Gastroenterology: An Introduction

GASTROENTEROLOGY

Gastroenterology (MeSH heading) is the branch of medicine focused on the digestive system and its disorders.

Diseases affecting the gastrointestinal tract, which include the organs from mouth to anus, along the alimentary canal, are the focus of this speciality. Physicians practicing in this field are called gastroenterologists.

They have usually completed about eight years of pre-medical and medical education, a year-long internship (if this is not a part of the residency), three years of an internal medicine residency, and two to three years in the gastroenterology fellowship. Some gastroenterology trainees will complete a “fourth-year” (although this is often their seventh year of graduate medical education) in transplant hepatology, advancedendoscopy, inflammatory bowel disease, motility or other topics.

Hepatology, or hepatobiliary medicine, encompasses the study of the liver, pancreas, and biliary tree, and is traditionally considered a sub-specialty.

Historical Background

Extracting from Egyptian papyri, Nunn identified significant knowledge of gastrointestinal diseases among practising physicians
during the periods of the pharaohs. Irynakhty, of the tenth dynasty, c. 2125 B.C., was a court physician specialising in gastroenterology, sleeping, and proctology.

Among ancient Greeks, Hippocrates attributed digestion to concoction. Galen's concept of the stomach having four faculties was widely accepted up to modernity in the seventeenth century.

Eighteenth century:
• Italian Lazzaro Spallanzani (1729–99) was one of the early physicians to disregard Galen’s theories, and in 1780 he gave experimental proof on the action of gastric juice on foodstuffs.
• German Johann von Zimmermann wrote an important work in 1767 on dysentery.
• In 1777, Maximilian Stoll of Vienna described cancer of the gallbladder.

Nineteenth century:
• Philipp Bozzini attempted first to observe inside the living human body using a tube he named Lichtleiter (light-guiding instrument) to examine the urinary tract, the rectum, and the pharynx. This is the earliest description of endoscopy.
• Charles Emile Troisier described enlargement of lymph nodes in abdominal cancer.
• William Prout in 1823, discovered that stomach juices contain hydrochloric acid.
• William Beaumont in 1833, published *Experiments and Observations on the Gastric Juice and the Physiology of Digestion* following years of experimenting on test subject Alexis St. Martin.
• In 1868, Adolf Kussmaul, a well-known German physician, developed the gastroscope. He perfected the technique on a sword swallower.
• In 1871, at the society of physicians in Vienna, Carl Stoerk demonstrated an esophagoscope made of two telescopic metal tubes, initially devised by Waldenburg in 1870.
• In 1876, Karl Wilhelm von Kupffer described the properties of some liver cells now called Kupffer cell.
• In 1883, Hugo Kronecker and Samuel James Meltzer studied oesophageal manometry in humans.

Twentieth century:
• In 1915, Jesse McClendon tested acidity of human stomach in situ.
• In 1921-22, Walter Alvarez did the first electrogastrography research.
• Rudolph Schindler described various important diseases involving the human digestive system during World War I in his illustrated textbook and is portrayed by some as the “father of gastroscopy”. He and Georg Wolf developed a semiflexible gastroscope in 1932.
• In 1932, Burrill Bernard Crohn described Crohn’s disease.
• In 1957, Basil Hirschowitz introduced the first prototype of a fibreoptic gastroscope.

Twenty-first century:
• In 2005, Barry Marshall and Robin Warren of Australia were awarded the Nobel Prize in Physiology or Medicine for their discovery of *Helicobacter pylori* (1982/1983) and its role in peptic ulcer disease. James Leavitt assisted in their
A gastroenterologist requires to have a detailed understanding of the normal physiology of all the above mentioned organs as well as motility through the intestines and gastrointestinal tract in order to maintain a healthy digestion, absorption of nutrients, removal of waste and metabolic processes.

A gastroenterologist also requires to have a clear understanding of ailments affecting the organs of the gastrointestinal system like:

- peptic ulcer disease
- gastric cancers
- esophageal cancers
- achalasia
- Barret’s esophagus
- colon polyps
- colon and bowel cancers
- pancreatitis
- pancreatic cancers
- cholecystitis
- biliary tract disease
- gallbladder stones and cancer
- hepatitis
- gastroesophageal reflux
- colitis
- nutritional problems and malabsorption,
- Irritable Bowel Syndrome (IBS)
- a host of other disease conditions.

Training

A Gastroenterologist must first complete a three-year Internal Medicine residency. He or she is then eligible for additional specialized training (fellowship) in Gastroenterology for two to three years. This means a total of 5-6 years of additional specialized
education after medical school. The fellowship is a hands-on intense and rigorous programme that gives the opportunity to the trainee to learn directly from nationally recognized experts and work to get a detailed understanding of gastrointestinal diseases.

Initiating from evaluation of patients to caring for them in the office as well as in the hospital is part of the training.

Training involves learning endoscopy (upper endoscopy, sigmoidoscopy, and colonoscopy), endoscopic biliary examination (endoscopic retrograde cholangiopancreatography or ERCP), endoscopic mucosal resection or EMR, endoscopic ultrasound (EUS) etc.

Along with endoscopy they are also trained in performing advanced endoscopic procedures such as polypectomy, esophageal and intestinal dilation and hemostasis. They are taught how to interpret imaging and pathology results in order to make appropriate recommendations to treat conditions. The fellowship is overseen by national societies like the American Board of Internal Medicine, the American College of Gastroenterology, the American Gastroenterological Association, and the American Society for Gastrointestinal Endoscopy. After completion of the fellowship the gastroenterologists are qualified to take the Gastroenterology board certification test administered by the American Board of Internal Medicine. Once they have successfully completed this examination they are “Board Certified.”

Renewal of Certification

Gastroenterologists renew their board certification through the American Board of Internal Medicine (ABIM) via the Maintenance of Certification (MOC) program. For this gastroenterologists require to schedule, take and pass the secure ABIM Gastroenterology Maintenance of Certification Examination as well as earn 100 points in Self-Evaluation of Medical Knowledge and Self-Evaluation of Practice Performance. In the latter test they are needed to earn a minimum of 20 points of medical knowledge and 20 points of practice performance. The remaining 60 points
may be from either medical knowledge, practice performance or both.

The ABIM Gastroenterology Maintenance of Certification Examination evaluates the knowledge and clinical judgment in relevant areas of practice. Exam questions are developed by a team of gastroenterologists in practice and in academic medicine. The computer-based examination is offered twice a year – in spring and fall.

GI DISEASES

At Gastroenterology Consultants we are dedicated to providing each patient with the individualized attention that you deserve. We provide each patient with state-of-the-art treatment methods that will help relieve the ailments and symptoms that you are experiencing. There are many different diseases and conditions that affect the overall health of the digestive system. The gastrointestinal tract is made up of the stomach and intestine and is often used to refer to all entities involved in the digestive tract from the mouth to anus.

Ascites

This condition is characterized by a buildup of fluid in the abdominal cavity, particularly within the peritoneal cavity that is located within the abdomen and the abdominal organs. A few of the most common signs of Ascites include swelling in the abdomen and the ankles, an increase in weight gain and also shortness of breath.

Barrett’s Esophagus

This is a precancerous condition that is characterized by the development of squamous cells that line the esophagus. Barrett’s Esophagus is generally the result of frequent manipulation and abuse to the esophageal lining, such as from chronic acid reflux or Gastroesophageal Reflux Disease (GERD). If left untreated, Barrett’s Esophagus could lead to esophageal cancer.
Chronic Hepatitis C

Hepatitis C is a blood-borne infection generally caused by a virus. This condition largely affects the liver, and is a very common infection among adults in the United States. Many patients that contract the disease do so through contact with infected blood via drug use, tattoos and sexual contact.

Colon Cancer

Cancer of the colon develops by the formation of malignant cancer cells within the large intestine. In many situations colon cancer is prompted by the development of polyps, noncancerous abnormalities that appear in the lining of the colon.

Constipation

This is a common condition characterized by infrequent bowel movements that are difficult to pass. Constipation is often brought on by a number of lifestyle factors, including diet, stress, and pregnancy other influences. Often, constipation acts as a symptom of a larger and more serious condition.

Diarrhea

Like constipation, diarrhea is also a condition that affects the integrity of bowel movements, but instead of causing difficulty diarrhea prompts watery and loose stools that are often uncontrollable. Diarrhea is a common experience among many people, and should only be considered a concern when it is frequent and long lasting, as it may indicate a more serious condition.

Diverticulosis and Diverticulitis

Small pouches called diverticula often develop within the walls of the colon, and occasionally cause pain by protruding from weak spots in the tissue that are present in the lining of the colon walls. The presence of diverticula in the colon walls is a condition known as Diverticulosis. When these diverticula become inflamed the condition often becomes much more painful and is known as Diverticulitis.
Esophageal Cancer

In this condition cancer affects the lining of the esophagus, the muscular tube that connects the mouth to the stomach. Cancer develops in either the upper or lower portions of the esophagus, and often occurs as a result of frequent disturbance to the esophagus by acid reflux.

Esophagitis

This is that condition which is defined by the swelling, irritation and inflammation of the esophagus, often as a result of frequent acid reflux or Gastroesophageal Reflux Disease (GERD). Esophagitis is often a very painful condition that causes extreme difficulty swallowing in addition to chest pain.

Gastritis

Gastritis is a condition that is marked by swelling and inflammation in the lining of the esophagus. Gastritis often occurs as a symptom of other gastrointestinal diseases, but if it is left untreated it could lead to the development of serious ailments such as stomach cancer.

GERD

Gastroesophageal Reflux Disease or GERD is a condition that involves frequent acid reflux and heartburn. GERD is a chronic condition that causes many patients lingering pain and discomfort for a long period of time. As a result, the acid reflux caused by GERD generally leads to the manipulation of the lining of the esophagus and can lead to the development of more serious conditions such as Barrett’s Esophagus and Esophageal Cancer.

