MAYO CLINIC LABORATORIES

Test Definition: ALKI

Alkaline Phosphatase, Total and Isoenzymes, Serum

Overview

Useful For

Diagnosis and treatment of liver, bone, intestinal, and parathyroid diseases

Determining the tissue source of increased alkaline phosphatase (ALP) activity in serum

Differentiating between liver and bone sources of elevated ALP

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
ALP	Alkaline Phosphatase, S	Yes	Yes
ALKE	Alkaline Phosphatase Isoenzymes, S	No	Yes

Method Name

ALP: Colorimetric

ALKE: Electrophoresis

NY State Available

Yes

Specimen

Specimen Type

Serum

Necessary Information

Patient's age and sex are required.

Specimen Required

Collection Container/Tube:

Preferred: Serum gel

Acceptable: Red top

Submission Container/Tube: Plastic vial

Specimen Volume: 1 mL, divided

Collection Instructions: Centrifuge and aliquot serum into 2 tubes, each containing 0.5 mL

Specimen Minimum Volume

0.5 mL divided into 2 tubes each containing 0.25 mL

Reject Due To

Gross hemolysis	Reject
Gross lipemia	OK
Gross icterus	OK

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Serum	Frozen (preferred)	14 days	
	Ambient	7 days	
	Refrigerated	7 days	

Clinical & Interpretive

Clinical Information

Alkaline phosphatase (ALP) is present in a number of tissues including liver, bone, intestine, and placenta. The activity of ALP found in serum is a composite of isoenzymes from those sites and, in some circumstances, placental or Regan isoenzymes. Serum ALP is of interest in the diagnosis of 2 main groups of conditions: hepatobiliary disease and bone disease associated with increased osteoblastic activity.

A rise in ALP activity occurs with all forms of cholestasis, particularly with obstructive jaundice. The response of the liver to any form of biliary tree obstruction is to synthesize more ALP. The main site of new enzyme synthesis is the hepatocytes adjacent to the biliary canaliculi.

ALP is also elevated in disorders of the skeletal system that involve osteoblast hyperactivity and bone remodeling, such as Paget disease, rickets, osteomalacia, fractures, and malignant tumors.

Moderate elevation of ALP may be seen in other disorders such as Hodgkin disease, congestive heart failure, ulcerative colitis, regional enteritis, and intra-abdominal bacterial infections.

Reference Values

ALKALINE PHOSPHATASE
Males
0-14 days: 83-248 U/L
15 days-<1 year: 122-469 U/L
1-<10 years: 142-335 U/L
10-<13 years: 129-417 U/L
13-<15 years: 116-468 U/L
15-<17 years: 82-331 U/L

17-<19 years: 55-149 U/L
> or =19 years: 40-129 U/L
Females
0-14 days: 83-248 U/L
15 days-<1 year: 122-469 U/L
1-<10 years: 142-335 U/L
10-<13 years: 129-417 U/L
13-<15 years: 57-254 U/L
15-<17 years: 50-117 U/L
> or =17 years: 35-104 U/L

ALKALINE PHOSPHATASE ISOENZYMES
Liver 1%
0-6 years: 5.1-49.0%
7-9 years: 3.0-45.0%
10-13 years: 2.9-46.3%
14-15 years: 7.8-48.9%
16-18 years: 14.9-50.5%
> or =19 years: 27.8-76.3%
Liver 1
0-6 years: 7.0-112.7 IU/L
7-9 years: 7.4-109.1 IU/L
10-13 years: 7.8-87.6 IU/L
14-15 years: 10.3-75.6 IU/L
16-18 years: 13.7-78.5 IU/L
> or =19 years: 16.2-70.2 IU/L
Liver 2%
0-6 years: 2.9-13.7%
7-9 years: 3.7-12.5%
10-13 years: 2.9-22.3%
14-15 years: 2.2-19.8%
16-18 years: 1.9-12.5%
> or =19 years: 0.0-8.0%
Liver 2
0-6 years: 3.0-41.5 IU/L
7-9 years: 4.0-35.6 IU/L
10-13 years: 3.3-37.8 IU/L
14-15 years: 2.2-32.1 IU/L
16-18 years: 1.4-19.7 IU/L
> or =19 years: 0.0-5.8 IU/L
Bone %
0-6 years: 41.5-82.7%
7-9 years: 39.9-85.8%
10-13 years: 31.8-91.1%

