MAYO CLINIC LABORATORIES

Test Definition: CRCOF

Chromium and Cobalt, Synovial Fluid

Overview

Useful For

Monitoring metallic prosthetic implant wear and local tissue destruction in failed hip arthroplasty constructs

This test is **not useful for** assessment of vitamin B12 activity.

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
CRSY	Chromium, Synovial Fl	Yes	Yes
COSY	Cobalt, Synovial Fl	Yes	Yes

Special Instructions

- Metals Analysis Specimen Collection and Transport

Method Name

Triple-Quadrupole Inductively Coupled Plasma Mass Spectrometry (ICP-MS/MS)

NY State Available

Yes

Specimen

Specimen Type

Synovial Fluid

Ordering Guidance

This test should only be ordered for individuals with chromium or cobalt implants.

Specimen Required

Patient Preparation: High concentrations of gadolinium and iodine are known to potentially interfere with most inductively coupled plasma mass spectrometry-based metal tests. If either gadolinium- or iodine-containing contrast media has been administered, **a specimen should not be collected for 96 hours**.

Supplies:

-Metal Free EDTA 3mL Tube (T989)

-Metal Free B-D Tube (EDTA), 6 mL (T183)

Container/Tube: Royal blue-top BD vacutainer with EDTA blood collection tube (3 mL) (BD catalog no. 367777) (T989)

Specimen Volume: 1 mL

Collection Instructions: See Metals Analysis Specimen Collection and Transport for complete instructions.

Additional Information: Cobalt and chromium are present in the black rubber plunger seals found in most disposable

syringes. As a result, synovial fluid **should not be** collected in these devices as contamination may occur.

Specimen Minimum Volume

0.4 mL

Reject Due To

Gross hemolysis	OK
Gross lipemia	OK
Gross icterus	OK

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Synovial Fluid	Refrigerated (preferred)	90 days	
	Ambient	90 days	
	Frozen	90 days	

Clinical & Interpretive

Clinical Information

Per US Food and Drug Administration recommendations, orthopedic surgeons should consider measuring and following serial chromium and cobalt concentrations in EDTA anticoagulated whole blood in symptomatic patients with metal-on-metal hip implants as part of their overall clinical evaluation. However, a recent publication(1) has shown synovial fluid measurements were superior to whole blood and serum chromium and cobalt concentrations in predicting local tissue destruction in failed hip arthroplasty constructs.

Prosthetic devices produced by Depuy Company, Dow Corning, Howmedica, LCS, PCA, Osteonics, Richards Company, Tricon, and Whiteside are typically made of chromium, cobalt, and molybdenum. This list of products is incomplete, and the products' compositions change occasionally; see each prostheses' product information for composition details.

Chromium:
Chromium (Cr) is a naturally occurring element widely distributed in the environment. It exists in several valence states with the 3 main forms being Cr(0), Cr(III), and Cr(VI). Cr(III) is an essential trace element that enhances the action of insulin. Deficiency leads to impaired growth, reduced life span, and corneal lesions, as well as alterations in carbohydrates, lipid, and protein metabolism.

Chromium is widely used in manufacturing processes to make various metal alloys, such as stainless steel. It is also used in many consumer products, including wood treated with copper dichromate, leather tanned with chromic sulfate, and metal-on-metal hip replacements.

The general population is most likely to be exposed to trace levels of chromium, as Cr(III) is naturally occurring in foods, such as fruits, vegetables, nuts, beverages, and meats. The highest potential occupational exposure occurs in the

metallurgy and tanning industries, where workers may be exposed to high air concentrations.

Cobalt:
Cobalt is a naturally occurring, hard, gray element widely distributed in the environment. It is used to produce alloys in the manufacturing of aircraft engines, cutting tools, and some artificial hip and knee joint prosthesis devices.

Cobalt is an essential cofactor in vitamin B12, which is necessary for neurological function, brain function, and the formation of blood. For most people, food is the largest source of cobalt intake. However, more than a million workers are potentially exposed to cobalt and its compounds, with the greatest exposure in mining processes, cemented tungsten-carbide industry, cobalt powder industry, and alloy production industry.