Heartburn and Acid Reflux

Heartburn and Acid Reflux are common symptoms of other gastrointestinal diseases, such as GERD, but also frequently occur on their own unrelated to larger conditions. When heartburn and acid reflux become frequent or chronic then they may be an indication of a more serious disease.
Hemorrhoids

Hemorrhoids are swollen veins and clusters of tissues that develop in the anus and lower rectum. Internal hemorrhoids develop inside of the lower rectum and are often less painful than external hemorrhoids, which develop underneath the skin surrounding the anus.

Irritable Bowel Syndrome

Irritable Bowel Syndrome or IBS is a disorder that affects the function of the colon by interfering with digestion by preventing the bowel from properly advancing a stool. The symptoms of IBS range widely based upon the severity of the condition in each particular patient, and the syndrome itself ranges from a mild to severe appearance.

Ulcerative Colitis

This condition is characterised by a form of Inflammatory Bowel Disease or IBD that is characterized largely by diarrhea and abdominal pain. Many patients that suffer from Ulcerative Colitis experience severe and debilitating pain that may lead to life threatening complications if left untreated.
Gastrointestinal Disease and its Procedures or Tests

Gastrointestinal diseases implies diseases comprising the gastrointestinal tract, such as the esophagus, stomach, small intestine, large intestine and rectum, and the accessory organs of digestion, the liver, gallbladder, and pancreas.

ORAL DISEASE

Even though anatomically part of the GI tract, diseases of the mouth are often not considered alongside other gastrointestinal diseases. By far the most common oral conditions are plaque-induced diseases (e.g. gingivitis, periodontitis, dental caries). Some diseases which involve other parts of the GI tract can manifest in the mouth, alone or in combination, including:

- Gastroesophageal reflux disease can cause acid erosion of the teeth and halitosis.
- Gardner’s syndrome can be associated with failure of tooth eruption, supernumerary teeth, and dentigerous cysts.
- Peutz–Jeghers syndrome can cause dark spots on the oral mucosa or on the lips or the skin around the mouth.
- Many GI diseases, especially those associated with malabsorption, can cause recurrent mouth ulcers, atrophic glossitis, and angular cheilitis (e.g. Crohn’s disease is
sometimes termed orofacial granulomatosis when it involves the mouth alone).

- Sideropenic dysphagia can cause glossitis, angular cheilitis.

**OESOPHAGEAL DISEASE**

Oesophageal diseases consist of a spectrum of disorders affecting the oesophagus. The most common condition of the oesophagus in Western countries is gastroesophageal reflux disease, which in chronic forms is thought to result in changes to the epithelium of the oesophagus, known as Barrett’s oesophagus.

Acute disease might include infections such as oesophagitis, trauma caused ingestion of corrosive substances, or rupture of veins such as oesophageal varices, Boerhaave syndrome or Mallory-Weiss tears. Chronic diseases might include congenital diseases such as Zenker’s diverticulum and esophageal webbing, and oesophageal motility disorders including the nutcracker oesophagus, achalasia, diffuse oesophageal spasm, and oesophageal stricture.

Oesophageal disease may result in a sore throat, throwing up blood, difficulty swallowing or vomiting. Chronic or congenital diseases might be investigated using barium swallows, endoscopy and biopsy, whereas acute diseases such as reflux may be investigated and diagnosed based on symptoms and a medical history alone.

**GASTRIC DISEASE**

Stomach diseases mean diseases affecting the stomach. Inflammation of the stomach by infection from any cause is called gastritis, and when including other parts of the gastrointestinal tract called gastroenteritis. When gastritis is persists in a chronic state, it is related to several diseases, including atrophic gastritis, pyloric stenosis, and gastric cancer. Another common condition is gastric ulceration, peptic ulcers. Ulceration erodes the gastric mucosa, which protects the tissue of the stomach from the stomach acids. Peptic ulcers are most commonly caused by a bacterial
Helicobacter pylori infection. As well as peptic ulcers, vomiting blood may result from abnormal arteries or veins that have ruptured, including Dieulafoy’s lesion and Gastric antral vascular ectasia.

Congenital disorders of the stomach include pernicious anaemia, in which a targeted immune response against parietal cells results in an inability to absorb vitamin B12.

Other common symptoms that stomach disease might cause comprise indigestion or dyspepsia, vomiting, and in chronic disease, digestive problems leading to forms of malnutrition. In addition to routine tests, an endoscopy might be used to examine or take a biopsy from the stomach.

**INTESTINAL DISEASE**

The small and large intestines may be affected by infectious, autoimmune, and physiological states. Inflammation of the intestines is known as enterocolitis, which may lead to diarrhoea. Acute conditions affecting the bowels include infectious diarrhoea and mesenteric ischaemia.

Causes of constipation may include faecal impaction and bowel obstruction, which may in turn be caused by ileus, intussusception, volvulus. Inflammatory bowel disease is a condition of unknown aetiology, classified as either Crohn’s disease or ulcerative colitis, that can affect the intestines and other parts of the gastrointestinal tract. Other causes of illness include intestinal pseudoobstruction, and necrotizing enterocolitis.

Diseases of the intestine may cause vomiting, diarrhoea or constipation, and altered stool, such as with blood in stool. Colonoscopy may be used to examine the large intestine, and a person’s stool may be sent for culture and microscopy.

Infectious disease may be treated with targeted antibiotics, and inflammatory bowel disease with immunosuppression. Surgery may also be used to treat some causes of bowel obstruction.
Small Intestine

The small intestine consists of the duodenum, jejunum and ileum. Inflammation of the small intestine is called enteritis, which if localised to just part is called duodenitis, jejunitis and ileitis, respectively.

Peptic ulcers are also common in the duodenum. Chronic diseases of malabsorption may affect the small intestine, including the autoimmune coeliac disease, infective Tropical sprue, and congenital or surgical short bowel syndrome.

Other rarer diseases affecting the small intestine include Curling’s ulcer, blind loop syndrome, Milroy disease and Whipple’s disease. Tumours of the small intestine include gastrointestinal stromal tumours, lipomas, hamartomas and carcinoid syndromes.

Diseases of the small intestine may present with symptoms such as diarrhoea, malnutrition, fatigue and weight loss. Investigations pursued may include blood tests to monitor nutrition, such as iron levels, folate and calcium, endoscopy and biopsy of the duodenum, and barium swallow. Treatments may include renutrition, and antibiotics for infections.

Large Intestine

Diseases that affect the large intestine may affect it in whole or in part. Appendicitis is one such disease, caused by inflammation of the appendix.

Generalised inflammation of the large intestine is referred to as colitis, which when caused by the bacteria *Clostridium difficile* referred to as pseudomembranous colitis. Diverticulitis is a common cause of abdominal pain resulting from outpouchings that particularly affects the colon.

Functional colonic diseases refer to disorders without a known cause, and include irritable bowel syndrome and intestinal pseudoobstruction. Constipation may result from lifestyle factors, impaction of a rigid stool in the rectum, or in neonates, Hirschprung’s disease.
Fig. Abdominal X-rays may be used to visualise the large intestine.

Diseases affecting the large intestine may cause to be passed with stool, may cause constipation, or may result in abdominal pain or a fever. Tests that specifically examine the function of the large intestine include barium swallows, abdominal x-rays, and colonoscopy.

Rectum and anus

Diseases that affect the rectum and anus are very common, especially in older adults. Hemorrhoids, vascular outpouchings of skin, are very common, as is pruritis ani, referring to anal itchiness. Other conditions, such as anal cancer may be associated with ulcerative colitis or with sexually transmitted infections such as HIV.

Inflammation of the rectum is known as proctitis, one cause of which is radiation damage associated with radiotherapy to other sites such as the prostate. Faecal incontinence can result from mechanical and neurological problems, and when associated with a lack of voluntary voiding ability is described as encopresis. Pain on passing stool may result from anal abscesses, small inflamed
nodules, anal fissures, and anal fistulas. Rectal and anal disease may be asymptomatic, or may present with pain when passing stools, fresh blood in stool, a feeling of incomplete emptying, or pencil-thin stools. In addition to regular tests, medical tests used to investigate the anus and rectum include the digital rectal exam and proctoscopy.

ACCESSORY DIGESTIVE GLAND DISEASE

Hepatic

Hepatic diseases imply those affecting the liver. Hepatitis refers to inflammation of liver tissue, and may be acute or chronic. Infectious viral hepatitis, such as hepatitis A, Band C, affect in excess of (X) million people worldwide.

Liver disease may also be a result of lifestyle factors, such as fatty liver and NASH. Alcoholic liver disease may also develop as a result of chronic alcohol use, which may also cause alcoholic hepatitis. Cirrhosis may develop as a consequence of chronic hepatic fibrosis in a chronically inflamed liver, such as one affected by alcohol or viral hepatitis. Liver abscesses are often acute conditions, with common causes being pyogenic and amoebic.

Chronic liver disease, such as cirrhosis, may be a cause of liver failure, a state where the liver is unable to compensate for chronic damage, and unable to meet the metabolic demands of the body.

In the acute setting, this may be a cause of hepatic encephalopathy and hepatorenal syndrome. Other causes of chronic liver disease are genetic or autoimmune disease, such as hemochromatosis, Wilson’s disease, autoimmune hepatitis, and primary biliary cirrhosis.

Acute liver disease rarely results in pain, but may result in jaundice. Infectious liver disease may cause a fever. Chronic liver disease may result in a buildup of fluid in the abdomen, yellowing of the skin or eyes, easy bruising, immunosuppression, and feminization. Portal hypertension is often present, and this may lead to the development of prominent veins in many parts of the
body, such as oesophageal varices, and haemorrhoids. With a view to investigate liver disease, a medical history, including regarding a person’s family history, travel to risk-prone areas, alcohol use and food consumption, may be taken. A medical examination may be conducted to investigate for symptoms of liver disease.

