Test Definition: SUP24

Supersaturation Profile, 24 Hour, Urine

Overview

Useful For

Diagnosis and management of patients with renal lithiasis:
-Predicting the likely composition of the stone, in patients who have a radiopaque stone, for whom stone analysis is not available
-May aid in designing a treatment program

Aiding in identification of specific risk factors for stones using a 24-hour urine collection

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

Evaluating kidney excretion of acid and urine pH

Estimating a patient's protein intake

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
SSINT	Supersaturation, 24 HR, U 1	No	Yes
NAUT	Sodium, 24 HR, U	Yes, (order NAU)	Yes
KUT	Potassium, 24 HR, U	Yes, (order KUR)	Yes
CALUT	Calcium, 24 HR, U	Yes, (order CALU)	Yes
MAGT	Magnesium, 24 HR, U	Yes, (order MAGU)	Yes
CLUT	Chloride, 24 HR, U	Yes, (order CLU)	Yes
POUT	Phosphorus, 24 HR, U	Yes, (order POU)	Yes
SULFT	Sulfate, 24 HR, U	Yes, (order SULFU)	Yes
CITT	Citrate Excretion, 24 HR, U	Yes, (order CITR)	Yes
OXUT	Oxalate, 24 HR, U	Yes, (order OXU)	Yes
UPHT	pH, 24 HR, U	Yes, (order PHU_)	Yes
URICT	Uric Acid, 24 HR, U	Yes, (order URCU)	Yes
CTUT	Creatinine, 24 HR, U	Yes, (order URCU)	Yes
OSMUT	Osmolality, 24 HR, U	Yes, (order UOSMU)	Yes
AMMT	Ammonium, 24 HR, U	Yes, (order AMMO)	Yes
UNT	Urea Nitrogen, 24 HR, U	No	Yes
PCRUT	Protein Catabolic Rate, 24 HR, U	No	Yes
DEMO9	Patient Demographics	No	Yes

Special Instructions

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

Method Name

AMMT, CITT, OXUT: Enzymatic
OSMUT: Freezing Point Depression
SULFT: High-Performance Ion Chromatography (HPIC)
CALUT, POUT: Photometric
MAGT: Colorimetric Endpoint Assay
UPHT: pH Meter
NAUT, KUT, CLUT: Potentiometric, Indirect Ion-Selective Electrode (ISE)
CTUT: Enzymatic Colorimetric Assay
URICT: Uricase
UNT: Kinetic UV Assay
PCRUT, SSINT: Calculation

NY State Available

Yes

Specimen

Specimen Type

Urine

Necessary Information

1. 24-Hour volume (in milliliters) is required.

2. **Patient's height in centimeters and weight in kilograms are required** if patient is younger than 18 years.

Specimen Required

Patient Preparation:

X-ray dyes and contrast media will affect uric acid test results.
-If a kidney X-ray with dye or computerized tomography (CT) scan with contrast has been performed, patient should wait a minimum of 1 day before starting collection.
-If a cholangiography (bile duct X-ray) has performed, patient should wait 7 days before starting collection.
-Urine must be collected before tablets have been taken for gallbladder X-ray, otherwise patient should wait 7 days before starting collection.

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

Collection Container/Tube: 24-hour graduated urine container with no metal cap or glued insert

Submission Container/Tube: Plastic, 60-mL urine bottle

Specimen Volume: 35 mL

Collection Instructions:

1. Add 5 mL of diazolidinyl urea as preservative at start of collection or refrigerate specimen during and after collection.
2. Collect urine for 24 hours.
3. Specimen pH should be between 4.5 and 8 and will stay in this range if diazolidinyl urea is added at the beginning of

the collection or kept refrigerated during the entirety of the collection. Specimens with pH above 8 indicate bacterial contamination, and testing will be canceled. Do not attempt to adjust pH as it will adversely affect results.
4. **If not using Germall, the specimen must be kept refrigerated** during the entirety of the collection and sent frozen.
Additional Information: See Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens 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.

