Overview

Useful For
Diagnosis and management of patients with renal lithiasis:

- In patients who have a radiopaque stone, for whom stone analysis is not available, the supersaturation data can be used to predict the likely composition of the stone. This may help in designing a treatment program.

Aiding in identification of specific risk factors for stones

Monitoring the effectiveness of therapy by confirming that the crystallization potential has indeed decreased

Evaluation of renal excretion of acid and urine pH

Estimation of a patient's protein intake

Profile Information

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Special Instructions
- Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens

Method Name
Test Definition: SAT24
Supersaturation, U

CITP: Enzymatic
OXUP: Enzymatic using Oxalate Oxidase
USOMP: Freezing Point Depression
SULFP: High-Pressure Ion Chromatography (HPIC)
CALCP: Photometric, NM-BAPTA Reaction
MAGP: Colorimetric Endpoint Assay
POUP: Molybdic Acid
UPHP: pH Meter
NAUP, KUP, CLUP: Potentiometric, Indirect Ion-Selective Electrode (ISE)
CTUP: Enzymatic Colorimetric Assay
URCP: Uricase
AMMP: Enzymatic Assay
UNP: Kinetic UV Assay

NY State Available
Yes

Specimen

Specimen Type
Urine

Necessary Information
1. 24-Hour volume is required.
2. Patient's height in centimeters and weight in kilograms are required if patient is younger than 18 years.

Specimen Required
Supplies: Diazolidinyl Urea (Germall) 5.0 mL (T822)

Container/Tube: Plastic, 60-mL urine bottle

Specimen Volume: 35 mL

Collection Instructions:
1. Collect urine for 24 hours.
2. Add 5 mL of diazolidinyl urea as preservative at start of collection, or refrigerate specimen during and after
collection.

3. Specimen pH should be between 4.5 and 8 and will stay in this range if kept refrigerated. Specimens with pH >8 indicate bacterial contamination, and testing will be cancelled. Do not attempt to adjust pH as it will adversely affect results.

Additional Information: See Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens in Special Instructions for multiple collections.

Forms

If not ordering electronically, complete, print, and send a Renal Diagnostics Test Request (T830) with the specimen.

Urine Preservative Collection Options

Note: The addition of preservative or application of temperature controls must occur at the beginning of the collection.

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Specimen Minimum Volume

25 mL

Reject Due To

| pH >8.0 | Reject |

Specimen Stability Information

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Clinical and Interpretive

Clinical Information

Urine is often supersaturated, which favors precipitation of several crystalline phases such as calcium oxalate, calcium phosphate, and uric acid. However, crystals do not always form in supersaturated urine because supersaturation is balanced by crystallization inhibitors that are also present in urine. Urinary inhibitors include ions (eg, citrate) and macromolecules but remain poorly understood.

Urine supersaturation is calculated by measuring the concentration of all the ions that can interact (potassium, calcium, phosphorus, oxalate, uric acid, citrate, magnesium, sodium, chloride, sulfate, and pH). Once the concentrations of all the relevant urinary ions are known, a computer program can calculate the theoretical supersaturation with respect to the important crystalline phases (eg, calcium oxalate).(1)

Since the supersaturation of urine has been shown to correlate with stone type,(2) therapy is often targeted towards decreasing those urinary supersaturations that are identified. Treatment strategies include alterations in diet and fluid intake as well as drug therapy, all designed to decrease the urine supersaturation.

Reference Values

SUPERSATURATION REFERENCE MEANS (Delta G: DG)

Calcium oxalate: 1.77 DG
Brushite: 0.21 DG
Hydroxyapatite: 3.96 DG
Uric acid: 1.04 DG
Sodium urate: 1.76 DG

INDIVIDUAL URINE ANALYTES

OSMOLALITY

0-11 months: 50-750 mOsm/kg
> or =12 months: 150-1,150 mOsm/kg

pH

4.5-8.0

ALL REFERENCE RANGES BELOW ARE BASED ON 24-HOUR COLLECTIONS.

SODIUM

41-227 mmol/24 hours

Reference values have not been established for patients <16 years of age.
POTASSIUM
17-77 mmol/24 hours
Reference values have not been established for patients < 16 years of age.

