Approach to the patient with elevated serum amylase or lipase

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INTRODUCTION

Serum amylase and lipase are common tests obtained as biochemical markers for acute pancreatitis in patients presenting with abdominal pain. However, the interpretation of these tests can be difficult since several non-pancreatic conditions can present with abnormal serum amylase and lipase levels [1,2]. We recommend estimating lipase levels alone for the diagnosis of acute pancreatitis as it is more sensitive than amylase, lasts longer, and is elevated in conditions like hypertriglyceridemia where amylase may be normal [3,4]. However, amylase levels continue to be frequently ordered concurrently [5]. Once the diagnosis of acute pancreatitis is established, serial estimation of pancreatic enzymes may not add much value to the management of the patient.

This topic review will present an approach to the patient with an elevated serum amylase or lipase. Elevation of these measures in the context of individual disorders (such as pancreatitis) is discussed separately. (See "Clinical manifestations and diagnosis of acute pancreatitis", section on 'Pancreatic enzymes and products'.)

EPIDEMIOLOGY

Elevations in pancreatic enzymes are not specific for acute pancreatitis. Between 11 and 13 percent of patients with non-pancreatic abdominal pain have elevated pancreatic enzymes [1,2]. Up to 24 percent of patients with diabetic ketoacidosis have non-specific elevations of lipase [6]. In a group of asymptomatic HIV-positive patients, 60 percent had an abnormal amylase or lipase measurement on at least one occasion [7].

PATHOPHYSIOLOGY

- **Amylase** – The main function of amylase is to cleave starch into smaller polysaccharides at the internal 1 to 4 alpha linkage in the process of digestion. The main sources of amylase in humans are the pancreas and salivary glands, but it can be found in other tissues in small quantities [8].

  Several isoforms of amylase can be identified by electrophoresis; the most abundant are the S form of salivary origin and the P form derived from the pancreas, which contribute to 60 and 40 percent of the circulating amylase, respectively [8]. The molecular weight of the isoforms is relatively small (about 50,000 Daltons) so they can be filtered by the kidneys [8]. Amylase is cleared by the reticuloendothelial system (75 percent) and the kidneys (25 percent).

- **Lipase** – Lipase is mainly synthesized and stored as granules in the pancreatic acinar cells. There are several lipases in the human body, including lingual, pancreatic, lipoprotein, intestinal, gastric, and hepatic lipase. Activity of all the lipases is inhibited by bile acids. The activity of pancreatic lipase depends upon the presence of another enzyme, colipase, which facilitates attachment to triglyceride droplets and prevents bile salts from deactivating pancreatic lipase. One of the commonly used assays for pancreatic lipase takes advantage of this property; bile acids and colipase are added to the assay to inhibit all lipases other than pancreatic lipase, thus providing a specific assay for pancreatic lipase.

  The main function of the pancreatic lipase is to hydrolyze triglycerides into glycerol and free fatty acids. Like amylase, lipase is a relatively small molecule that can be filtrated by the kidney. Unlike amylase, lipase can be reabsorbed in the renal tubules, which increases its half-life (6.9 to 13.7 hours).

CAUSES

Elevations in amylase and lipase — Elevated amylase and lipase may be due to increase in pancreatic or extrapancreatic production or a decrease in clearance (table 1 and table 2). However, in some cases, pancreatic enzymes can be elevated in the absence of an identifiable disease. Hence, estimation of these enzymes without a valid reason is to be discouraged.

Pancreatic disease — Patients with acute pancreatitis typically have an acute threefold elevation of amylase and/or lipase. However, enzyme elevations may not be as significant in patients with acute on chronic pancreatitis and alcoholic pancreatitis. Pancreatic enzymes may be elevated following trauma to the pancreas, post-endoscopic retrograde cholangiopancreatography, or pancreatic ductal obstruction or surgery. (See 'Isolated/predominant lipase elevation' below.)

