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# Communiqué

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Feature

*Kidney Stones and Stone Analysis*

Inside



# Kidney Stones and Stone Analysis

The incidence of kidney stones is on the rise. Currently, more than 1 million cases are reported on an annual basis and your chance of passing a kidney stone in your lifetime is 10 percent. Not good news considering that the experience of passing a kidney stone has been described as excruciatingly painful. Fortunately, the composition of the individual kidney stone and urine studies can help the physician determine the right treatment and measures to prevent formation of new stones.


*Image 1. Individual stones vary in size and conformation and many patients have multiple small stones. A, B, and C are examples of multiple stones from 3 different patients (additional stones from these patients were crushed for analysis). D is a larger, more irregularly surfaced stone. E is a smooth stone with visible layers (cross-sectioned). F is made up of a core covered with protruding stalks. G shows 5 sections from one stone with well-defined layers.*

## Kidney Stones – What Are They and Where Do They Come From?

There are several terms for kidney stones: renal lithiasis, urinary calculi, urinary stones, and bladder stones. The various names all come back to the same thing, a "stone" develops as a result of crystal formation in urine. One reason crystals may form is because the urine becomes too concentrated. However, other conditions can cause crystal formation. Calcium, oxalate (oxalic acid), uric acid, and cystine all have the tendency to form crystals, while substances such as citrate and magnesium help prevent crystal formation. Any number of conditions can affect the delicate balance between these substances: heredity, diet, drugs, climate (natural or artificial), lifestyle, and certain medical conditions.

*Image 2. The stones in this photo demonstrate the widely varying shape and texture which may be seen. The largest stone (which shows a cut made during the analysis of the stone) has a flattened, circular shape with a gritty surface. The smallest stone has a roughly round shape and a very sandy texture, with larger particles that come off when handled. The white stones have an irregular, hard smooth surface. The dark brown stones are densely pitted and have a hard surface that flakes off*

The crystals may form on the inner surface of your kidneys and can break off and enter the ureter (tubes leading from the kidney to the bladder). The stone then travels to the bladder, down the urethra, and exits the body. Problems occur when the stone is too large to pass through the ureter or the urethra, causing pain, and potentially, damage. (See Photos 1 and 2.)

Two less common types of stones include struvite and cystine stones. Struvite stones are almost always a result of a urinary tract infection and usually are found in women. The bacteria causing the urinary tract infection secrete specific enzymes that increase the ammonia in the urine. Struvite stones are primarily formed of crystals containing ammonia, magnesium, and phosphate, are often

large and can have a characteristic stag's horn shape that can cause serious kidney damage. (See Photo 3) Cystine stones are a result of a hereditary disorder that causes the kidneys to excrete excessive amounts of cystine and certain other amino acids.

*Image 3. The characteristic stag's horn shape of a struvite stone.*

Many kidney stones pass unnoticed. It is not uncommon for kidney stones to be discovered during a medical work-up for an unrelated problem. Symptoms of kidney stones vary and can include:

- Bloody, cloudy, or foul-smelling urine
- Nausea and vomiting
- Persistent urge to urinate
- Fever and chills if an infection is present

The most common initial symptom of a kidney stone is pain. When the stone enters the urinary tract, it can block the tract or cause irritation as the muscles contract to move the stone along. Pain usually occurs in the general area of the kidney, or may move into the lower abdomen; the pain is usually sharp and cramping. Small kidney stones may pass unassisted or by simply drinking lots of water, however, large stones may require surgical treatment. Kidney stones can be broken up with extracorporeal shock wave lithotripsy, the resulting small particles are then passed normally or thorough a catheter. (See Photo 4)

If the stone is especially large or located in the ureter, the physician may elect to perform percutaneous nephrolithotomy or ureteroscopic stone removal.

**Kidney Stone Analysis**

Regardless of the selected treatment, for proper management of patients with *recurrent* stone formation

*Image 4. Particles resulting from lithotripsy treatment.*

(approximately 80% of the stone-forming patients), qualitative and quantitative analysis of all crystal material present is essential to guide therapy.