Blood tests may be used, particularly liver function tests, and other blood tests may be used to investigate the presence of the Hepatitis viruses in the blood, and ultrasound used. If ascites is present, abdominal fluid may be tested for protein levels.

Pancreatic

Pancreatic diseases that affect digestion refers to disorders affecting the exocrine pancreas, which is a part of the pancreas involved in digestion. One of the most common conditions of the exocrine pancreas is acute pancreatitis, which in the majority of cases relates to gallstones that have impacted in the pancreatic part of the biliary tree, or due to acute or chronic alcohol abuse or as a side-effect of ERCP.

Other forms of pancreatitis include chronic and hereditary forms. Chronic pancreatitis may predispose to pancreatic cancer and is strongly linked to alcohol use. Other rarer diseases affecting the pancreas may include pancreatic pseudocysts, exocrine pancreatic insufficiency, and pancreatic fistulas.

Pancreatic disease may present with or without symptoms. When symptoms occur, such as in acute pancreatitis, a person may suffer from acute-onset, severe mid-abdominal pain, nausea and vomiting. In severe cases, pancreatitis may lead to rapid blood loss and systemic inflammatory response syndrome.

When the pancreas is unable to secrete digestive enzymes, such as with a pancreatic cancer occluding the pancreatic duct, result in jaundice. Pancreatic disease might be investigated using abdominal x-rays, MRCP or ERCP, CT scans, and through blood tests such as measurement of the amylase and lipase enzymes.
Gastrointestinal Disease and its Procedures or Tests

Gallbladder and biliary tract

Diseases of the hepatobiliary system affect the biliary tract (also known as the biliary tree), which secretes bile in order to aid digestion of fats. Diseases of the gallbladder and bile ducts are commonly diet-related, and may include the formation of gallstones that impact in the gallbladder (cholecystolithiasis) or in the common bile duct (choledocholithiasis).

Gallstones are a common cause of inflammation of the gallbladder, called cholecystitis. Inflammation of the biliary duct is called cholangitis, which may be associated with autoimmune disease, such as primary sclerosing cholangitis, or a result of bacterial infection, such as ascending cholangitis.

Disease of the biliary tree may cause pain in the upper right abdomen, particularly when pressed. Disease might be investigated using ultrasound or ERCP, and might be treated with drugs such as antibiotics or UDCA, or by the surgical removal of the gallbladder.

STOMACH DISEASE

The stomach is a significant organ in the body. It plays a vital role in digestion of foods, releases various enzymes and also protects the lower intestine from harmful organisms. The stomach connects to the esophagus above and to the small intestine below. It is intricately related to the pancreas, spleen and liver. The stomach does vary in size but its J shape is constant. The stomach lies in the upper part of the abdomen just below the left rib cage.

Gastropathy is a common term used for stomach diseases. Instances including the name include portal hypertensive gastropathy and Ménétrier’s disease, also known as “hyperplastic hypersecretory gastropathy”. However, there are many other stomach diseases that don’t include the word “gastropathy” such as gastric or peptic ulcer disease, gastroparesis, and dyspepsia.

Several kind of stomach diseases are related to infection. Historically, it was widely believed that the highly acidic
environment of the stomach would keep the stomach immune from infection. However, various studies have indicated that most cases of stomach ulcers, gastritis, and stomach cancer are caused by *Helicobacter pylori* infection. One of the ways it is able to survive in the stomach involves its urease enzymes which metabolize urea (which is normally secreted into the stomach) to ammonia and carbon dioxide which neutralises gastric acid and thus prevents its digestion. In recent years, it has been discovered that other *Helicobacter* bacteria are also capable of colonising the stomach and have been associated with gastritis. Having too little or no gastric acid is known as hypochlorhydria or achlorhydria respectively and are conditions which can have negative health impacts. Having high levels of gastric acid is called hyperchlorhydria. Many people believe that hyperchlorhydria can cause stomach ulcers. However, recent research indicates that the gastric mucosa which secretes gastric acid is acid-resistant.

Gastritis and stomach cancer can be caused by *Helicobacter pylori* infection. There are various types of chronic disorders which affect the stomach. However, since the symptoms are localized to this organ, the typical symptoms of stomach problems include nausea, vomiting, bloating, cramps, diarrhea and pain.

**Chronic Disorders**

Stomach disorders are very common and induce a significant amount of morbidity and suffering in the population. Data from hospitals indicate that more than 25% of the population suffers from some kind of chronic stomach disorder including abdominal pain and indigestion. These symptoms occur for long periods and cause prolonged suffering, time off work and a poor quality of life. Moreover, visits to doctors, expense of investigations and treatment result in many days lost from work and a colossal cost to the financial system.

**Gastritis**

In the stomach there is a little balance between acid and the wall lining which is protected by mucus. When this mucus lining
is disrupted for whatever reason, signs and symptoms of acidity result. This may result in upper abdominal pain, indigestion, loss of appetite, nausea, vomiting and heartburn. When the condition is allowed to progress, the pain may become continuous; blood may start to leak and be seen in the stools. If the bleeding is rapid and of adequate volume it may even result in vomiting of bright red blood (hematemesis).

When the acidity is uncontrolled, it can even cause severe blood loss (anemia) or lead to perforation (hole) in the stomach which is a surgical emergency. In many individuals, the progressive bleeding from an ulcer mixes with the feces and presents as black stools. Presence of blood in stools is often the first sign that there is a problem in the stomach.

**Gastroparesis**

Another very common long term problem which is now more appreciated is gastroparesis. Gastroparesis affects millions of individuals and is often never suspected and most patients have a delay in diagnosis. Basically in gastroparesis, the stomach motility disappears and food remains stagnant in the stomach. The most common cause of gastroparesis is diabetes but it can also occur from a blockage at the distal end of stomach, a cancer or a stroke. Symptoms of gastroparesis includes abdominal pain, fullness, bloating, nausea, vomiting after eating food, loss of appetite and feeling of fullness after eating small amounts of food.

**Diarrhea**

During digestion, food is stored in the liquid present in the stomach. The food that is not digested travels to the large intestine and colon in liquid form. These organs begin to absorb the water turning the food into a more solid form. Different viruses or bacteria can increase the amount of liquid that is secreted and moves too quickly through the digestive tract for the water to be absorbed. Diarrhea comes in two types: acute diarrhea and chronic diarrhea. The acute diagnosis can last for a few days up to a week of time. Chronic diarrhea lasts for several days or longer periods
of time lasting a few weeks. The difference in diagnosis will help
determine the cause of the illness.

**Crohn’s Disease**

Crohn’s disease is an inflammatory bowel disease that can affect any part of the digestive tract, even the stomach, although it’s a rare presentation. Its main feature is inflammatory ulcers that can affect the total thickness of the stomach wall and can bleed but rarely perforate. Symptoms include abdominal pain, loss of appetite, and weight loss.

Diarrhea is also a symptom that can develop, so checking stools for the appearance of blood is important. It is possible for symptoms of Crohn’s Disease to remain with a person for weeks or go away on their own. Reporting the symptoms to a doctor is recommended to prevent further complications.

**Cancers**

Stomach cancers are rare and the incidence has been declining worldwide. Stomach cancers usually occur due to fluctuations in acidity level and may present with vague symptoms of abdominal fullness, weight loss and pain. The actual cause of stomach cancer is not known but has been linked to infection with *Helicobacter pylori*, pernicious anemia, Menetriere’s disease, and nitrogenous preservatives in food.

**Causes and Treatment**

Smoking has been linked to various types of disorders of the stomach. Tobacco is known to stimulate acid production and impairs production of the protective mucus. This leads to development of ulcers in the majority of smokers. Chronic stomach problems have also been linked to excess intake of alcohol. It has been shown that alcohol intake can cause stomach ulcer, gastritis and even stomach cancer. Thus, avoidance of smoking and excess alcohol consumption can help prevent the majority of chronic stomach disorders. One of the most causes of chronic stomach problems is use of medications. Use of aspirin and other non-
steroidal anti-inflammatory drugs to treat various pain disorders can damage lining of the stomach and cause ulcers. Other medications like narcotics can interfere with stomach emptying and cause bloating, nausea, or vomiting.

Most of the chronic stomach problems are treated medically. However, there is evidence that a change in life style may help. Even though there is no specific food responsible for causing chronic stomach problems, experts recommend eating a healthy diet which consists of fruits and vegetables. Lean meat should be limited. Moreover, people should keep a diary of foods that cause problems and avoid them.

**Endoscopy**

There are various tools for investigating stomach problems. The most common is endoscopy. This procedure is performed as an outpatient and utilizes a small flexible camera.

The procedure does need intravenous sedation and takes about 30–45 minutes; the endoscope is inserted via the mouth and can visualize the entire swallowing tube, stomach and duodenum. The procedure also allows the physician to obtain biopsy samples. In many cases of bleeding, the surgeon can use the endoscope to treat the source of bleeding with laser, clips or other injectable drugs.

**X rays**

Other radiological studies frequently used to assess patients with chronic stomach problems include a barium swallow, where a dye is consumed and pictures of the esophagus and stomach are obtained every few minutes. Other tests include a 24-hour pH study, CT scans or MRI.

**PANCREATIC DISEASE**

Various kind of Pancreatic diseases are as under:

**Pancreatitis**

Pancreatitis is inflammation of the pancreas. There are two
forms of pancreatitis, which are different in causes and symptoms, and require different treatment:

- Acute pancreatitis is a rapid-onset inflammation of the pancreas, most frequently caused by alcoholism or gallstones.
- Chronic pancreatitis is a long-standing inflammation of the pancreas.