CALCIUM
Males: < 250 mg/24 hours
Females: < 200 mg/24 hours
Reference values have not been established for patients < 18 years and > 83 years of age

MAGNESIUM
51-269 mg/24 hours
Reference values have not been established for patients < 18 years and > 83 years of age

CHLORIDE
40-224 mmol/24 hours
Reference values have not been established for patients < 16 years of age.

PHOSPHORUS
< 1,100 mg/24 hours

SULFATE
7-47 mmol/24 hours

CITRATE EXCRETION
0-19 years: not established
20 years: 150-1,191 mg/24 hours
21 years: 157-1,191 mg/24 hours
22 years: 164-1,191 mg/24 hours
23 years: 171-1,191 mg/24 hours
24 years: 178-1,191 mg/24 hours
25 years: 186-1,191 mg/24 hours
26 years: 193-1,191 mg/24 hours
27 years: 200-1,191 mg/24 hours
28 years: 207-1,191 mg/24 hours
29 years: 214-1,191 mg/24 hours
30 years: 221-1,191 mg/24 hours
31 years: 228-1,191 mg/24 hours
32 years: 235-1,191 mg/24 hours
33 years: 242-1,191 mg/24 hours
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45 years: 328-1,191 mg/24 hours
46 years: 335-1,191 mg/24 hours
47 years: 342-1,191 mg/24 hours
48 years: 349-1,191 mg/24 hours
49 years: 356-1,191 mg/24 hours
50 years: 363-1,191 mg/24 hours
51 years: 370-1,191 mg/24 hours
52 years: 378-1,191 mg/24 hours
Supersaturation, U

53 years: 385-1,191 mg/24 hours
54 years: 392-1,191 mg/24 hours
55 years: 399-1,191 mg/24 hours
56 years: 406-1,191 mg/24 hours
57 years: 413-1,191 mg/24 hours
58 years: 420-1,191 mg/24 hours
59 years: 427-1,191 mg/24 hours
60 years: 434-1,191 mg/24 hours
>60 years: not established

OXALATE
0.11-0.46 mmol/24 hours

URIC ACID
Diet-dependent: <750 mg/24 hours

CREATININE
Normal values mg per 24 hours:
Males: 955-2936 mg/24 hours
Females: 601-1689 mg/24 hours
Reference ranges for male and female patients <18 and >83 years of age have not been established.
The expected urine creatinine excretion per 24 hours:
Males: 13-29 mg/kg of body weight/24 hours
Females: 9-26 mg/kg of body weight/24 hours
Reference ranges for male and female patients <18 and >83 years of age have not been established.
Note: To convert to mg/kg of body weight/24 hours, divide the mg/24 hours result by body weight in kg.

AMMONIUM
15-56 mmol/24 hour
Reference values have not been established for patients <18 years and >77 years of age.
UREA NITROGEN
5.0-16.0 g/24 hours

PROTEIN CATABOLIC RATE
56-125 g/24 hours

**Interpretation**

Delta G (DG), the Gibbs free energy of transfer from a supersaturated to a saturated solution, is negative for undersaturated solutions and positive for supersaturated solutions. In most cases the supersaturation levels are slightly positive even in normal individuals but are balanced by an inhibitor activity.

While the DG of urine is often positive, even in the urine of nonstone formers, on average, the DG is even more positive in those individuals who do form kidney stones. The "normal" values were simply derived by comparing urinary DG values for the important stone-forming crystalline phases between a population of stone formers and a population of nonstone formers. Those DG values that are outside the expected range in a population of nonstone formers are marked "abnormal."

If the urine citrate is low, secondary causes should be excluded including hypokalemia, renal tubular acidosis, gastrointestinal bicarbonate losses (eg, diarrhea or malabsorption), or an exogenous acid load (eg, excessive consumption of meat protein).

A normal or increased citrate value suggests that potassium citrate may be a less effective choice for treatment of a patient with calcium oxalate or calcium phosphate stones.

An increased urinary oxalate value may prompt a search for genetic abnormalities of oxalate production (ie, primary hyperoxaluria). Secondary hyperoxaluria can result from diverse gastrointestinal disorders that result in malabsorption. Milder hyperoxaluria could result from excess dietary oxalate consumption, or reduced calcium (dairy) intake, perhaps even in the absence of gastrointestinal disease. High urine ammonium and low urinary pH suggests ongoing gastrointestinal losses. Such patients are at risk of uric acid and calcium oxalate stones.

Low urine ammonium and high urine pH suggest renal tubular acidosis. Such patients are at risk of calcium phosphate stones.

