Collection

- Error in collection technique
- Failure to collect a full 24 hours' worth of urine
- Changes in the patient's diet for the sake of the study
- Intermittent indiscretions in diet
- Failure of specimen to accurately represent typical day
- Bacterial contamination

General Recommendations for Stone Formers

Fluid Recommendations

- **Low urine volume is perhaps the most important risk factor for kidney stone formation. Increased fluid intake is a powerful tool in preventing stone recurrence for all stone types and likely does so via a decrease in urinary supersaturation of stone components .**

- **Therefore, a mainstay of conservative management for kidney stone prevention is increased fluid intake to achieve a urine output of at least 2.5 L/day.**

- **Epidemiologic data has demonstrated that consumption of sugar-sweetened soda and punch is associated with a higher risk for stone formation, and coffee, tea, beer, and wine are associated with a lower risk for stone formation .**

Animal Protein

- **Nondairy animal protein (meat, fish, poultry, eggs) intake can affect several urinary parameters that may increase kidney stone risk including calcium, uric acid, oxalate, and citrate.**

- animal protein consumption through a mechanism of bone reabsorption and lower tubular calcium reabsorption .

- high animal protein as a source of purines can deliver an acid load that reduces tubular reabsorption of citrate and hypocitraturia and increases urinary uric acid levels resulting in hyperuricosuria .

- The effect of high animal protein intake appears to be most harmful when coupled with a diet that is low in calcium .

- **Epidemiologic studies have suggested that the incidence of nephrolithiasis is higher in populations in which there is increased animal protein intake.**

- **diets high in potassium and lower in animal protein may be effective in preventing kidney stone formation.**

- **Dietary Approaches to Stop Hypertension (DASH) diet has been evaluated for its effect on kidney stone formation. The DASH diet is rich in fruits and vegetables, moderate in low-fat dairy products, and low in animal protein. In a prospective population-based study, higher DASH scores were associated with a lower risk for kidney stone formation .**

- **In summary, patients with calcium oxalate or uric acid stones are most likely to benefit from a diet limiting nondairy animal protein and increasing fruit and vegetable intake .**