**Diabetes mellitus**

The pancreas is central in the pathophysiology of both major types of diabetes mellitus. In type 1 diabetes mellitus, there is direct damage to the endocrine pancreas that results in insufficient insulin synthesis and secretion. Type 2 diabetes mellitus, which begins with insulin resistance, is characterized by the ultimate failure of pancreatic ß cells to match insulin production with insulin demand.

**Exocrine pancreatic Insufficiency**

Exocrine pancreatic insufficiency (EPI) is the inability to properly digest food because of a lack of digestive enzymes made by the pancreas. EPI is found in humans afflicted with cystic fibrosis and Shwachman-Diamond syndrome. It is caused by a progressive loss of the pancreatic cells that make digestive enzymes. Chronic pancreatitis is the most common cause of EPI in humans. Loss of digestive enzymes leads to maldigestion and malabsorption of nutrients.

**Cystic Fibrosis**

Cystic fibrosis, is a hereditary disease that affects the entire body, causing progressive disability and early death. It is caused by a mutation in the cystic fibrosis transmembrane conductance regulator (CFTR) gene. The product of this gene helps create sweat, digestive juices, and mucus. The name *cystic fibrosis* means the characteristic ‘fibrosis’ (tissue scarring) and cyst formation within the pancreas, causing irreversible damage, and often resulting in painful inflammation (pancreatitis).
Pseudocysts

A pancreatic pseudocyst is a circumscribed collection of fluid rich in amylase and other pancreatic enzymes, blood and necrotic tissue, typically located in the lesser sac.

Cysts

X-ray computed tomography (CT scan) findings of cysts in the pancreas are common, and generally are benign. In a study of 2,832 patients without pancreatic disease, 73 patients (2.6%) had cysts in the pancreas. About 85% of these patients had a single cyst. Cysts ranged in size from 2 to 38 mm (mean, 8.9 mm). There was a strong correlation between the presence of cysts and age. No cysts were identified among patients less than 40 years of age, while 8.7 percent of the patients aged 80 to 89 years had a pancreatic cyst.

Cysts also may be present due to intraductal papillary mucinous neoplasm.

Congenital malformations

Pancreas divisum

Pancreas divisum is a malformation in which the pancreas fails to fuse. It is a rare condition that affects only 6% of the world’s population, and of these few, only 1% ever have symptoms that require surgery.

Annular pancreas

Annular pancreas is characterized by a pancreas that encircles the duodenum. It results from an embryological malformation in which the early pancreatic buds undergo inappropriate rotation and fusion, which can lead to small bowel obstruction.

TESTS OR PROCEDURES OF GASTROINTESTINAL

Colonoscopy

A colonoscopy is an examination that is recommended for the
treatment and diagnosis of abnormalities in the colon (large intestine) and rectum. The colonoscopy exam is an outpatient procedure, and is often used to evaluate a variety of symptoms that impact the lower gastrointestinal (GI) tract, including:

- Anemia
- Blood in the stool
- Abdominal pain
- Irregular bowel habits.

Besides to these symptoms, a colonoscopy exam may also be recommended as a preventative procedure in the treatment or diagnosis of colon cancer.

During a colonoscopy exam a tool called a colonoscope, which is a long and flexible tube, is directed by your physician into the rectum. At the top of the colonoscope there is a small light and camera that provides your physician with the ability to see the inside of your colon.

Besides to providing enhanced images of your large intestine, the colonoscope provides your physician with the ability to remove polyps or take a tissue sample (or biopsy) to evaluate further.

**Preparing for your Colonoscopy Exam**

Before undergoing a colonoscopy exam, it is very important that you discuss any prior or pending medical conditions that you may have, such as pregnancy, heart disease, allergies, diabetes or any lung conditions.

In certain situations your doctor may suggest you take antibiotics before undergoing a colonoscopy exam. For several days leading up to your colonoscopy exam, you will be asked to refrain from certain foods and fluids, and your physician may additionally recommend laxative use or a colon cleans to attain optimal clarity during the examination. It is significant that you follow the precautionary guidelines that your physician sets for you, as dietary and medical preparations will vary depending on your individual circumstances.
During a Colonoscopy what to Expect

The colonoscopy exam is likely to last between 30 and 60 minutes, and you should expect to receive a mild sedative so that you will stay awake and relaxed during the procedure. Your doctor will then instruct you to lie on your left side and the colonoscope will be inserted in through your rectum to evaluate any abnormalities that may be present along the lining of the colon.

The colonoscope contains a tube or channel that allows your doctor to pump air into your colon, which forces it to expand, allowing easier maneuverability and visibility. The introduction of air into your colon may cause brief abdominal cramping or the sensation to pass a bowel movement, but these side effects are mild and temporary. After the examination is over and your sedative has worn off, you will be able to return to your daily work schedule the following day.

ERCP

Endoscopic Retrograde Cholangiopancreatogram (ERCP) is an examination that combines the use of an endoscope (a flexible, lighted tube) with x-ray technology to examine areas surrounding the liver, gallbladder and pancreas. The ERCP can be used to detect abnormalities from your esophagus to your gallbladder, and if necessary can be used to obtain a biopsy, or tissue sample.

There are various reasons that your physician may recommend an ERCP examination, like:
- Persistent abdominal pain
- The detection of disease within the liver, bile ducts, or pancreas
- The removal of gallstones.

Preparation for the ERCP procedure

During preparation for your ERCP exam, make sure that you notify your doctor of past conditions that may add complications
to the procedure such as hay fever, hives, allergies, or asthma. If you are allergic to shell fish it is crucial that you notify your physician, as the iodine used as contrast material for the x-ray may prompt an allergic reaction.

Because of the involvement of the x-ray during an ERCP examination, you should expect to be required to remove all jewelry before undergoing the exam. You will also be required to remove any dentures or contact lenses before the exam begins, in addition to fully emptying your bladder.

**What to expect during the ERCP procedure**

Your gastroenterologist will conduct your ERCP examination in a hospital setting with the help of an endoscope, a flexible fiber optic tool. There are several uses of an ERCP procedure, including the removal of gallstones. In situations where gallstones are removed during an ERCP, or a stent is inserted into the body an overnight hospital stay will likely be required in order to prevent complication. Otherwise, you will be able to return home after a brief recovery time that generally takes one to two hours. You should expect the ERCP procedure to encompass 30 to 60 minutes.

During the exam, your gastroenterologist will insert an endoscope through your mouth, and will then be gently guided down the throat and into your esophagus, stomach and duodenum until it finally reaches the pancreatic ducts and gallbladder. Your throat will be numbed prior to the entrance of the endoscope to relieve any discomfort, and your teeth will be guarded from the endoscope with a mouth-guard.

In addition, you should expect a sedative to be administered via an IV in order to permit relaxation during the exam.

Once the endoscope is inserted into your throat, you may be asked to swallow to help expedite the process of the endoscope into your esophagus. The endoscope will advance until it reaches the papilla area where the ducts from the pancreas and gallbladder drain into the duodenum. Once the endoscope reaches this point a catheter is inserted so that the contrast material necessary for
the x-ray can be introduced, after which several x-rays will be taken. If minor complications such as a gallstone are found to be present during the exam, your physician will easily be able to remove them through the endoscope with the use of specialized surgical instruments created for biopsy use.

**ESOPHAGEAL DILATION**

The esophagus is a long narrow tube that is used during the consumption of food by carrying food and liquid from your mouth to your stomach. If the esophagus becomes blocked or injured the delivery of food to your stomach could become disrupted.

An esophageal stricture can be caused by a various reasons, including:

- Acid reflux
- Achalasia
- Ingestion of harmful agents
- Heredity
- Schatzki’s ring
- Tumors.

The most common cause of esophageal stricture is scarring of the esophagus because of repeated acid reflux, often a result of gastroesophageal reflux disease (GERD). This constriction often leads to trouble swallowing and the reoccurring sensation of food being stuck in the chest which often causes severe discomfort.

**How to Prepare for Esophageal Dilation**

The day of your esophageal dilation procedure, you will be instructed to refrain from all food and drink, including water. If you take any medications or struggle with any medical conditions it is important that you discuss your medical history with your physician to avoid any unnecessary complications. Also, make sure to inform your doctor of any allergies that you experience.

There are varied nature of methods of treatment esophageal dilation, and it is always important to remain educated and
understand which procedure your physician is planning on pursuing prior to the day of your procedure.

**During Esophageal Dilation what to Expect**

Each method of esophageal dilation has individual advantages and is the most appropriate form of treatment under certain circumstances. Different procedures for esophageal dilation comprise:

- Simple bougie dilation
- Guided wire bougie
- Balloon dilators
- Achalasia dilators

The simple bougie dilation is able to be completed in your doctor’s office with only a simple anesthetic spray on your throat. The guided wire bougie and balloon dilator are both conducted via endoscopy, and so frequently need to be completed in a hospital while the patient is placed under sedation. Achalasia dilation is completed with the assistance of x-rays. The time period necessary for esophageal dilation varies largely from method to method. While the simple bougie dilation will only encompass several minutes, other techniques may require up to half of an hour for completion. In most or almost all the situations you will be able to resume regular activity, such as eating and drinking, soon after your exam is finished. The majority of patients suffer from no serious side effects after the procedure, though there is occasionally the risk of tear to the esophageal lining. Several patients experience a mild sore throat after esophageal dilation, but this symptom is temporary and will relieve itself over a short period of time. Though esophageal dilation is often successful in relieving the discomfort of esophageal strictures, depending on the cause and severity of the blockage it is possible that multiple dilation procedures will be necessary to fully treat the symptoms that you are experiencing.

Additionally, if your stricture was caused by acid reflux there may be medications available to help enhance the results of your
dilation procedure that would reduce your need for additional treatment in the future. Your gastroenterologist will be able to determine the best course of treatment for your specific needs.