Ambient (No additive)	No
Refrigerate (No additive)	OK
Frozen (No additive)	No
50% Acetic Acid	No
Boric Acid	No
Diazolidinyl Urea (Germall)	Preferred
6M Hydrochloric Acid	No
6M Nitric Acid	No
Sodium Carbonate	No
Thymol	No
Toluene	No

Specimen Minimum Volume

10 mL

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Urine	Refrigerated (preferred)	14 days	
	Ambient	72 hours	
	Frozen	14 days	

Clinical & 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 present in the 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 the urinary supersaturations 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)
Men:
Calcium oxalate: 1.89 DG
Brushite: 0.46 DG
Hydroxyapatite: 4.19 DG
Uric acid: 1.18 DG

Women:
Calcium oxalate: 1.59 DG
Brushite: -0.11 DG
Hydroxyapatite: 3.62 DG
Uric acid: 0.89 DG

INDIVIDUAL URINE ANALYTES

OSMOLALITY, 24 HOUR, URINE
0-11 months: 50-750 mOsm/kg
> or =12 months: 150-1,150 mOsm/kg

pH, 24 HOUR, URINE
4.5-8.0

SODIUM, 24 HOUR, URINE
> or =18 years: 22-328 mmol/24 h
Reference values have not been established for patients who are younger than 18 years.

POTASSIUM, 24 HOUR, URINE
> or =18 years: 16-105 mmol/24 h
Reference values have not been established for patients who are younger than 18 years.

CALCIUM, 24 HOUR, URINE
Males: <250 mg/24 h
Females: <200 mg/24 h
Reference values have not been established for patients who are younger than 18 years.

MAGNESIUM, 24 HOUR, URINE

51-269 mg/24 h
Reference values have not been established for patients who are younger than 18 years.

CHLORIDE, 24 HOUR, URINE
> or =18 years: 34-286 mmol/24 h
Reference values have not been established for patients who are younger than 18 years.

PHOSPHORUS, 24 HOUR, URINE
> or =18 years: 226-1,797 mg/24 h
Reference values have not been established for patients who are younger than 18 years.

SULFATE, 24 HOUR, URINE
7-47 mmol/24 h

CITRATE EXCRETION, 24 HOUR, URINE
0-19 years: Not established
20 years: 150-1,191 mg/24 h
21 years: 157-1,191 mg/24 h
22 years: 164-1,191 mg/24 h
23 years: 171-1,191 mg/24 h
24 years: 178-1,191 mg/24 h
25 years: 186-1,191 mg/24 h
26 years: 193-1,191 mg/24 h
27 years: 200-1,191 mg/24 h
28 years: 207-1,191 mg/24 h
29 years: 214-1,191 mg/24 h
30 years: 221-1,191 mg/24 h
31 years: 228-1,191 mg/24 h
32 years: 235-1,191 mg/24 h
33 years: 242-1,191 mg/24 h
34 years: 250-1,191 mg/24 h
35 years: 257-1,191 mg/24 h
36 years: 264-1,191 mg/24 h
37 years: 271-1,191 mg/24 h
38 years: 278-1,191 mg/24 h
39 years: 285-1,191 mg/24 h
40 years: 292-1,191 mg/24 h
41 years: 299-1,191 mg/24 h
42 years: 306-1,191 mg/24 h
43 years: 314-1,191 mg/24 h
44 years: 321-1,191 mg/24 h
45 years: 328-1,191 mg/24 h
46 years: 335-1,191 mg/24 h
47 years: 342-1,191 mg/24 h
48 years: 349-1,191 mg/24 h

49 years: 356-1,191 mg/24 h
50 years: 363-1,191 mg/24 h
51 years: 370-1,191 mg/24 h
52 years: 378-1,191 mg/24 h
53 years: 385-1,191 mg/24 h
54 years: 392-1,191 mg/24 h
55 years: 399-1,191 mg/24 h
56 years: 406-1,191 mg/24 h
57 years: 413-1,191 mg/24 h
58 years: 420-1,191 mg/24 h
59 years: 427-1,191 mg/24 h
60 years: 434-1,191 mg/24 h
>60 years: Not established

OXALATE, 24 HOUR, URINE
0.11-0.46 mmol/24 h
9.7-40.5 mg/24 h
Reference values have not been established for patients who are younger than 16 years.

URIC ACID, 24 HOUR, URINE
Males: > or =18 years: 200-1,000 mg/24 h
Females: > or =18 years: 250-750 mg/24 h
Reference values have not been established for patients who are younger than 18 years.

CREATININE, 24 HOUR, URINE
Males: > or =18 years: 930-2,955 mg/24 h
Females: > or =18 years: 603-1,783 mg/24 h
Reference values have not been established for patients who are younger than 18 years.