Extrapancreatic disease — Amylase and lipase elevation are not specific to the pancreatic disease and may be elevated in patients with other intra- or extra-abdominal conditions or the use of medications (table 1 and table 3 and table 4 and table 2). While most extrapancreatic causes of pancreatic enzyme elevations are not associated with a greater than threefold elevation, lipase greater than three times normal has been reported in patients with renal insufficiency, malignant tumors, cholecystitis, and esophagitis [9].

Isolated amylase elevation

- **Salivary diseases** – Salivary diseases, including parotitis, associated with alcohol use can result in elevations in serum amylase of salivary origin. The most commonly used amylase assays cannot differentiate between salivary and pancreatic amylase, and measurement of isoenzymes in the serum is not widely available, as it cannot differentiate between acute pancreatitis and other non-pancreatitis abdominal conditions that can cause abdominal pain.

- **Macroamylasemia** – Serum amylase levels may be elevated in settings in which amylase is bound to other macromolecules like immunoglobulins and polysaccharides, forming complexes known as macroamylase [10]. Several diseases have been described in association with macroamylasemia, including celiac disease, HIV infection, lymphoma, ulcerative colitis, rheumatoid arthritis, and monoclonal gammopathy [11-20]. Because of the size of these complexes, renal excretion is reduced and the amylase level as measured by serologic tests is increased. Such patients typically have chronically elevated serum amylase levels, although the degree of elevation can fluctuate [11]. Macroamylasemia may resolve in patients with celiac disease following a gluten-free diet [12,20]. (See 'Patients with isolated amylase elevation' below.)

- **Idiopathic hyperamylasemia** – Persistent elevations in amylase may be a normal variant (Gullo's syndrome) and in some cases may be familial [21,22]. Patients with Gullo's syndrome may have elevations in one or both pancreatic enzymes. Enzyme levels may fluctuate with elevations more than 3-fold the upper limit of normal and return to normal, without clinical or radiologic evidence of pancreatic disease [23]. We follow these patients for one year with repeat imaging, and only then make the diagnosis if no other etiology is found.

Isolated/predominant lipase elevation — Several conditions may be associated with a predominant elevation in serum lipase and normal or minimal elevations in amylase. Normoamylasemia is reported in 19 to 32 percent of patients with acute pancreatitis [24].

- **Delayed presentation of acute pancreatitis** – As serum amylase has a shorter half-life as compared with serum lipase, patients with a delayed presentation of acute pancreatitis can appear to have isolated elevations in lipase. Amylase levels typically normalize within 24 hours of an episode of acute pancreatitis whereas lipase levels remain elevated for several days. (See 'Pathophysiology' above.)

- **Acute alcoholic pancreatitis** – Patients with acute alcoholic pancreatitis may present with a normal amylase and elevated serum lipase. In a retrospective review of 284 patients with acute pancreatitis, patients with acute alcoholic pancreatitis were more likely to present with minimal (less than three times the upper limit of normal) elevations in the pancreatic enzymes [25]. Normoamylasemia was significantly associated with a number of previous attacks, suggesting that pancreatic parenchyma is no longer able to produce sufficient amounts of enzymes [26].

- **Acute on chronic pancreatitis** – Pancreatic tissue in chronic pancreatitis demonstrates a substantial decline in both amylase and lipase activity, with amylase activity showing a greater decrease compared to lipase (91 versus 26 percent) [27]. (See "Chronic pancreatitis: Clinical manifestations and diagnosis in adults", section on 'Laboratory findings'.)

- **Hypertriglyceridemia-induced pancreatitis** – In patients with hypertriglyceridemia-induced acute pancreatitis, serum amylase levels may be normal. Serum amylase levels are spuriously low due to a circulatory inhibitor of serum amylase which interferes with the assay, but it can be corrected if lactescent plasma is recognized by the laboratory and serial dilution techniques are performed. (See "Hypertriglyceridemia-induced acute pancreatitis", section on 'Laboratory findings'.)

INITIAL APPROACH

The approach to the patient with abdominal pain and elevated amylase and/or lipase is based on whether the clinical presentation is consistent with acute pancreatitis.