**ESOPHAGEAL MOTILITY STUDIES**

Esophageal Manometry (muh-NOM-uh-tree) is a test that gauges how well your Esophagus works. Essentially this study is used to evaluate the movement (motility) of food through the Esophagus and into the stomach. Your Esophagus is the long, muscular tube that connects your throat to your stomach. This test will also measure how well the circular bands of muscle (sphincters) at the top and bottom of your Esophagus open and close, as well as the pressure, strength and pattern of the wave of Esophageal muscle contractions that moves food along.

Your doctor may recommend Esophageal Manometry if you’re experiencing symptoms that could be related to an Esophageal disorder. Those symptoms may include:

- Difficulty swallowing (Dysphagia)
- Pain when swallowing (Odynophagia).

During an Esophageal Manometry test, a thin, flexible tube (catheter) that contains sensors is passed gently through your nose, down your Esophagus and into your stomach. Esophageal Manometry can be helpful in diagnosing some mostly uncommon disorders that affect your Esophagus.

The 24 Hour pH/Impedance Study is a test done to detect Reflux activity using pH/impedance probe. Since this test provides statistical analysis regarding symptom associations, it permits for the detection of both acid and nonacid Reflux in patients with refractory GERD while on or off acid-suppressive therapy. For those patients who experience symptoms such as cough, heartburn, regurgitation and chest pain are generally difficult to diagnose so the use of this monitoring system employs Impedance to detect ALL Reflux activity and uses pH to categorize each episode as acid or nonacid for Total Reflux Monitoring. Comprehensive
analysis by the provider quantifies all Reflux patterns and symptom associations in patients studied.

**EUS**

Endoscopic Ultrasound (EUS) is an examination that combines endoscopy and ultrasound to evaluate the digestive tract and surrounding tissues for abnormalities. The EUS procedure is generally very beneficial in the diagnosis and treatment of disorders within the digestive tract. This procedure offers your physician with optimal visualization into your digestive tract. While the endoscopy provides your physician with images of the stomach, small intestine, colon and esophagus, the ultrasound utilizes high frequency sound waves to provide images of internal organs that otherwise could not be viewed without surgery.

The combination of these two technologies permit your physician to obtain a detailed view of the lining and walls of the gastrointestinal tract in addition to surrounding organs such as the pancreas, bile duct and gallbladder. The EUS procedure often provides insight into the cause of a condition when other exams have fallen short or have been inconclusive.

There are some situations where the EUS procedure is very recommended, including:

- For further evaluation into identified but unexplained abnormalities in the pancreas, bile duct, or gastrointestinal wall
- To identify the cause of pancreatitis
- To evaluate pancreatic cysts
- To check for gallstones or bile duct stones
- For the biopsy of lymph nodes that are found close to the esophagus, stomach, duodenum or rectum
- For the biopsy of lesions to the spleen, liver or left adrenal glands
- Screening, staging and diagnosis of certain cancers, including esophageal, stomach, rectum, pancreas, gallbladder and lung cancer.
Before the availability of EUS, many of these disorders were very difficult to view within the body, and therefore were difficult to properly diagnose. This is because serious conditions are often hidden from your physician’s view by their position beneath organs and intestines. The EUS procedure offers a variety of angles to combat this problem, and offers enhanced imaging for the early diagnosis and treatment of certain conditions.

At present, the EUS procedure is not available by many health care providers. In fact, Gastroenterology Consultants is the first to offer this service in the North Nevada and Reno areas. In much of this area, Gastroenterology Consultants remains the only practice that offers the EUS treatment. In preparation for the EUS procedure you will be asked to fast from all food and liquid for six hours prior to the procedure.

Just before the examination you will be treated with a mild sedative in order to relieve any discomfort from the endoscope. Because of the sedatives, you will not be able to work or drive for 24 hours following the exam, but will be released from the hospital shortly after the examination to return home. For this reason, it is important that you have a companion with you to take you home when your exam is complete.

During the procedure, your Gastroenterologist will monitor the inside of your intestinal tract on a TV monitor that is inside of the examination room. The procedure will take between 30 and 60 minutes. Due to the endoscopy component to the EUS procedure you may feel slightly bloated or experience a mild sore throat after the procedure. These side effects are temporary and will diminish quickly on their own.

FLEXIBLE SIGMOIDOSCOPY

This exam is generally used in the evaluation of the lower part of the large intestine, or the colon, and also the rectum. The exam is conducted by your physician with the use of a sigmoidoscope, a flexible tube that is about 60 cm long and comprises the thickness of your little finger. Your gastroenterologist may recommend a
flexible sigmoidoscopy exam to investigate the cause of certain symptoms, such as:

- Changes in bowel habits
- Rectal bleeding
- Rectal pain
- Diarrhea.

Flexible sigmoidoscopy is also often utilized to evaluate the colon and to screen for colon cancer.

**How to Prepare for a Flexible Sigmoidoscopy**

With a view to avoid unnecessary complications during your exam, it is very important that you follow all directions that your physician provides you with in detail. It is likely that your physician will instruct you to cleanse your colon with enemas before undergoing the procedure. It is very important that there is no stool in your lower colon or rectum in order for your doctor to obtain accurate results from the flexible sigmoidoscopy exam. In situations where the exam is being prompted by frequent diarrhea you may not require any laxative use in preparation for the exam. Your physician will be able to provide you with specified instructions tailored to your individual needs and purposes in preparation for your upcoming flexible sigmoidoscopy.

Before undergoing any type of examination it is important to speak with your physician regarding all medications that you are currently taking in addition to your history of health complications. Be especially cautious to discuss your health history with your doctor if you have any heart conditions, an artificial heart valve or have had a knee or hip replaced in the past.

**During a Flexible Sigmoidoscopy what to Expect**

In general, the flexible sigmoidoscopy exam does not cause much pain or discomfort, and as a result sedation is usually not required. Because the lack of sedation you will be able to return to your daily schedule after your exam. During your exam, your physician will insert the sigmoidoscope into your rectum. This
typically causes mild feelings of fullness, pressure, cramping and the sensation of being bloated.

During the exam, you will be instructed to lie on your left side and as the sigmoidoscope is advanced through your rectum and colon your physician will be able to see enhanced images on a TV monitor in the examination room. The procedure typically encompasses between five to fifteen minutes. If an abnormality is detected within your rectum or colon, your physician will be able to obtain a tissue sample (or biopsy) to be evaluated further under a microscope.

One common abnormality found during this exam is a polyp, which is a small growth that occurs on the inner lining of the colon. If the polyps are found during your flexible sigmoidoscopy, you may be asked to return for a colonoscopy, a similar exam that evaluates the entire length of your colon instead of just the lower part. After the examination is complete you will be able to return to your normal routine. You may experience cramping and bloating for the remainder of the day, but these symptoms will pass quickly.

**LIVER BIOPSY PROCEDURE**

A liver biopsy is a procedure during which a small sample of tissue is removed from your liver for the purpose of further examination under a microscope. A biopsy allows for an in depth evaluation into the liver for the detection of abnormalities, damage or disease that may be the cause of certain symptoms.

There are several reasons that your physician may recommend a liver biopsy, including:

- Detection of liver disease, such as a fatty liver
- Determine the cause of an abnormal blood test, particularly from aspartate aminotransferase (AST) and alanine aminotransferase (ALT)
- Evaluate inflammation or damage to the liver caused by hepatitis
- Evaluate the function of a transplanted liver
• Determine the cause of lingering and unexplained fever
• Evaluate a mass found on the liver during an x-ray, CT scan or ultrasound

The percutaneous liver biopsy is the most common form of this procedure. It involves the insertion of a thin needle through your abdomen between two of your lower right ribs. The needle is used to remove a small piece of tissue that is used in the evaluation of serious conditions that may be present in your liver. In addition to the percutaneous procedure, liver biopsies are also administered through a vein in the neck, which is called a transjugular biopsy, or a laparoscopic biopsy which employs the use of a small abdominal incision. Your physician will determine which method of liver biopsy is the most beneficial for your needs.

While there are several risks associated with liver biopsies, extreme complications are incredibly rare. Possible risks associated with this procedure include:
• Pain
• Bleeding
• Damage to surrounding organs
• Infection
• Abdominal pain

The best way to avoid complications pertaining to liver biopsy is to ensure that your procedure is being performed by an experienced physician, which you can ensure by having your liver biopsy performed by a physician with Gastroenterology Consultants.

To prepare for a liver biopsy your physician will instruct you to refrain from food six-to-eight hours prior. You will also have a small amount of blood drawn to ensure that you do not have any blood clotting problems. If it is found that your blood does not clot properly you may be prescribed medication to reduce the risk of bleeding during and after the procedure. A liver biopsy is an out-patient procedure, so you should expect to be able to return home after the exam is complete, though due to the sedative you
Gastrointestinal Disease and its Procedures or Tests

will not be permitted to drive for the remainder of the day. Depending on the form of biopsy that is being conducted, the procedure will take between 15 and 60 minutes, and you should also expect to remain in the hospital between two and six hours following the exam so that your physician can ensure that you do not experience any complications.

UPPER ENDOSCOPY EXAM

An upper endoscopy exam, also called esophagastroduodenoscopy or EGD, is used to evaluate the inside of the upper digestive tract, which includes the esophagus, the stomach and the duodenum, or the first portion of the small intestine.

The Upper Endoscopy exam is used to detect the cause of certain symptoms such as:

- Chest pain
- Abdominal pain
- Nausea
- Heartburn
- Problems swallowing
- Bleeding.

Upper Endoscopy is generally useful in the detection and diagnosis of conditions within the digestive tract, such as tumors, ulcers or inflammation due to infection.