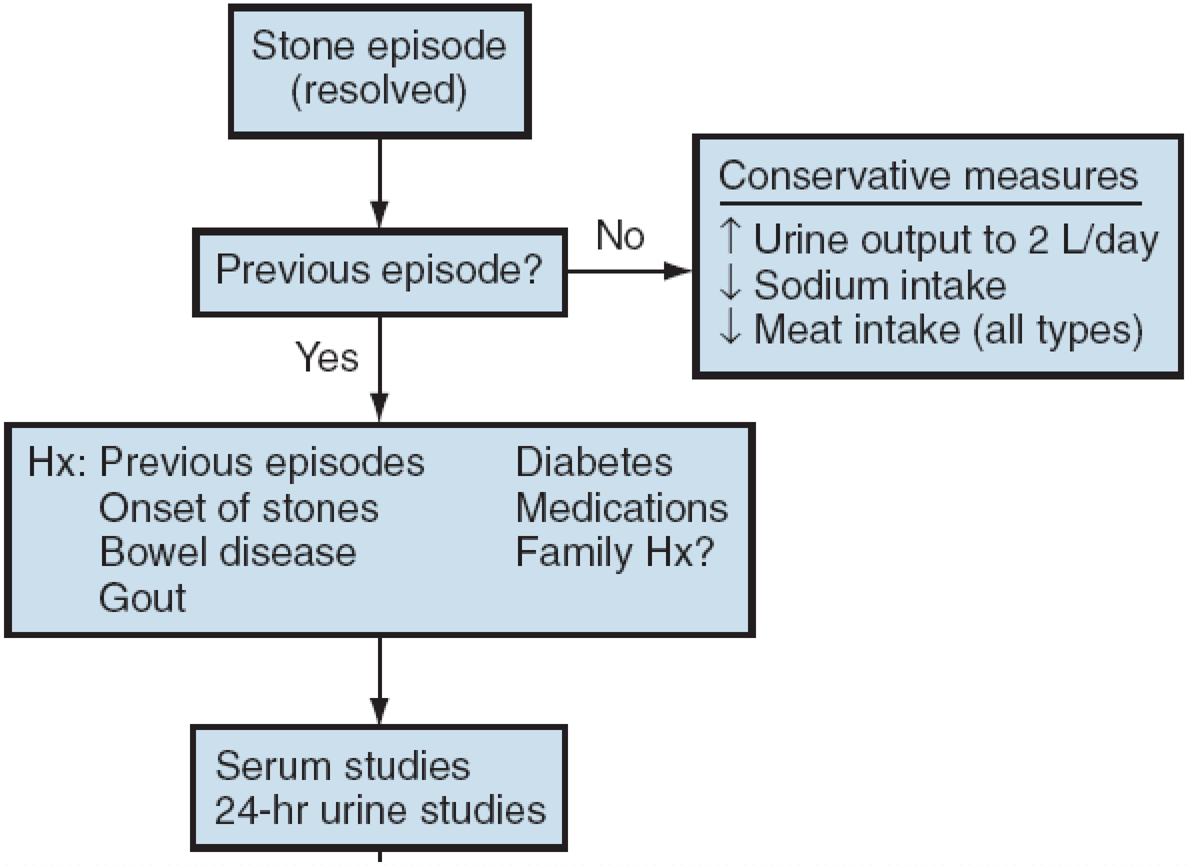
CALCIUM BASED CALCULI

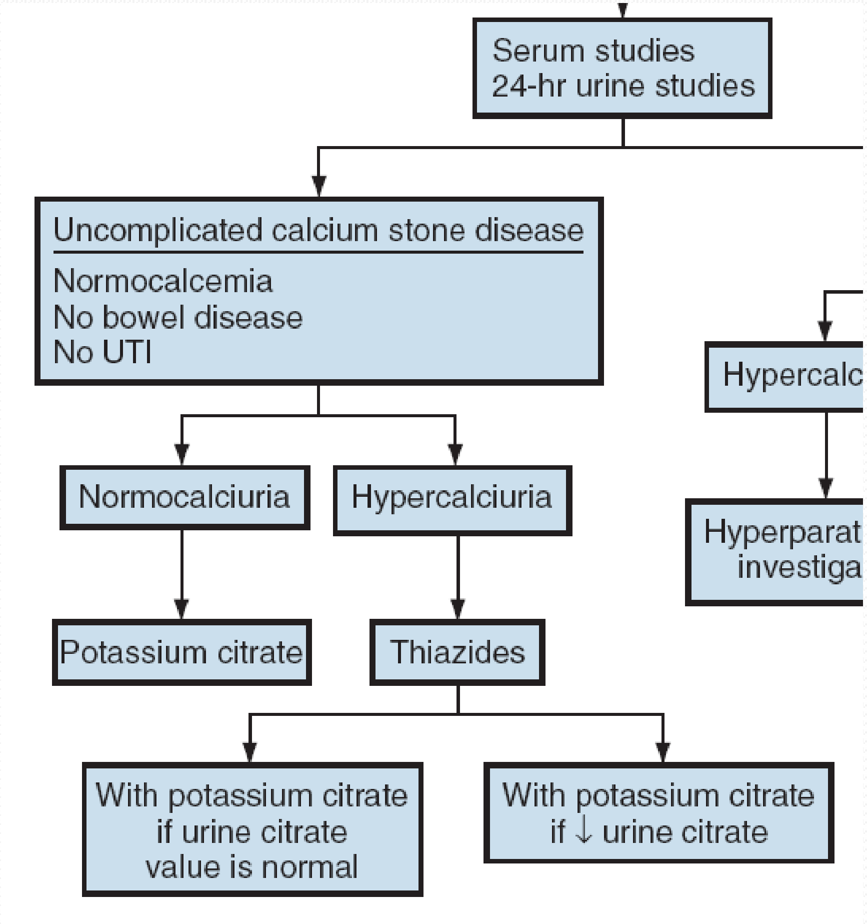
- • Calcium-based calculi are the most common type of urinary stones.
- • Calcium oxalate is the most common subtype.
- • Calcium phosphate stones are more common in young women and associated with alkaline urinary pH.
- • Brushite is a type of calcium phosphate strongly associated with rapid stone growth and recurrence.