Presentation consistent with acute pancreatitis — Acute pancreatitis should be suspected in a patient with acute onset of a persistent, severe, epigastric pain with tenderness on palpation on physical examination. In patients with characteristic abdominal pain and elevation in serum lipase or amylase up to three times or greater than the upper limit of normal, no imaging is required to establish the diagnosis of acute pancreatitis.

In patients with serum amylase or lipase levels that are less than three times the upper limit of normal, we obtain abdominal imaging with contrast-enhanced abdominal computed tomography (CT) to establish the diagnosis of acute pancreatitis and to exclude other causes of acute abdominal pain. (See "Clinical manifestations and diagnosis of acute pancreatitis", section on 'Clinical features'.)

Presentation inconsistent with acute pancreatitis

Clinical history — The clinical history may provide valuable clues as to the possible cause of abdominal pain and/or elevated pancreatic enzymes. Patients with chronic pancreatitis may report intermittent episodes of abdominal pain during acute exacerbations but may also suffer from chronic, persistent pain caused by chronic inflammation and/or complications of the disease, such as pseudocysts or duodenal stenosis [28]. In pancreatic cancer pain, intensity usually progresses steadily. The presence of pronounced constitutional symptoms (eg, persistent fevers, night sweats, weight loss, decreased activity level) may be suggestive of a systemic neoplastic disease (table 1 and table 3).

Other important aspects of the history include a recent history of pancreatic instrumentation (endoscopic retrograde cholangiopancreatography), trauma, cardiac surgery, and the presence of an established diagnosis of a systemic disease associated with pancreatic enzyme elevations. Recurrent acute pancreatitis without obvious other causes may lead to the suspicion of pancreas divisum or sphincter of Oddi dysfunction. A thorough medication history should be obtained, with particular attention paid to drugs that are associated with pancreatic enzyme elevations (table 2 and table 4), alcohol consumption, and a family history of pancreatitis or asymptomatic pancreatic enzyme elevations. This may help to clarify etiology of pancreatic enzyme elevations in the absence of acute pancreatitis.

Laboratory evaluation — We obtain the following laboratory studies, which, if not already performed, should be obtained to rule out other causes of acute abdominal pain:

- Complete blood count, electrolytes
- Alanine aminotransferase, aspartate aminotransferase, bilirubin
- Calcium and albumin
- Pregnancy test in all women of childbearing age

As an example, jaundice due to obstruction of the common bile duct by the chronically inflamed pancreatic head may be due to chronic pancreatitis or obstruction due to pancreatic cancer.

Abdominal imaging — In patients with abdominal pain that is not characteristic for acute pancreatitis, we perform abdominal imaging with a contrast-enhanced abdominal CT scan or magnetic resonance imaging (MRI) and magnetic resonance cholangiopancreatogram (MRCP) to evaluate the pancreas and to exclude other causes of acute abdominal pain and elevated pancreatic enzymes. The imaging modality chosen will depend on suspected etiology and the presence of renal failure.

In patients with severe contrast allergy or renal failure, we perform an abdominal MRI without gadolinium. The advantages of MRI over CT include a lower risk of nephrotoxicity from gadolinium in patients without underlying renal disease; the ability of MRI to better categorize fluid collections as acute fluid collections, necrosis, abscess, hemorrhage, and pseudocyst; and the greater sensitivity of MRI to detect mild acute pancreatitis compared with CT. In addition, unlike CT, MRCP delineates the pancreatic and bile ducts better, and MRCP is comparable to endoscopic retrograde cholangiopancreatography for the detection of choledocholithiasis.

SUBSEQUENT APPROACH

Subsequent management in patients with a negative initial evaluation depends on the presence of continued abdominal pain.

Patients with continued abdominal pain — Patients with persistent abdominal pain with negative initial imaging should be evaluated for other causes of abdominal pain. Repeating amylase and/or lipase in such patients is not clinically useful. Additional evaluation with endoscopic ultrasound can be helpful in the diagnosis of chronic pancreatitis, and in patients suspected of having an occult pancreatic malignancy. (See "Evaluation of the adult with abdominal pain".)