Cobalt is not highly toxic, but large doses may produce adverse clinical manifestations. Acute symptoms include pulmonary edema, allergy, nausea, vomiting, hemorrhage, and kidney failure. Chronic exposure to cobalt-containing hard metal (dust or fume) can result in a serious lung disease called hard metal lung disease, which is a type of pneumoconiosis (lung fibrosis). Furthermore, inhalation of cobalt particles can cause respiratory sensitization, asthma, shortness of breath, and decreased pulmonary function. Even though the primary route of occupational exposure to cobalt is the respiratory tract, skin contact is also important because dermal exposures to hard metal and cobalt salts can result in significant systemic uptake. Sustained exposures can cause skin sensitization, which may result in eruptions of contact dermatitis. In cases of suspected toxicity, blood, serum, or urine concentrations of cobalt can be checked. Vitamin B12 should be used to assess nutritional status.

Reference Values

CHROMIUM:
0-17 years: Not established
> or =18 years: <16.9 ng/mL

COBALT:
0-17 years: Not established
> or =18 years: <19.8 ng/mL

Interpretation

Chromium:
Based on an internal study, synovial fluid chromium concentrations of 16.9 ng/mL or above were more likely due to a metal reaction (eg, adverse local tissue reaction [ALTR]/adverse reaction to metal debris [ARMD]) versus a nonmetal reaction in patients undergoing metal-on-metal revision (sensitivity of 92.3% and specificity of 92.6%).

Cobalt:
Based on an internal study, synovial fluid cobalt concentrations of 19.8 ng/mL or above were more likely due to a metal reaction (eg, ALTR/ ARMD) versus a nonmetal reaction in patients undergoing metal-on-metal revision (sensitivity of 92.3% and specificity of 96.3%).

Cautions

Chromium is present in the environment at 100-fold to 1000-fold higher concentration than found in biological tissues. Reports of increased chromium could be due to external contamination.

Specimen collection procedures for cobalt require special specimen collection tubes, rigorous attention to ultraclean

specimen collection and handling procedures, and analysis in an ultraclean facility. Elevated trace element concentrations in the absence of corroborating clinical information do not independently predict prosthesis wear or failure.

Because this test uses mass spectrometry detection, the radioactive form of cobalt, (60)Co, is not quantified.

Clinical Reference

1. Houdek MT, Taunton MJ, Wyles CC, Jannetto PJ, Lewallen DG, Berry DJ. Synovial fluid metal ion levels are superior to blood metal ion levels in predicting an adverse local tissue reaction in failed total hip arthroplasty. J Arthroplasty. 2021;36(9):3312-3317.e1. doi:10.1016/j.arth.2021.04.034
2. Eltit F, Assiri A, Garbuz D, et al. Adverse reactions to metal on polyethylene implants: Highly destructive lesions related to elevated concentration of cobalt and chromium in synovial fluid. J Biomed Mater Res A. 2017;105(7):1876-1886. doi:10.1002/jbm.a.36057
3. Lass R, Grubl A, Kolb A, et al. Comparison of synovial fluid, urine, and serum ion levels in metal-on-metal total hip arthroplasty at minimum follow-up of 18 years. J Orthop Res. 2014;32(9):1234-1240. doi:10.1002/jor.22652
4. De Pasquale D, Stea S, Squarzoni S, et al. Metal-on-metal hip prostheses: Correlation between debris in the synovial fluid and levels of cobalt and chromium ions in the bloodstream. Int Orthop. 2014;38(3):469-475. doi:10.1007/s00264-013-2137-5
5. Wise JP Jr, Young JL, Cai J, Cai L. Current understanding of hexavalent chromium [Cr(VI)] neurotoxicity and new perspectives. Environ Int. 2022158:106877. doi:10.1016/j.envint.2021.106877

Performance

Method Description

The metal of interest is analyzed by triple-quadrupole inductively coupled plasma mass spectrometry.(Unpublished Mayo method)

PDF Report

No

Day(s) Performed

Friday

Report Available

2 to 15 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

83018
82495

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
CRCOF	Chromium and Cobalt, Synovial Fl	95525-2

Result ID	Test Result Name	Result LOINC® Value
606352	Cobalt, Synovial Fl	23842-8
606353	Chromium, Synovial Fl	95526-0