Previously, stone analysis required grinding up the stone, mixing the powder with potassium bromide, using special equipment to compress the material into a standard pellet, drying the pellet, then analyzing it utilizing infrared spectrometry. Today, this time-consuming method has been greatly simplified. Mayo's Metals Laboratory has compiled data on the reference spectra of all known stone components. As a result, the laboratory is able to pulverize the stone into a fine powder, take an infrared spectrum reading from the powder, compare the reading to the reference spectra and provide a complete analysis of the complex crystal mixture, as well as the hydration state of each crystal type.

The composition of kidney stones may vary from a simple crystal to a complex mixture containing several different species of crystals. The composition of the nidus, the original crystal over which new layers form, may be entirely different from that of the peripheral layers. Stones are most commonly made up of calcium oxalate. The proportions of oxalate dihydrate vs. oxalate monohydrate can give clues to the age of the stone, with older stones being composed of primarily of monohydrate. Monohydrate is a more stable form than dihydrate, and can be formed from the conversion of dihydrate to monohydrate (but not vice versa). Outer newly formed layers may be primarily dihydrate. (See Photo 5.)

Most stones (95%) are composed of calcium oxalate, uric acid, or calcium phosphate. However, as pharmacology advances, some drugs are being

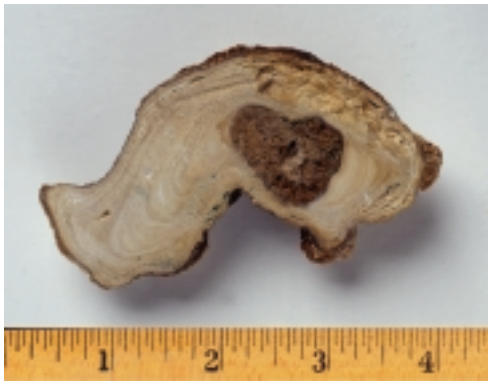

*Image 5. This cross-section allows you to see the irregular deposition of the various layers.*

identified as the causative agent in some stone formation. For example, stones formed as a result of the use of indinavir (an antiviral agent) and its metabolites have now been identified. Additionally, over-the-counter stimulants such as guaifenesin (a cough suppressant) have been shown to cause stone formation. Thanks to the development of better techniques and equipment, the laboratory now can identify the composition of these nontraditional kidney stones.

**Proper Specimen Submission**

In our experience, many of the specimens received for Stone Analysis #8596 require additional time for analysis because they are submitted improperly. We often receive specimens with various amounts of tissue attached, which must be removed before the specimen can be properly dried and analyzed. It is also a common misconception that the stones must be kept in liquid until they reach the laboratory, or shipped in metal-free containers. In fact, with today's high-tech equipment, the turnaround time is optimized if the specimen is received already washed and dried, with all extraneous material removed

Another common problem that MML encounters occurs when stones get taped to paper products for mailing, to ensure the stone is not lost. This causes difficulties for the lab, as the size of many stones make removing paper and tape fragments extremely difficult, and the adhesive material can interfere with the analytical procedure. The best option for submitting a specimen is to clean the stone of any foreign materials or tissue, dry the specimen, and place the specimen in a small vial or tube. Transportation fluid and metal-free containers are not necessary. Specimens may be shipped at any transport temperature. Think that stone is too small to analyze? Absolutely not, if you can see it, we can analyze it!

**Treatment and Prevention of Kidney Stones**

Each stone is different, and each patient needs to have his/her stone analysis used in the context of his/her clinical situation to determine the proper treatment and optimum behaviors to reduce the likelihood of reoccurrence. As general guidelines, following patterns are often treated as follows:

- Past production of uric acid stones together with current hyperuricuria, indicates the patient's urine should be alkalinized to increase the solubility of uric acid.
- Past production of hydroxyapatite stones and current hypercalciuria indicate the patient's urine should be acidified to increase the solubility of calcium. However, concentrations of urine phosphate, sulfate, oxalate, and citrate concentrations, as well as urine pH may also alter the therapeutic regimen.
- Past production of calcium oxalate stones and current hyperoxaluria indicate the patient's daily fluid intake should be increased if the 24 hour urine collection shows low urine volume. If hypercalciuria is evident, then reduction of daily intake of calcium may be indicated; however, daily requirements for calcium to maintain good bone formation complicate the treatment.
- Production of magnesium ammonium phosphate stones (struvite) indicates that the cause of stone formation was infection. Stone removal combined with treatment of the infection is the only way to inhibit further stone formation.