Preparing for Upper Endoscopy

The most significant step in preparing for any type of procedure is discussing your prior medical conditions with your doctor. If you have or have had a lung or heart condition in the past, or are pregnant your doctor needs to be aware before beginning the Upper Endoscopy procedure. If you take medication daily, make sure to review these prescriptions with your doctor to ensure that you are safe to take them the day of your exam. If so, be sure to take your medication with as minimal amount of water possible, preferably just a small sip. Eight hours leading up to the procedure
you will need to refrain from all food and beverage. While you will be able to return home following your procedure, you will not be permitted to drive so it is important that you plan on having a friend or family member accompany you to your appointment.

**Expectation during Upper Endoscopy**

During this procedure you will be asked to lie on your left side and you will receive a sedative via IV in addition to a local anesthetic on the back of your throat. A mouthpiece will be placed in your mouth to guard your teeth from coming into contact with the endoscope. Your physician will then insert the endoscope into your mouth and will guide the tool gently down your throat and into your esophagus before it finally reaches your stomach. The entire exam takes between 15 and 30 minutes.

Upper Endoscopy is a useful examination in the determination and diagnosis of abnormalities in the upper digestive tract. During the exam, your physician may diagnose or even treat certain conditions, including:

- Polyps, which are growths of tissue that appear in the stomach. Polyps can be both identified and removed with the use of an endoscope.
- Biopsies, which are small samples of tissue used to determine the presence of disease such as cancer can be taken at this time.
- Stricture or blockage in the esophagus, duodenum or stomach can be dilated or stretched during Upper Endoscopy.
- Any foreign object, like food that became stuck in the esophagus can be removed with the use of the endoscope.
- Ulcers or tumors that may have caused bleeding can be treated at this time.

**GERD**

Gastroesophageal Reflux Disease (GERD) is a condition that arises when acid and bile from the stomach reflux into the esophagus, resulting in frequent heartburn. Overtime, the chronic
acid reflux can cause damage to the lining of the esophagus, which is the muscular tube that connects the stomach and mouth. Treatment for GERD varies depending on the severity of your condition and can be broken down into three categories: lifestyle remedies, medication and surgery. Some people require a combination of all three treatment types for full relief.

**Lifestyle Modifications**

For several people, behavioral and lifestyle changes are enough to combat the frequent and painful symptoms. Often, lifestyle modifications are recommended as a first step in the treatment process of GERD. Simple behavioral adjustments that often help to treat the pain and discomfort of GERD include:

- Eating less at each meal
- Losing weight
- Quitting smoking
- Avoiding triggers that aggravate your heartburn and acid reflux.

For several people, these simple lifestyle changes are enough to cause a significant improvement in their overall quality of life. Others require medication and even surgical treatment for full relief from the different symptoms of GERD.

**Medications**

There are various types of medications that help control acid production and prevent acid reflux. A lot of medications that can successfully treat GERD in certain people are available over-the-counter. Others are only accessible with a prescription from your physician. One type of medication that generally helps to alleviate heartburn and acid reflux are antacids, which work by neutralizing stomach acids. While they often provide immediate relief antacids do not help in the prevention of future symptoms. Examples of antacids include Pepto-Bismol, Milk of Magnesia and Alka-Seltzer.

Proton pump inhibitors are the strongest type of anti-reflux medications and are only available through a prescription from
your physician. Proton Pump inhibitors are not fast acting like antacids, but work instead by decreasing the production of acid in the stomach and provide the esophagus with relief for 24 hours, allowing you time to heal.

**Surgical Treatment Options**

Under some circumstances surgery is the most successful method for treating GERD. Many patients benefit from medication and lifestyle adjustments and do not require surgery. Surgery is a recommended treatment method for GERD when:

- Medicine has not succeeded in relieving symptoms
- Patients cannot tolerate the medications, often due to the side effects
- The sphincter muscle no longer works properly
- Complications have occurred such as bleeding, or narrowing of the esophagus
- Esophageal cancer develops.

Generally, GERD can be treated with laparoscopic surgery. Laparoscopic surgery is minimally invasive, which means that it does not require any large incisions like a traditional, open operation would. Laparoscopic surgery is performed with the use of a laparoscope, a thin and flexible tool that is similar to a telescope. The laparoscope has a small camera and light on its tip which provides your surgeon with visibility during the procedure.

Advantages of Laparoscopic surgery for GERD include:

- Reduced hospital stay
- Less pain
- Faster recovery
- Reduced cost
- Less risk of infection
- Small incision
- Reduced scarring.

Laparoscopic anti-reflux surgery treats GERD by restoring the valve between the esophagus and the stomach, therefore protecting your esophagus from acid reflux. In the process of procedure, your
physician will wrap the upper portion of your stomach around the lower part of your esophagus. This process adds strength to the muscles that prevent stomach acid and bile from regurgitating into the esophagus.

HEMORRHOID BANDING

Hemorrhoids are a collection of nerves, connective tissue, veins and arteries in the anal wall that generally enlarge over time and cause severe pain and discomfort. In some cases hemorrhoids prolapse, or fall outwards from the anus, which increases the pain associated with the condition.

Symptoms of hemorrhoids comprise:

- Bleeding from the anus, especially after bowel movements
- Irritated skin
- Burning or itching around the anal wall
- Rectal pain or discomfort.

Hemorrhoids are a common problem, but for many the pain is mild and does not require any medical treatment. For others, the pain associated with enlarged hemorrhoids is severe and requires medical attention. In some cases, hemorrhoids are an indication of other, more severe conditions such as ulcers or rectal tumors.

Treatment for Hemorrhoids

Rubber band ligation, or hemorrhoid banding, is one of the leading medical treatment options for hemorrhoids. During a hemorrhoid banding procedure, the hemorrhoid is tied at its base with rubber bands that are intended to cut the flow of blood to the hemorrhoid.

As the hemorrhoid is cut off from additional blood flow it will shrink and eventually fall off after several days. A scar will form where the hemorrhoid previously was, and this will cause all nearby veins to stay in place and avoid any future formation of a hemorrhoid in that location. Rubber band ligation is an outpatient
procedure that is performed in your doctor’s office. In order to perform the hemorrhoid banding procedure your physician will use an anoscope. The anoscope is a tool that provides your gastroenterologist with images of the problematic area while also assisting with the banding process by grasping the hemorrhoid and placing the rubber bands around the base of it. In order for the hemorrhoid banding procedure to work properly the rubber bands must be placed on the hemorrhoid very tightly. For many people the discomfort of the bands themselves is mild, but if you feel that they are extremely painful your physician will be able to numb the banded hemorrhoids to relieve the discomfort.

Your physician will be able to treat up to two hemorrhoids during a single appointment. If you have more hemorrhoids that require treatment you will need to wait up to six weeks to allow your anal wall time to heal before repeating the procedure.

BARRX

BARRX is a minimally invasive endoscopic procedure that is able to successfully treat Barrett’s esophagus, thus minimizing the patients risk for developing esophageal cancer. Barrett’s esophagus is a serious condition that is generally the result of frequent heartburn that is often caused by Gastroesophageal Reflux Disease, or GERD. The BARRX procedure treats Barrett’s esophagus by removing the abnormality in the tissue of the esophageal lining. This is completed in an outpatient procedure with the use of an endoscope.

The first step of BARRX procedure is the placement of a sizing balloon into your esophagus. The dilated balloon is attached to the tip of a catheter that is inserted into your esophagus alongside the endoscope. Once the catheter and balloon are successfully within the esophagus near the area in need of treatment the balloon is inflated. The balloon, together with a HALO energy generator are able to correctly measure the diameter of your esophagus, which allows your physician to choose the best treatment catheter for your needs. Once this is accomplished the sizing balloon will
be removed and the HALO ablation catheter is inserted in its place.

Very like the catheter used to measure your esophagus, the HALO ablation catheter also has a balloon at its tip. This balloon however is used in the treatment of the abnormal tissue due to the band of radiofrequency electrodes that surrounds it. The HALO Energy Generator and ablation catheter treat the abnormal tissue by delivering a short burst of energy to the circumference of your esophagus. This burst of energy is delivered at 360 degrees and removes the diseased tissue that causes Barrett’s esophagus, therefore reducing your risk of developing esophageal cancer.

PEG PLACEMENT

PEG placement, or Percutaneous Endoscopic Gastrostomy is the medical placement of a feeding tube and is ideal for patients that are having difficulty swallowing and maintaining proper nutrition. The PEG procedure is a safe and effective method for the administration of food, liquid and medicine directly into the stomach.

This procedure is a less invasive procedure than others of its kind, in that it does not involve the need for a large open incision into the abdomen for the placement of the tube. Instead, the feeding tube is inserted through a minor incision and the use of a needle that is guided by an endoscope that is introduced orally. PEG placement is recommended for patients that are not able to ingest food or liquid, and are not expected to be able to consume food regularly for some time.

Opposite to other procedures performed at GI Consultants the PEG placement procedure is not intended to cure a condition or directly relieve any symptoms. As a result of various different disorders of the gastrointestinal tract, many patients develop difficulty maintaining proper nutrition levels due to severe discomfort while swallowing. The PEG placement procedure is therefore recommended for patients of all ages and with a wide variety of GI diseases.
Before the insertion of the feeding tube, you will meet with your physician in addition to a dietician and a home care coordinator to speak about your preparation for the procedure, and readiness for life following the insertion of the tube.

It is very important that you share your medical history with your physician at this time besides any questions or concerns that you have. It is especially important that you inform your doctor if you have a history of lung or heart disease, or if you are allergic to any medications as this may increase your risk of complications from the placement of the feeding tube. It is significant that you avoid eating and drinking for eight hours leading up to your procedure.

Its Procedure

The PEG placement procedure is conducted with the use of an endoscope, a long, thin flexible tube that has a camera and light on its tip. In order to prevent soreness and discomfort during the procedure a local anesthetic is applied to numb the throat. The endoscope is then passed through the mouth, throat and esophagus until it finally reaches the stomach to assist in the correct placement of the tube.