14-15 years: 30.6-85.4%
16-18 years: 38.9-72.6%
> or =19 years: 19.1-67.7%
Bone
0-6 years: 43.5-208.1 IU/L
7-9 years: 41.0-258.3 IU/L
10-13 years: 39.4-346.1 IU/L
14-15 years: 36.4-320.5 IU/L
16-18 years: 32.7-214.6 IU/L
> or =19 years: 12.1-42.7 IU/L
Intestine %
0-6 years: 0.0-18.4%
7-9 years: 0.0-18.3%
10-13 years: 0.0-11.8%
14-15 years: 0.0-8.2%
16-18 years: 0.0-8.7%
> or =19 years: 0.0-20.6%
Intestine
0-6 years: 0.0-37.7 IU/L
7-9 years: 0.0-45.6 IU/L
10-13 years: 0.0-40.0 IU/L
14-15 years: 0.0-26.4 IU/L
16-18 years: 0.0-12.7 IU/L
> or =19 years: 0.0-11.0 IU/L
Placental
Not present

Interpretation

Total Alkaline Phosphatase:
Alkaline phosphatase (ALP) elevations tend to be more marked (more than 3-fold) in extrahepatic biliary obstructions (eg, by stone or cancer of the head of the pancreas) than in intrahepatic obstructions: the more complete the obstruction, the greater the elevation. With obstruction, serum ALP activities may reach 10 to 12 times the upper limit of normal, returning to normal upon surgical removal of the obstruction. The ALP response to cholestatic liver disease is similar to the response of gamma-glutamyltransferase (GGT) but more blunted. If both GGT and ALP are elevated, a liver source of the ALP is likely.

Among bone diseases, the highest level of ALP activity is encountered in Paget disease, because of the action of the osteoblastic cells as they try to rebuild bone that is being resorbed by the uncontrolled activity of osteoclasts. Values from 10 to 25 times the upper limit of normal are not unusual. Only moderate rises are observed in osteomalacia, while levels are generally normal in osteoporosis. In rickets, levels 2 to 4 times normal may be observed. Primary and secondary hyperparathyroidism are associated with slight to moderate elevations of ALP; the existence and degree of elevation reflects the presence and extent of skeletal involvement. Very high enzyme levels are present in patients with osteogenic bone cancer. A considerable rise in ALP is seen in children following accelerated bone growth.

ALP increases of 2 to 3 times normal may be observed in women in the third trimester of pregnancy, although the reference interval is very wide, and levels may not exceed the upper limit of normal in some cases. In pregnancy, the additional enzyme is of placental origin.

ALP Isoenzymes:
Liver ALP isoenzyme is associated with biliary epithelium and is elevated in cholestatic processes. Various liver diseases (primary or secondary cancer, biliary obstruction) increase the liver isoenzyme.

Liver 1 is increased in some nonmalignant diseases (such as cholestasis, cirrhosis, viral hepatitis, and in various biliary and hepatic pathologies). It is also increased in malignancies with hepatic metastasis, in cancer of the lungs and digestive tract, and in lymphoma.

An increase of liver 2 may occur in cholestasis and biliary diseases (eg, cirrhosis, viral hepatitis) and in malignancies (eg, breast, liver, lung, prostate, digestive tract) with liver metastasis.

Osteoblastic bone tumors and hyperactivity of osteoblasts involved in bone remodeling (eg, Paget disease) increase the bone isoenzyme. Paget disease leads to a striking, solitary elevation of bone ALP.