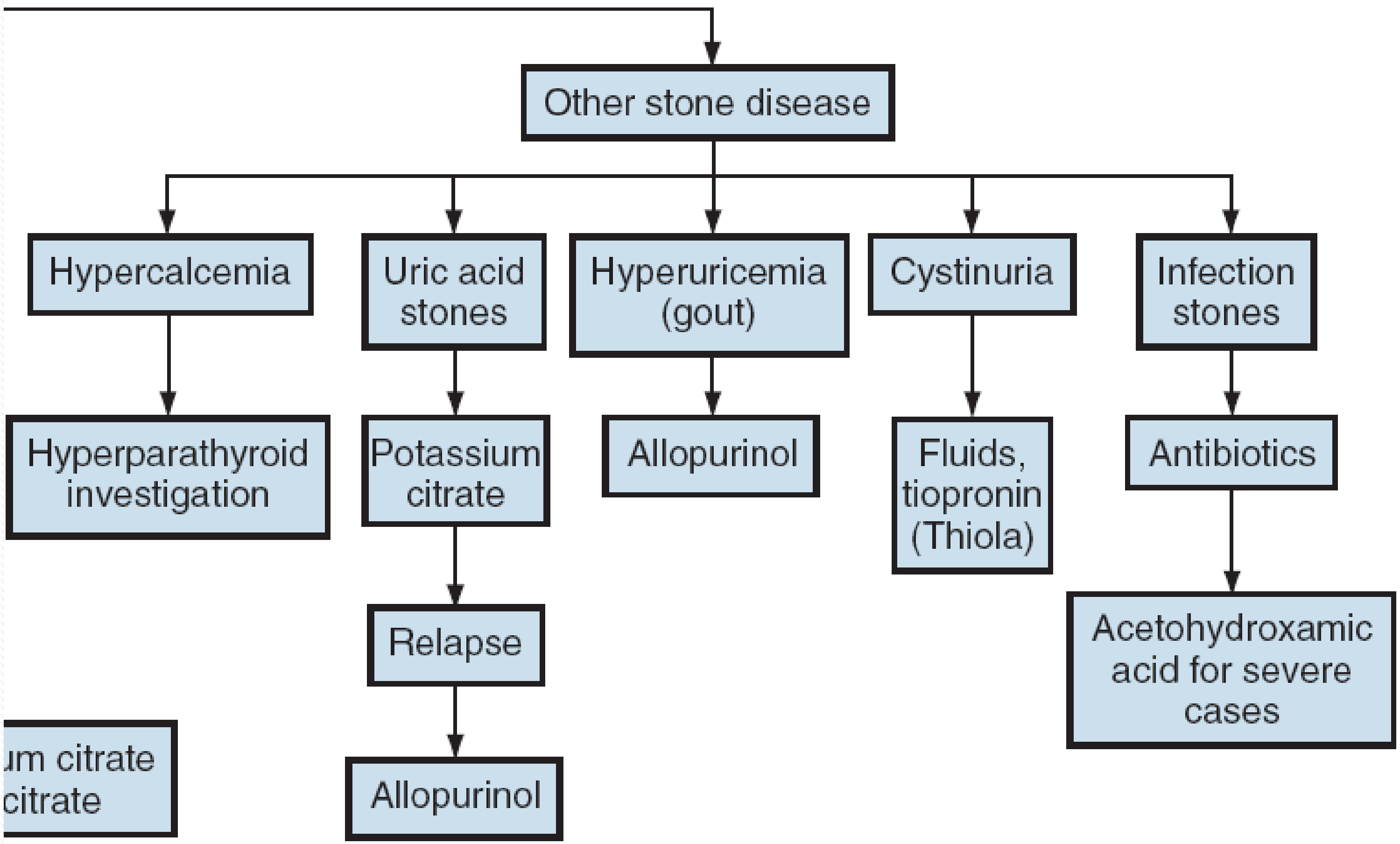
- • Dietary calcium restriction actually increases stone recurrence risk.
- • Calcium supplementation is likely safest when taken with meals.
- • Calcium citrate appears to be a more stone-friendly calcium supplement because of the additional inhibitory action of citrate.

Calcium Supplementation

- The influence of dietary and supplemental calcium and vitamin D remains an incompletely understood process. Administration of exogenous calcium and vitamin D supplements has been found to correlate with higher urinary calcium levels, but the overall effect this may have on stone formation remains unclear .


Stone episode (resolved)
Previous episode?
No
Conservative measures
↑ Urine output to 2 L/day
↓ Sodium intake
↓ Meat intake (all types)
Yes
Hx: Previous episodes
Onset of stones
Bowel disease
Gout
Diabetes
Medications
Family Hx?
Serum studies
24-hr urine studies


Serum studies
24-hr urine studies
Uncomplicated calcium stone disease
Normocalcemia
No bowel disease
No UTI
Hypercalc
Normocalciuria
Hypercalciuria
Hyperparat
investiga
Potassium citrate
Thiazides
With potassium citrate
if urine citrate
value is normal
With potassium citrate
if ↓ urine citrate



Other stone disease
Hypercalcemia
Uric acid stones
Hyperuricemia (gout)
Cystinuria
Infection stones
Hyperparathyroid investigation
Potassium citrate
Allopurinol
Fluids, tiopronin (Thiola)
Antibiotics
Relapse
Acetohydroxamic acid for severe cases
um citrate
citrate
Allopurinol

Thanks for your attention