Once in place, your physician will make a small insertion into your abdomen and will push a needle through your skin and into the stomach.

The feeding tube is inserted into the stomach through this needle, and the protruding part of the tube is tied in place on the skin. Various patients are able to return home the day of their procedure.

Like any other operation, the PEG procedure does come with risk of complications. For this reason it is very important that you only have your feeding tube inserted by an experienced and specialized physician. Complications of the PEG placement procedure include:

- Infection at the site of the incision
• Leaking
• Clogging
• Dislodgement of the feeding tube.

Fecal transplantation also called as fecal bacteriotherapy, stool transplant, or human probiotic infusion (HPI). The very common condition that is treated with fecal transplantation is a gastrointestinal bacteria infection called Clostridium difficile. This condition causes severe and excruciating diarrhea that persists and generally leads to weight loss, dehydration, etc. There are about 250,000 cases reported annually in the United States. The incidence Clostridium difficile infection has been on significant rise in both community and hospital settings. In recent past, the morbidity and mortality of Clostridium difficile infection have also increased greatly. It has been estimated that Clostridium difficile infection may be responsible for as many as 15,000 deaths a year in the United States. For patients suffering from severe or recurrent Clostridium difficile infection, who have received numerous and costly unsuccessful treatments, fecal transplantation is curative and life saving.

The most common cause of Clostridium difficile infection is antibiotic use. Clostridium difficile is commonly treated with antibiotics that is costly and can be counterproductive. Up to 30% patients will develop recurrent Clostridium difficile infections after antibiotic treatment. Some patients may develop as many as 10-20 recurrence.

Patients with recurrent Clostridium difficile infection often become chronically and even seriously ill, some require multiple hospitalizations or long-term antibiotic therapy. However, repeated or long-term antibiotic therapy makes restoration of normal gut flora almost impossible, and Clostridium difficile is more likely to recur. The vicious cycle continues.
Very doctors are turning to fecal transplantation for treatment of patients with \textit{Clostridium difficile} infection. The concept of this treatment is to transfer normal gut bacterial flora (stool) from a healthy person to a patient with \textit{Clostridium difficile} infection. The transplanted normal bacterial flora colonizes and displaces the pathogenic \textit{Clostridium difficile} in the intestines, and restoration of normal bio-environment occurs.

Fecal transplantation comprises the administering of stool obtained from a healthy donor into the infected patient’s intestines. The donor, typically a spouse or close relative, is evaluated and screened for a wide array of infections. On the day of the fecal transplant procedure, the donor submits fresh stool, which is then processed and then delivered into the infected intestines. Studies and case reports connote that fecal transplantation is an extremely effective therapy for \textit{Clostridium difficile} infection. GI Consultants is the only center in Northern Nevada to offer fecal transplantation to patients with \textit{Clostridium difficile} infections.
FUNCTIONAL GI DISORDERS

The term “functional” is generally applied to disorders where the body’s normal activities in terms of the movement of the intestines, the sensitivity of the nerves of the intestines, or the way in which the brain controls some of these functions is impaired. However, there are no structural abnormalities that can be seen by endoscopy, x-ray, or blood tests. Thus it is identified by the characteristics of the symptoms and infrequently, when needed, limited tests. The Rome diagnostic criteria categorize the functional gastrointestinal disorders and define symptom based diagnostic criteria for each category.

Functional gastrointestinal (GI) and motility disorders are the most common GI disorders in the general population. Estimates vary, but about 1 in 4 people or more in the U.S. have one of these disorders. The conditions account for about 40% of GI problems seen by doctors and therapists.

**Functional Esophageal Disorders**

Globus: a sensation of a lump, something stuck, or a tightness in the throat.
Functional chest pain: the feeling of chest pain, presumably of esophageal origin (can be confused with cardiac pain which must be examined).

Functional heartburn: persistent burning sensation in the absence of gastroesophageal reflux disease (GERD), a motility disorder, or a structural explanation.

Functional dysphagia: the sensation of difficulty swallowing.

**Functional gastroduodenal Disorders**

*Functional dyspepsia:* pain or discomfort located in the upper abdomen.

*Aerophagia:* repetitive air swallowing or ingesting air and belching.

*Functional vomiting:* recurrent vomiting in the absence of all known medical and psychiatric causes.

*Rumination syndrome:* effortless regurgitation of recently swallowed food.

**Functional bowel disorders and abdominal Pain**

*Irritable bowel syndrome (IBS):* a group of bowel disorders characterized by abdominal discomfort or pain associated with defecation or a change in bowel habit.

*Functional abdominal bloating:* a group of functional bowel disorders dominated by a feeling of abdominal fullness or bloating

Functional constipation: a group of functional disorders characterized by persistent difficult, infrequent, or seemingly incomplete defecation.

Functional diarrhea: continuous or recurrent passage of loose or watery stools without abdominal pain

**Functional abdominal Pain**

Functional abdominal pain: continuous or frequently recurrent abdominal pain, either not or infrequently related to gut function, and associated with some loss of daily activities
Functional disorders of the biliary tract and Pancreas

Gall bladder dysfunction: characterized by episodes of severe steady pain accompanied by decreased gall bladder emptying.

Sphincter of Oddi dysfunction: a motility disorder characterized by severe steady pain with no structural abnormalities that explain the symptoms. It sometimes occurs following gall bladder removal, but also may occur with an intact gall bladder.

Functional disorders of the anus and Rectum

Functional fecal incontinence: recurrent uncontrolled passage of fecal material where no structural or neurological cause is evident.

Functional anorectal pain: Levator ani syndrome is a dull ache in the rectum that lasts for hours to days. Proctalgia fugax is an infrequent sudden, severe pain in the anal area of short duration.

Functional defecation disorders: Dyssynergic defecation or inadequate defecatory propulsion.

Functional disorders: neonate and Toddlers

Infant regurgitation: uncomplicated involuntary return (regurgitation) of stomach contents into the mouth. Common and normal in infants.

Infant rumination syndrome: voluntary, habitual regurgitation of recently swallowed stomach contents. Rare.

Cyclic vomiting syndrome: recurrent episodes of intense nausea and vomiting lasting hours to days separated by symptom-free intervals lasting weeks to months.

Infant colic: long bouts of crying or irritability without obvious cause.

Functional diarrhea: daily, painless, recurrent passage of 3 or more large, unformed stools for at least 4 weeks in infancy or preschool years.
Infant dyschezia: straining and crying with stool passage.

Functional constipation: infrequent, painful, hard, or large diameter bowel movements.

**Functional disorders: children and adolescents**

Vomiting and aerophagia: adolescent rumination syndrome, cyclic vomiting syndrome, aerophagia


Constipation and incontinence: functional constipation, non-retentive fecal incontinence

**CLASSIFICATION**

The Rome process has helped to define the functional gastrointestinal disorders.

Successively, the Rome I, Rome II, and the Rome III meetings have proposed a consensual classification system and terminology, as recommended by the Rome Coordinating Committee.

- Functional esophageal disorders
- Functional heartburn
- Functional chest pain of presumed esophageal origin
- Functional dysphagia
- Globus pharyngis
- Functional colonic disease: In medicine, the term functional colonic disease (or functional bowel disorder) refers to a group of bowel disorders which are characterised by chronic abdominal complaints without a structural or biochemical cause that could explain symptoms.
- Functional constipation
- Functional rectal pain
- Functional dyspepsia
- Noncardiac chest pain
Functional Gastrointestinal Disease

- Chronic functional abdominal pain
- Irritable bowel syndrome

Epidemiology

Functional gastrointestinal disorders have been found in 60-70% of both Canadian and American populations. Globally, irritable bowel syndrome and functional dyspepsia alone affect 16–26% of the population.

Functional heartburn

Functional heartburn is heartburn of unknown cause. It is associated with other functional gastrointestinal disorder like irritable bowel syndrome and is the chief cause of lack of improvement post treatment with proton pump inhibitors (PPIs). PPIs are however still the primary treatment with response rates in about 50% of people. The diagnosis is one of elimination, based upon the Rome III criteria: 1) burning retrosternal discomfort; 2) elimination of heart attack and GERD as the cause; and 3) no esophageal motility disorders. It was found to be present in 22.3% of Canadians in one survey.

GLOBUS PHARYNGIS

Globus pharyngis (also called globus sensation, globus or, somewhat outdatedly, globus hystericus, commonly referred to as having a “lump in one’s throat”), is the persistent sensation of having phlegm, a pill or some other sort of obstruction in the throat when there is none. Swallowing can be performed normally, so it is not a true case of dysphagia, but it can become very irritating. One may also feel mild chest pain or even severe pain with a clicking sensation when swallowing.

Causes

The “lump in the throat” sensation that characterizes globus pharyngis is often caused by inflammation of one or more parts of the throat, such as the larynx or hypopharynx, due to Cricopharyngeal Spasm, gastroesophageal reflux (GERD),
Laryngopharyngeal reflux or esophageal variety. In few cases the cause is unknown and symptoms may be attributed to a psychogenic cause i.e. a somatoform or anxiety disorder. It has been recognised as a symptom of depression, which responds to anti-depressive treatment.

Differential diagnosis must be made from Eagle syndrome which uses the patient’s description of “something caught in my throat” as a diagnostic tool. Eagle syndrome is an elongation of the styloid process causing irritation to nerves and muscles in the region resulting in a number of unusual symptoms.

The results of recent studies have strongly suggested that GERD is a major cause of globus, though this remains under considerable debate.