The intestinal isoenzyme may be increased in patients with cirrhosis and in individuals who are blood group O or B secretors.

The placental (carcino-placental antigen) and Regan isoenzyme can be elevated in cancer patients.

Cautions
No significant cautionary statements

Clinical Reference
1. Rifai N, Horvath AR, Wittwer CT, eds. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics 6th ed. Elsevier; 2018
2. Lowe D, Sanvictores T, John S. Alkaline phosphatase. In: StatPearls [Internet]. StatPearls Publishing; 2021. Updated August 11, 2021. Accessed November 10, 2021. Available at www.ncbi.nlm.nih.gov/books/NBK459201
3. Teitelbaum JE, Laskowski A, Barrows FP: Benign transient hyperphosphatasemia in infants and children: a prospective cohort. J Pediatr Endocrinol Metab. 2011;24(5-6):351-353
4. Jassam NJ, Horner J, Marzo-Ortega H, et al: Transient rise in alkaline phosphatase activity in adults. BMJ Case Rep. 2009;2009: bcr09.2009.2250
5. Verma J, Gorard DA: Persistently elevated alkaline phosphatase. BMJ Case Reports. 2012 Aug;24;2012:bcr2012006768
6. Sharma U, Pal D, Prasad R: Alkaline phosphatase: An overview. Indian J Clin Biochem. 2014 Jul;29(3):269-278

Performance

Method Description
Total Alkaline Phosphatase:

In the presence of magnesium and zinc ions, p-nitrophenyl phosphate is cleaved by phosphatases into phosphate and p-nitrophenol. The p-nitrophenol released is directly proportional to the catalytic alkaline phosphatase (ALP) activity. It is determined by measuring the increase in absorbance.(Package insert: Alkaline Phosphatase reagent. Roche Diagnostics; 02/2012)

ALP Isoenzymes:
Serum samples are electrophoresed through alkaline buffered (pH 9.1) agarose gels. Almost all ALP isoenzymes can be separated by electrophoresis according to their charge difference. However, because the electrophoretic mobilities of the liver and bone isoenzymes are quite similar, a modification is required for separation. The Sebia system utilizes differences between liver and bone isoenzyme sialation to achieve separation. Each sample is applied to the agarose gel in duplicate. One sample is passed through wheat germ lectin (wheat germ agglutin:WGA) and is deposited anodally from the point of sample application. The bone isoenzyme, which is rich in sialic acids, reacts with WGA and precipitates adjacent to the lectin application point. The separated isoenzymes are visualized using a specific chromogenic substrate, 5-bromo-4-chloro-3-indolyl phosphate/nitro blue tetrazolium in aminomethyl propanol (AMP) buffer, pH 10.0. The dried gels are read on a densitometer for the quantification of tissue isoforms.(Package insert: Sebia Hydragel 7 and 15 ISO-PAL. Sebia; 01/2017)

PDF Report
No

Day(s) Performed
Monday through Friday

Report Available
2 to 5 days

Specimen Retention Time
7 days

Performing Laboratory Location
Rochester

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 has been cleared, approved, or is exempt by the US Food and Drug Administration and is used per manufacturer's instructions. Performance characteristics were verified by Mayo Clinic in a manner consistent with CLIA requirements.

Test Definition: ALKI

Alkaline Phosphatase, Total and Isoenzymes, Serum

CPT Code Information

84075
84080

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
ALKI	Alkaline Phosphatase, Tot and Iso,S	24332-9

Result ID	Test Result Name	Result LOINC® Value
ALP	Alkaline Phosphatase, S	6768-6
89503	Alkaline Phosphatase Isoenzymes, S	49243-9
45488	Liver 1 %	15348-6
57034	Liver 1	13874-3
45489	Liver 2 %	15349-4
57035	Liver 2	13875-0
45490	Bone %	15013-6
57036	Bone	1777-2
45491	Intestine %	15014-4
57037	Intestine	1778-0
29324	Placental	40793-2