**Other Stone Types**

*Bladder Stones*

Stones also may form in the urinary bladder and are usually a result of incomplete bladder emptying. Bladder stones are analyzed by the same technique as kidney stones and have the same submission requirements; bladder stone analysis is available as Stone Analysis #8596. (See Photos 6 and 7.)

*Image 6. This stone has the characteristic "jack" structure of a bladder stone. Enlarged to show detail, this stone is less than ¼ inch. The 4th arm of the stone extends out towards the camera. This photo was taken under 3x magnification.*

*Gallstones*

Stones also may form in the gallbladder, although the pathogenesis of gallbladder stones is different from urinary system stones. (See Photos 8 and 9.)

*Image 7. The orange coloration is typical of a uric acid stone. Uric acid and uric acid dihydrate stones are most commonly found in the bladder, although they also can occur in the kidney. This photo was taken under 6x magnification.*

Gallstones are analyzed for their cholesterol content and the test is available through MML as Gallstone Cholesterol Content #81981. Gallstones must be rinsed in demineralized or distilled water and shipped in a securely capped vial.

**Stone Analysis at MML**

Mayo's Metals Laboratory's experienced technologists analyzed almost 20,000 kidney stones last year. If possible, separate testing of the layers forming the stone is performed. Our comprehensive stone analysis allows the physician to optimize preventive treatments.

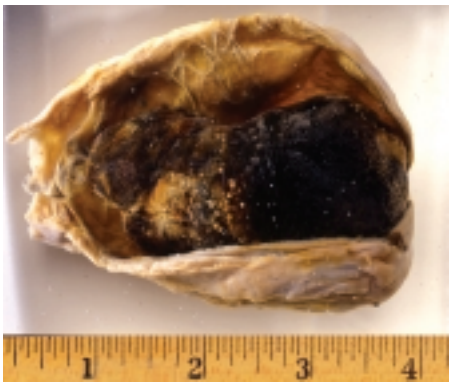

*Image 8. The dark mass is a gallstone approximately 3 x 1 ¾ inches; the white surrounding tissue is the gallbladder.*

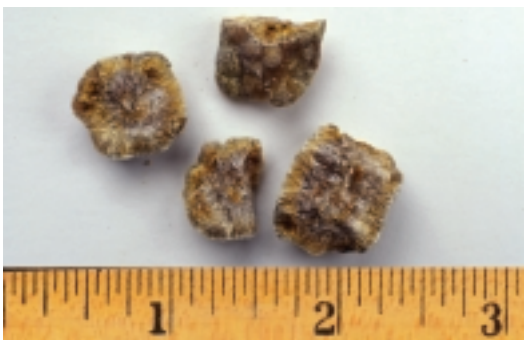

*Image 9. A fragmented cholesterol stone.*

## 17-Hydroxyprogesterone Test Changes

**17-Hydroxyprogesterone, Plasma or Serum (#9231)**, has been converted to High Performance Liquid Chromatography / Tandem Mass Spectrometry (LC / MS / MS) instrumentation. This assay is more accurate than the previous method. The name will change to 17-Hydroxyprogesterone, Serum (#9231), to reflect the change in preferred specimen type.

New Specimen Required:

Draw blood in a plain, red-top tube or an SST tube. Spin down and send 0.5 mL of serum refrigerated. (This is a change from the previously requested 0.2 mL of serum.)

EDTA plasma will still be accepted.

## Testosterone Specimen Requirement Reminder

Total testosterone, whether ordered as Testosterone, Total (#8533) or Testosterone, Total and Free (#8508), is measured using an automated, competitive chemiluminescent immunoassay. When a patient value for Testosterone, Total is lower than 30 ng / mL, an additional extraction using 0.9 mL of specimen is performed to increase the sensitivity of the assay. When insufficient specimen is received for the Testosterone, Total extraction, the value is reported as <30 ng / mL.

When insufficient specimen for Testosterone, Total and Free is received, Testosterone, Total will be performed. If needed, and if sufficient specimen is received, the extraction assay will be performed. The Free Testosterone will be reported as "Quantity Not Sufficient." (QNS)

To avoid a short-specimen situation, please submit the full preferred volume.

Specimen Required:

For Testosterone, Total and Free (#8508)

Draw blood in either a plain red-top tube or an SST tube. Spin down and send 2.5 mL of serum refrigerated.