Patients with calcium oxalate and calcium phosphate stones are often treated with citrate to raise the urine citrate (a natural inhibitor of calcium oxalate and calcium phosphate crystal growth). However, since citrate is metabolized to bicarbonate (a base) this drug can also increase the urine pH. If the urine pH gets too high with citrate treatment, one may unintentionally increase the risk of calcium phosphate stones. Monitoring the urine ammonium is one way to titrate the citrate dose and avoid this problem. A good starting citrate dose is about one-half of the urine ammonium excretion (in mEq of each). One can monitor the effect of this dose on urine ammonium, citrate, and pH values, and adjust the citrate dose based upon the response. A fall in urine ammonium should indicate whether the current citrate is enough to partially (but not completely) counteract the daily acid load of that given patient.

The protein catabolic rate is calculated from urine urea. Under routine conditions, the required protein intake is often estimated as 0.8 g/ kg body weight.

The results can be used to determine the likely effect of a therapeutic intervention on stone-forming risk. For example, taking oral potassium citrate will raise the urinary citrate excretion, which should reduce calcium phosphate supersaturation (by reducing free ionic calcium), but citrate administration also increases urinary pH (because it represents an alkali load) and a higher urine pH promotes calcium phosphate crystallization. The net result of this or any therapeutic manipulation could be assessed by collecting a 24-hour urine and comparing the supersaturation
calculation for calcium phosphate before and after therapy.

Important stone-specific factors:

- Calcium oxalate stones: urine volume, calcium, oxalate, citrate, and uric acid excretion are all risk factors that are possible targets for therapeutic intervention.

- Calcium phosphate stones (apatite or brushite): urinary volume, calcium, pH, and citrate significantly influence the supersaturation for calcium phosphate. Of note, a urine pH of less than 6 may help reduce the tendency for these stones to form.

- Uric acid stones: urine pH, volume, and uric acid excretion levels influence the supersaturation. Urine pH is especially critical, in that uric acid is unlikely to crystallize if the pH is greater than 6.

- Sodium urate stones: alkaline pH and high uric acid excretion promote stone formation.

A low urine volume is a universal risk factor for all types of kidney stones.

**Cautions**

The urine is often supersaturated with respect to the common crystalline constituents of stones, even in nonstone formers.

Individual interpretation of the supersaturation values in light of the clinical situation is critical. In particular, treatment may reduce the supersaturation with respect to one crystal type, but increase the supersaturation with respect to another. Therefore, the specific goals of treatment must be considered when interpreting the test results.

**Clinical Reference**


**Performance**

**Method Description**

The major analytes evaluated are potassium, calcium, phosphorus, oxalate, uric acid, citrate, magnesium, sodium, chloride, sulfate, ammonium, urea nitrogen and pH. The protein catabolic rate is calculated from urine urea nitrogen using the formula: Protein catabolic rate (g/day) = [(UUN+4)* 6.25] g. Given the measured urine concentrations of these analytes and the known affinity constants of the ions for each other at the given pH, a computer program (EQUIL2) calculates a supersaturation for each ion pair of interest (eg, calcium oxalate)(1). Results are expressed as a Delta G (DG) value for each ion pair. DG is the Gibbs free energy of transfer from a supersaturated to a saturated solution. (Moreira DM, Friedlander JI, Hartman C, et al: Using 24-hour urinalysis to predict stone type. J Urol 2013;190:2106-2111)
Test Definition: SAT24
Supersaturation, U

PDF Report
No

Day(s) and Time(s) Test Performed
Monday through Friday; 8 a.m.-4 p.m.

Analytic Time
2 days; Excess capacity for this test is limited.

Maximum Laboratory Time
5 days

Specimen Retention Time
7 days

Performing Laboratory Location
Rochester

Fees and Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their Regional Manager. For assistance, contact Customer Service.

Test Classification
This test was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. This test has not been cleared or approved by the U.S. Food and Drug Administration.

CPT Code Information
82340-Calcium
82436-Chloride
82507-Citrate excretion
82570-Creatinine
83735-Magnesium
83935-Osmolality
83945-Oxalate
83986-pH
84105-Phosphorus
84133-Potassium
## Test Definition: SAT24
Supersaturation, U

84300-Sodium
84392-Sulfate
84560-Uric acid
82140-Ammonium
84540-Urea Nitrogen

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