



# Test Definition: CARU

Cyclic Adenosine Monophosphate (cAMP),  
Urinary Excretion, Serum and Urine

## Overview

### Useful For

Differential diagnosis of hypercalcemia

As an adjunct to serum parathyroid hormone measurements, especially in the diagnosis of parathyroid hormone resistance states, such as pseudohypoparathyroidism

### Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
ACREA	Creatinine, S	Yes, (order CRTS1)	Yes
CAMP	Cyclic Amp, Urinary Excretion	No	Yes
CRETR	Creatinine, Random, U	Yes, (order RCTUR)	Yes

### Method Name

ACREA, CRETR: Enzymatic Colorimetric Assay

CAMP: Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS)

### NY State Available

Yes

## Specimen

### Specimen Type

Serum  
Urine

### Specimen Required

Both serum and urine are required. Serum must be collected at the time of the urine collection.

**Specimen Type:** Serum

**Supplies:** Sarstedt Aliquot Tube, 5 mL (T914)

**Container/Tube:**

**Preferred:** Serum gel

**Acceptable:** Red top

**Submission Container/Tube:** Plastic vial

**Specimen Volume:** 1 mL

**Collection Instructions:**

1. Within 2 hours of collection serum gel tubes should be centrifuged.
2. Within 2 hours of collection red-top tubes should be centrifuged, and the serum aliquoted into a plastic vial.
3. Label specimen as serum.

**Specimen Type:** Urine

**Supplies:** Sarstedt Aliquot Tube, 5 mL (T914)

**Container/Tube:** Plastic vial

**Specimen Volume:** 5 mL

**Collection Instructions:**

1. Collect a random urine specimen.
2. Label specimen as urine.

**Specimen Minimum Volume**

Serum: 0.5 mL

Urine: 1 mL

**Reject Due To**

Gross hemolysis	Reject
Gross lipemia	OK
Gross icterus	OK

**Specimen Stability Information**

Specimen Type	Temperature	Time	Special Container
Serum	Refrigerated (preferred)	7 days	
	Frozen	90 days	
Urine	Refrigerated (preferred)	28 days	
	Frozen	28 days	

**Clinical & Interpretive**

**Clinical Information**

3'-5'-cyclic adenosine monophosphate (cAMP) functions as an intracellular "second messenger" playing a key role in cellular functions such as transcription, metabolism, mitochondrial homeostasis, cell division, and cell death. Several hormones such as calcitonin, dopamine, glucagon, glucagon like peptide-1, vasoactive intestinal peptide and parathyroid hormone (PTH) have been shown to increase the formation of cAMP in the kidney by the action of adenylate cyclase. It has been shown that a significant portion of the urinary cAMP is generated in response to parathyroid hormone. As a result, urinary cAMP measurements can be used for distinguishing between PTH or non-PTH mediated hypercalcemia and aid in the differential diagnosis of hypercalcemia. Additionally, measurements of urinary cAMP levels following PTH stimulation are useful for the differential diagnosis of hypoparathyroid disorders. Urinary cAMP is elevated in about 85%

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of patients with hyperparathyroidism.

**Reference Values**

## CYCLIC AMP

1.3-3.7 nmol/dL of glomerular filtrate

## CREATININE, SERUM

## Males

0-11 months: 0.17-0.42 mg/dL

1-5 years: 0.19-0.49 mg/dL

6-10 years: 0.26-0.61 mg/dL

11-14 years: 0.35-0.86 mg/dL

> or =15 years: 0.74-1.35 mg/dL

## Females

0-11 months: 0.17-0.42 mg/dL

1-5 years: 0.19-0.49 mg/dL

6-10 years: 0.26-0.61 mg/dL

11-15 years: 0.35-0.86 mg/dL

> or =16 years: 0.59-1.04 mg/dL

## CREATININE, URINE

No reference values apply. Interpret with other clinical data.

**Interpretation**

3'-5'-cyclic adenosine monophosphate (cAMP) is elevated in about 85% of patients with hyperparathyroidism and in about 50% of patients with humoral hypercalcemia of malignancy.