For Testosterone, Total (#8533)

Draw Blood in either a plain red-top tube or an SST tube. Spin down and send 1.0 mL of serum refrigerated.

# *Meeting* Calendar

## *Interactive Satellite Program . . .*

**May 10, 2001**
New Advances in Arthritis-Part 1
Steven R. Ytterberg, M.D.

**June 19, 2001**
New Advances in Arthritis-Part 2
Steven R. Ytterberg, M.D.

## *Upcoming Education Conferences . . .*

**June 14-15, 2001**
Phlebotomy 2001
Rochester Marriott Hotel, Rochester, Minnesota
Course Director: Linda Iverson
Presented by Mayo Medical Laboratories

**September 12-14, 2001**
Integration Through Community Laboratory Insourcing
Chateau Sonesta, New Orleans, Louisiana
Course Director: Rodney Forsman
Presented by Mayo Medical Laboratories

**For additional information regarding the above programs, please contact the Mayo Reference Services Education Office at 1-800-533-1710.**

### LSD Confirmation Test Method and Reference Change

Lysergic Acid Diethylamide (LSD) Confirmation, Urine (#81743) has been changed from an immunoassay/gas chromatography/mass spectrometry (GC/MS) method to an immunoassay/liquid chromatography with tandem mass spectrometry detection (LC/MS/MS). This test is designed to detect the presence of LSD and its prevalent metabolite, 2-oxo-3-hydroxy-LSD, in urine following either oral or topical application. With this change in method, the test will be offered Monday through Friday.

New Reference Values:

Negative
Lysergic Acid Diethylamide (LSD)
0.5 ng/mL (cutoff concentration)
LSD quantity will be reported when >0.5 ng/mL
2-oxo-3-hydroxy-lysergic acid diethylamide (LSD metabolite)
5.0 ng/mL (cutoff concentration)
LSD metabolite quantity will be reported when >0.5 ng/mL

Both LSD and LSD metabolite quantity will be reported when above cutoff concentration.

Previous Reference Values:

Negative
Cutoff concentration: 0.5 ng/mL
LSD quantity will be reported when >0.5 ng/mL

### Galactose-1-Phosphate Uridyltransferase (GPUT and GPUTG) Specimen Change

The preferred specimen for Galactose-1-Phosphate Uridyltransferase (GPUT), Blood (#8333) and Galactose-1-Phosphate Uridyltransferase (GPUT) Genotyping, Erythrocytes (#80341) has changed to allow the addition of molecular genetic testing on the same specimen if requested. Heparin and ACD-solution B anticoagulants are still acceptable for these tests.

New Specimen Requirements:

Draw blood in a lavender-top (EDTA) tube(s), and send 5.0 mL (pediatric: 2.0 mL) of EDTA whole blood refrigerated.
**SPECIMEN CANNOT BE FROZEN**.

Previous Specimen Requirements:

Draw blood in green-top (heparin) tube(s), and send 5.0 mL (pediatric: 2.0 mL) of heparinized whole blood refrigerated.
**SPECIMEN CANNOT BE FROZEN.**

## Ask US

**Q:** Do calcium supplements increase your risk of kidney stones?

**A:** In studies, researchers have found that women with the highest calcium intake were less likely to develop kidney stones than women who ate the least amount of calcium. Dietary calcium binds with oxalates in the gastrointestinal tract so that oxalates can't be absorbed from the intestine and excreted by the kidney to form stones. Calcium supplements may not have the same protective effect as dietary calcium, however, if they're not taken with meals. When taken on an empty stomach, the calcium can't bind with the oxalates in food.

(Source: MayoClinic.com)

## *Abstracts* of Interest

### Acute Renal Failure: A Practical Update

**Robert C. Albright, Jr, DO**

Acute renal failure (ARF) affects almost all medical specialties. Its occurrence seems to be increasing in hospitalized patients. A structured approach to the evaluation and management of ARF would facilitate rapid diagnosis and treatment in most patients. Appreciation for the multiple drugs that affect renal function is especially important. Exclusion of urinary outflow obstruction and administration of therapies that improve renal perfusion should be given top priority with respect to managing ARF. Dialytic intervention for ARF is required when otherwise irreversible pathophysiologic derangements of electrolyte homeostasis, fluid balance, and uremic solute control are imminent. This article provides a brief review and update on the clinical evaluation and management of ARF.

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# *Communiqué*

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