Patients with isolated amylase elevation — In patients with isolated elevations in amylase, the diagnosis of macroamylasemia can be established by determining the molecular weight of the serum amylase, by immunologic assays, or the amylase-to-creatinine clearance ratio (ACCR) [29]. In patients with macroamylasemia, the ACCR is reduced because of poor filtration of the large macroamylase complexes. A ratio less than 1 percent on a 24-hour collection strongly supports the diagnosis of macroamylasemia (normal 3 to 4 percent) [30].

The ratio is measured by the following formula:

$$\text{ACCR} = \frac{\text{Amylase(urine)} \times \text{Creatinine(serum)} \times 100}{\text{Amylase(serum)} \times \text{Creatinine(urine)}}$$

ACCR is increased in the setting of acute pancreatitis but is not more helpful than serum amylase determinations alone [31]. Even moderate renal insufficiency interferes with accuracy of the ACCR. Furthermore, an increase in the ACCR is not specific to acute pancreatitis and can be seen in patients with severe burns or diabetic ketoacidosis [32]. Precipitation of macroamylase with polyethylene glycol, colorimetric measurement of total amylase activity, and immunoinhibition for the determination of pancreatic isoamylase can be used to estimate pancreatic isoamylase [33].

Patients without persistent abdominal pain — In patients in whom abdominal pain has resolved, we do not pursue additional evaluation.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Acute pancreatitis".)

SUMMARY AND RECOMMENDATIONS

- **Epidemiology** – Elevations in pancreatic enzymes are not specific for acute pancreatitis. Between 11 and 13 percent of patients admitted to the hospital with non-pancreatic abdominal pain have elevated pancreatic enzymes. (See 'Epidemiology' above.)
- **Etiology of elevated amylase and lipase** – Elevated amylase and lipase may be due to increase in pancreatic or extrapancreatic production or a decrease in clearance (table 1

and table 2). However, in some cases pancreatic enzymes can be elevated in the absence of an identifiable disease. (See 'Causes' above.)

Patients with acute pancreatitis typically have a threefold elevation of amylase and/or lipase. However, patients with acute on chronic pancreatitis, hypertriglyceridemia-induced pancreatitis, and alcoholic pancreatitis may only have elevations in lipase. Isolated elevations in amylase may be due to salivary disease, and in rare cases, due to macroamylasemia. (See 'Isolated amylase elevation' above and 'Isolated/predominant lipase elevation' above.)

- **Initial evaluation guided by the clinical presentation** – The approach to the patient with abdominal pain and elevated amylase and/or lipase is based on whether the clinical presentation is consistent with acute pancreatitis. (See 'Initial approach' above.)
  - **Clinical presentation consistent with acute pancreatitis** – In patients with characteristic abdominal pain and elevation in serum lipase or amylase up to three times or greater than the upper limit of normal, no imaging is required to establish the diagnosis of acute pancreatitis. (See 'Presentation consistent with acute pancreatitis' above.)
  - **Clinical presentation inconsistent with acute pancreatitis** – In patients whose clinical presentation is not consistent with acute pancreatitis, we obtain a detailed clinical history that includes medications, laboratory evaluation, and abdominal imaging to determine the cause of abdominal pain and elevated pancreatic enzymes. (See 'Presentation inconsistent with acute pancreatitis' above.)
- **Additional evaluation in selected patients** – Subsequent management in patients with a negative initial evaluation depends on the presence of continued abdominal pain. (See 'Subsequent approach' above.)
  - **Patients without abdominal pain** – In patients in whom abdominal pain has resolved, we do not pursue additional evaluation. (See 'Patients without persistent abdominal pain' above.)
  - **Patients with persistent abdominal pain** – Patients with persistent abdominal pain and negative initial imaging should be evaluated for other causes of abdominal pain. Repeating amylase and/or lipase in such patients is not clinically useful. Additional evaluation with endoscopic ultrasound can be helpful in the diagnosis of chronic pancreatitis, and in patients suspected of having an occult pancreatic malignancy. (See 'Patients with continued abdominal pain' above.)