Minimal to no increase in cAMP levels following parathyroid hormone stimulation suggests type I pseudohypoparathyroidism.

**Cautions**

Parathyroid suppression (hypoparathyroidism) does not lower urinary 3'-5'-cyclic adenosine monophosphate (cAMP) excretion to definitively subnormal values.

**Clinical Reference**

1. Shaw JW, Oldham SB, Rosoff L, Bethune JE, Fichman MP. Urinary cyclic AMP analyzed as a function of the serum calcium and parathyroid hormone in the differential diagnosis of hypercalcemia. *J Clin Invest.* 1977;59(1):14-21. doi:10.1172/JCI108611
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3. Dohan PH, Yamashita K, Larsen PR, Davis B, Deftos L, Field JB. Evaluation of urinary cyclic 3'5'-adenosine monophosphate excretion in the differential diagnosis of hypercalcemia. *J Clin Endocrinol Metab.* 1972;35(6):775-784. doi:10.1210/jcem-35-6-775
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- hypercalciurias. *N Engl J Med.* 1975;292(10):497-500. doi:10.1056/NEJM197503062921002
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6. Drezner MK, Neelon FA, Curtis HB, Lebovitz HE. Renal cyclic adenosine monophosphate: an accurate index of parathyroid function. *Metabolism.* 1976;25(10):1103-1112. doi:10.1016/0026-0495(76)90018-4
7. Delrue C, Speeckaert R, Moresco RN, Speeckaert MM. Cyclic Adenosine Monophosphate Signaling in Chronic Kidney Disease: Molecular Targets and Therapeutic Potentials. *Int J Mol Sci.* 2024;25(17):9441. doi:10.3390/ijms25179441
8. Kaminsky NI, Broadus AE, Hardman JG, et al. Effects of parathyroid hormone on plasma and urinary adenosine 3',5'-monophosphate in man. *J Clin Invest.* 1970;49(12):2387-95. doi:10.1172/JCI106458
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10. Ishida M, Seino Y, Simotsuji T, et al. Differential diagnosis of hypoparathyroid disorders during childhood. *Calcif Tissue Int.* 1980;31(3):203-207. doi:10.1007/BF02407182
11. Mantovani G. Clinical review: Pseudohypoparathyroidism: diagnosis and treatment. *J Clin Endocrinol Metab.* 2011;96(10):3020-3030. doi:10.1210/jc.2011-1048

## Performance

### Method Description

Acetonitrile is added to urine samples to dilute and precipitate proteins in proteinaceous samples. Next, the sample is further diluted with buffer followed by the addition of internal standard (8-methyl amino cyclic AMP). The resulting supernatant is then injected on the liquid chromatography tandem mass spectrometry instrument, which performs chromatographic separation and target measurement of 3'-5'-cyclic adenosine monophosphate (cAMP). Urine and serum creatinine levels are used to determine the clearance of cAMP from the kidneys. (Unpublished Mayo method)

#### Creatinine:

The enzymatic method is based on the determination of sarcosine from creatinine with the aid of creatininase, creatinase, and sarcosine oxidase. The liberated hydrogen peroxide is measured via a modified Trinder reaction using a colorimetric indicator. Optimization of the buffer system and the colorimetric indicator enables the creatinine concentration to be quantified both precisely and specifically. (Package insert: Creatinine plus v2. Roche Diagnostics; V15.0, 03/2019)

### PDF Report

No

### Day(s) Performed

Wednesday

### Report Available

2 to 11 days

### Specimen Retention Time

14 days

**Performing Laboratory Location**

Mayo Clinic Laboratories - Rochester Superior Drive

**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**

82030

82570

82565

**LOINC® Information**

Test ID	Test Order Name	Order LOINC® Value
CARU	Cyclic Amp, Urinary Excretion	21052-6

Result ID	Test Result Name	Result LOINC® Value
179	Cyclic Amp, Urinary Excretion	22712-4
ACREA	Creatinine, S	2160-0
CRETR	Creatinine, Random, U	2161-8