AMMONIUM, 24 HOUR, URINE
15-56 mmol/24 h
Reference values have not been established for patients who are younger than 18 years or older than 77 years.

UREA NITROGEN, 24 HOUR, URINE
> or =18 years: 7-42 g/24 h
Reference values have not been established for patients who are younger than 18 years.

PROTEIN CATABOLIC RATE, 24 HOUR, URINE
56-125 g/24 h

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 non-stone formers, on average, the DG is more positive in those individuals who do form kidney stones. The reference values were derived by comparing urinary DG values for the important stone-forming crystalline phases between a population of stone formers and a population of non-stone formers. DG values that are outside the expected range in a population of non-stone 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 suggest 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 concentration 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 on the response. A fall in urine ammonium levels 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), which 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 of calcium phosphate. Of note, a urine pH below 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 above 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

Urine is often supersaturated with respect to the common crystalline constituents of stones, even in non-stone 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

1. Werness PG, Brown CM, Smith LH, Finlayson B. EQUIL2: a BASIC computer program for the calculation of urinary saturation. J Urol. 1985;134(6):1242-1244
2. Parks JH, Coward M, Coe FL. Correspondence between stone composition and urine supersaturation in nephrolithiasis. Kidney Int. 1997;51(3):894-900
3. Finlayson B. Calcium stones: Some physical and clinical aspects. In: David DS, ed. Calcium Metabolism in Renal Failure and Nephrolithiasis. John Wiley and Sons; 1977:337-382
4. Burtis CA, Bruns DE: Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics. 7th ed. Saunders; 2014
5. Tiselius HG, Daudon M, Thomas K, Seitz C. Metabolic work-up of patients with urolithiasis: indications and diagnostic algorithm. Eur Urol Focus. 2017 Feb;3(1):62-71. doi:10.1016/j.euf.2017.03.014

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). 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.(Werness PG, Brown CM, Smith LH, Finlayson B. EQUIL2: a BASIC computer program for the calculation of urinary saturation. J Urol. 1985;134(6):1242-1244; Moreira DM, Friedlander JI, Hartman C, Elsamra SE, Smith AD, Okeke Z. Using 24-hour urinalysis to predict stone type. J Urol. 2013;190(6):2106-2111)

PDF Report

Supplemental

Day(s) Performed
Monday through Sunday

Report Available
2 to 5 days

Specimen Retention Time
See Individual Test IDs

Performing Laboratory Location
Mayo Clinic Laboratories - Rochester Main Campus

Fees & 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 account representative. 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. It has not been cleared or approved by the US 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
84300-Sodium
84392-Sulfate
84560-Uric acid
82140-Ammonium
84540-Urea Nitrogen

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
SUP24	Supersaturation, 24 HR, U	81232-1

Test Definition: SUP24

Supersaturation Profile, 24 Hour, Urine

Result ID	Test Result Name	Result LOINC® Value
CRU24	Creatinine, 24 HR, U	2162-6
AMU24	Ammonium, 24 HR, U	25308-8
CAU24	Calcium, 24 HR, U	6874-2
CIT24	Citrate Excretion, 24 HR, U	6687-8
OXM24	Oxalate, 24 HR, U (mmol/24 HR)	14862-7
OXG24	Oxalate, 24 HR, U (mg/24 HR)	2701-1
CLU24	Chloride, 24 HR, U	2079-2
BSA1	Patient Surface Area	8277-6
HT6	Height (cm)	3137-7
WT6	Weight (kg)	29463-7
KU24	Potassium, 24 HR, U	2829-0
MGU24	Magnesium, 24 HR, U	24447-5
NAU24	Sodium, 24 HR, U	2956-1
UOSMT	Osmolality, 24 HR, U	2694-8
PCRUT	Protein Catabolic Rate, 24 HR, U	93746-6
POU24	Phosphorus, 24 HR, U	2779-7
21060	Interpretation	69051-1
616217	Calcium Oxalate Crystal	81623-1
616218	Brushite Crystal	101825-8
616219	Hydroxyapatite Crystal	81622-3
616220	Uric Acid Crystal	101827-4
SSDUR	Collection Duration	13362-9
SSVOL	Volume	3167-4
SUL24	Sulfate, 24 HR, U	26889-6
UNU24	Urea Nitrogen, 24 HR, U	3096-5
UPHT	pH, 24 HR, U	27378-9
URC24	Uric Acid, 24 HR, U	3087-4