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Topic 5643 Version 23.0

GRAPHICS

Conditions associated with a high serum amylase

Pancreatic disease
Pancreatitis
Complications of pancreatitis (pseudocysts, abscess)
Trauma
Surgery
Endoscopic retrograde cholangiopancreatography (ERCP)
Ductal obstruction
Pancreatic carcinoma
Cystic fibrosis
Salivary disease
Infection
Trauma
Radiation
Ductal obstruction
Gastrointestinal disease
Perforated or penetrating peptic ulcer
Perforated bowel
Obstructed bowel
Mesenteric infarction
Appendicitis
Cholecystitis
Liver disease
Severe gastroenteritis
Celiac disease
Gynecologic disease
Ruptured ectopic pregnancy
Ovarian or fallopian cysts
Pelvic inflammatory disease

Neoplasms
Solid tumors of the ovary, prostate, lung, esophagus, breast, and thymus
Multiple myeloma
Pheochromocytoma
Other
Renal failure
Alcoholism
Macroamylasemia
Burns
Type 2 diabetes mellitus
Acidosis (ketotic and nonketotic)
Pregnancy
Acquired immune deficiency syndrome (AIDS)
Cerebral trauma
Abdominal aortic aneurysm
Anorexia nervosa, bulimia
Postoperative
Drug induced
Idiopathic
Following double-balloon enteroscopy
Myocardial infarction
Coronavirus disease 2019 (COVID-19)

Graphic 63497 Version 6.0

Drugs affecting serum amylase values

Increase
Adrenocorticotropic hormone
Aminosalicylic acid
Some antibiotics (eg, nitrofurantoin)
Some antineoplastics (eg, asparaginase)
Aspirin
Atovaquone
Calcium salts
Chloride salts
Chlorpromazine
Chlorthalidone
Cholinergics (eg, bethanechol)
Cimetidine
Codeine
Cyproheptadine
Didanosine
Estrogens
Ethacrynic acid
Ethanol

Increase (cont.)
Fluorides
Iodine-containing contrast media
Lamivudine
Meperidine
Methylcholine
Methyldopa
Metoclopramide
Metronidazole
Pegaspargase
Prochlorperazine
Sulfonamides
Sulindac
Sunitinib
Sorafenib
Thiazide diuretics
Triprolidine/pseudoephedrine
Valproic acid

Decrease
Citrates
Intravenous dextrose
Oxalates
Saquinavir

Graphic 64829 Version 4.0

Conditions associated with a high serum lipase

Acute pancreatitis
Chronic pancreatitis
Renal failure
Acute cholecystitis
Bowel obstruction or infarction
Duodenal ulceration
Pancreatic calculus
Pancreatic tumors
Type 2 diabetes mellitus
Diabetic ketoacidosis
HIV disease
HCV infection
Macrolipasemia
Post-ERCP/trauma
Sarcoidosis
Celiac disease
Inflammatory bowel disease
Idiopathic
Drugs

HCV: hepatitis C virus; HIV: human immunodeficiency virus; ERCP: endoscopic retrograde cholangiopancreatography.

Graphic 77323 Version 5.0

Drugs affecting serum lipase values

Increase
Adrenocorticotropic hormone
Ardeparin
Cholinergics (eg, bethanechol)
Dipeptidyl peptidase-4 (DPP-4) inhibitors
Fat emulsions
Furosemide
Indomethacin
Methacholine
Methylprednisolone
Metronidazole
Narcotics (eg, codeine)
Oral contraceptives
Pegaspargase
Pentazocine
Secretin
Sulfisoxazole
Thiazide diuretics
Triprolidine/pseudophedrine
Valproic acid
Zalcitabine
Decrease
5-aminosalicylic acid
Calcium ions
Hydroxyurea
Protamine
Somatostatin

Graphic 77633 Version 4.0

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