A less common cause, distinguished by a “lump in the throat” accompanied with clicking sensation and considerable pain when swallowing, may be because of thyroid-cartilage rubbing against anomalous asymmetrical laryngeal anatomy e.g. the superior cornu abrading against the thyroid lamina, surgically trimming the offending thyroid-cartilage provides immediate relief in all cases. However this cause is frequently misdiagnosed, despite requiring a simple clinical examination involving careful palpation of the neck side to side which elicits the same click sensation (laryngeal crepitus) and pain as when swallowing, most cases are due to prior trauma to the neck.

High resolution computed tomographic (CT) or MRI scan of the larynx is generally required to fully understand the anomalous laryngeal anatomy. Anterior displacement the thyroid ala on the affected side while swallowing can help resolve symptoms.

FUNCTIONAL CONSTIPATION

Functional constipation, called chronic idiopathic constipation (CIC), is constipation that does not have a physical (anatomical) or physiological (hormonal or other body chemistry) cause. It may have a neurological, psychological or psychosomatic cause. A
person with functional constipation may be healthy, yet has difficulty defecating.

**Main Symptoms and Diagnosis**

Chronic idiopathic Constipation is resemble to constipation-predominant irritable bowel syndrome (IBS-C), however people with CIC do not have other symptoms of IBS, such as abdominal pain. Diagnosing CIC can be difficult as other syndromes must be ruled out as there is no physiological cause for CIC. Doctors will typically look for other symptoms, like blood in stool, weight loss, low blood count, or other symptoms.

To be considered functional constipation, symptoms must be present at least a fourth of the time.

Functional constipation, as medically defined by the Rome III criteria, has various causes, including

- Anismus
- Descending perineum syndrome
- Other inability or unwillingness to control the external anal sphincter, which normally is under voluntary control
- A bad diet
- An unwillingness to defecate
- Nervous reactions, including prolonged and/or chronic stress and anxiety, that close the internal anal sphincter, a muscle that is not under voluntary control
- Deeper psychosomatic disorders which sometimes affect digestion and the absorption of water in the colon

**Research**

Children with functional constipation generally claim to lack the sensation of the urge to defecate, and may be conditioned to avoid doing so due to a previous painful experience. One retrospective study showed that these children did indeed have the urge to defecate using colonic manometry, and suggested behavioral modification as a treatment for functional constipation.
CHEST PAIN

This kind of pain may be a symptom of a number of serious disorders and is, in general, considered a medical emergency. Even though it may be determined that the pain is noncardiac in origin (does not come from a heart problem), this is often a diagnosis of exclusion made after ruling out more serious causes of the pain. Cardiac (heart-related) chest pain is called angina pectoris. Pain in the chest wall muscles is called by other names, such as pectoralgia, stethalgia, thoracalgia, and thoracodynia.

Chest pain is a common presenting problem, as the following numbers illustrate:

- In the US, an estimated 5 million patients per year present to the Emergency Department with chest pain.
- More than 50% of patients presenting to emergency facilities with unexplained chest pain will have coronary disease ruled out.
- 1.5 million patients are admitted annually for workup of acute coronary syndrome (ACS).
- Approximately 8 billion dollars are used annually to evaluate complaints of chest pain.
- Pediatric patients with chest pain account for 0.3% to 0.6% of pediatric emergency department visits

Differential diagnosis

Causes of chest pain range from non-serious to serious to life-threatening. DiagnosisPro lists more than 440 causes on its website.

In adults the most common causes of chest pain comprise: gastrointestinal (42%), coronary artery disease (31%), musculoskeletal (28%), pericarditis (4%) and pulmonary embolism (2%). Other less common causes include: pneumonia, lung cancer, and aortic aneurysms. Chest pain in children differs from adults in that there can be congenital causes and syndromes. In children the most common causes for chest pain are musculoskeletal and unknown.
**Functional Gastrointestinal Disease**

**Cardiovascular**
- Acute coronary syndrome
- Unstable angina
- Myocardial infarction ("heart attack")
- Aortic dissection
- Pericarditis and cardiac tamponade
- Arrhythmia - atrial fibrillation and a number of other arrhythmias can cause chest pain.
- Stable angina pectoris - this can be treated medically, and, although it warrants investigation, it is not an emergency in its strictest sense
- Myocarditis
- Mitral valve prolapse syndrome
- Aortic aneurysm

**Respiratory**
- Bronchitis
- Pulmonary embolism
- Pneumonia
- Hemothorax
- Pneumothorax and Tension pneumothorax
- Pleurisy - an inflammation that can cause painful respiration
- Tuberculosis
- Tracheitis
- Lung malignancy

**Gastrointestinal**
- Esophageal rupture
- Gastroesophageal reflux disease (GERD) and other causes of heartburn
- Esophagitis
- Hiatus hernia
- Achalasia, nutcracker esophagus, diffuse esophageal spasm and other motility disorders of the esophagus
- Functional dyspepsia
Chest wall

- Costochondritis or Tietze’s syndrome - a benign and harmless form of osteochondritis often mistaken for heart disease
- Spinal nerve problem
- Fibromyalgia
- Chest wall problems
- Radiculopathy
- Precordial catch syndrome - another benign and harmless form of a sharp, localised chest pain often mistaken for heart disease
- Breast conditions
- Herpes zoster commonly known as shingles
- Tuberculosis
- Osteoarthritis
- Bornholm disease

Psychological

- Panic attack
- Anxiety
- Clinical depression
- Somatization disorder
- Hypochondria

Others

- Hyperventilation syndrome often presents with chest pain and a tingling sensation of the fingertips and around the mouth
- Da Costa’s syndrome
- Carbon monoxide poisoning
- Sarcoidosis
- Lead poisoning
- High abdominal pain may also mimic chest pain
- Prolapsed intervertebral disc
- Thoracic outlet syndrome.
Diagnostic approach

History taking

Knowing a patient’s risk factors can be very useful in ruling in or ruling out serious causes of chest pain. For instance, heart attack and thoracic aortic dissection are very rare in healthy individuals under 30 years of age, but significantly more common in individuals with great risk factors, like older age, smoking, hypertension, diabetes, history of coronary artery disease or stroke, positive family history (premature atherosclerosis, cholesterol disorders, heart attack at early age), and other risk factors.

Chest pain that radiates to one or both shoulders or arms, chest pain that occurs with physical activity, chest pain associated with nausea or vomiting, chest pain accompanied by diaphoresis or sweating, or chest pain described as “pressure,” has a higher likelihood of being pertaining to acute coronary syndrome, or inadequate supply of blood to the heart muscle, but even without these symptoms chest pain may be a sign of acute coronary syndrome.

Physical examination

In the emergency department the typical approach to chest pain involves ruling out the most dangerous causes: heart attack, pulmonary embolism, thoracic aortic dissection, esophageal rupture, tension pneumothorax, and cardiac tamponade. By elimination or confirmation of the most serious causes, a diagnosis of the origin of the pain may be made. Generally, no definite cause will be found and reassurance is then provided. If acute coronary syndrome (“heart attack”) is suspected, many people are admitted briefly for observation, sequential ECGs, and measurement of cardiac enzymes in the blood over time.

On occasion, further tests on follow up may determine the cause. TIMI score performed at time of admission may help stratify risk. Careful medical history and physical examination is essential in separating dangerous from trivial causes of disease, and the management of chest pain may be done on specialised units (termed
medical assessment units) to concentrate the investigations. Occasionally, invisible medical signs will direct the diagnosis towards particular causes, like Levine’s sign in cardiac ischemia. A rapid diagnosis can be life-saving and often has to be made without the help of medical tests. However, in general, additional tests are required to establish the diagnosis.

Medical tests

On the basis of the above, a various nature of tests may be ordered:

- An electrocardiogram (ECG)
- Chest radiograph or chest x rays are frequently performed
- CT scanning is used in the diagnosis of aortic dissection
- V/Q scintigraphy or CT pulmonary angiogram (when a pulmonary embolism is suspected)
- Blood tests:
  - Troponin I or T (to indicate myocardial damage)
  - Complete blood count
  - Electrolytes and renal function (creatinine)
  - Liver enzymes
  - Creatine kinase (and CK-MB fraction in many hospitals)
  - D-dimer (when suspicion for pulmonary embolism is present but low)
  - serum lipase or amylase to exclude acute pancreatitis

Management

Aspirin increases survival in people with acute coronary syndrome and it is reasonable for EMS dispatchers to recommend it in people with no recent serious bleeding. In people with chest pain supplemental oxygen is not needed unless the oxygen saturations are less than 94% or there are signs of respiratory distress.

Entonox is frequently used by EMS personnel in the prehospital environment. However, there is little evidence about its effectiveness.
Epidemiology

Chest pain is the presenting symptom in about 12% of emergency department visits in the United States and has a one-year mortality of about 5%. The rate of ED visits in the US for chest pain increased 13% from 2006-2011.

CHRONIC FUNCTIONAL ABDOMINAL PAIN (CFAP)

Chronic functional abdominal pain (CFAP) or functional abdominal pain syndrome (FAPS) is the ongoing presence of abdominal pain for which there is no known medical explanation. It is very similar to, but less common than, irritable bowel syndrome (IBS), and many of the same treatments for IBS can also be of benefit to those with CFAP. The basic difference between IBS and CFAP is that in CFAP, unlike in IBS, there is no change in bowel habits such as constipation or diarrhea. Bowel dysfunction is a necessary diagnostic criterion of IBS.

CFAP is characterized by chronic pain, with no physical explanation or findings (no structural, infectious, or mechanical causes can be found). It is theorized that CFAP is a disorder of the nervous system where normal nociceptive nerve impulses are amplified “like a stereo system turned up too loud” resulting in pain. Alternately it is hypothesized that there exists in the intestine a protozoan (namelyblastocystis) which is interacting with the sympathetic nervous system and causing the pain. Newer semi-synthetic antibiotics such as rifaximin have been used in treatment. This visceral hypersensitivity may be a stand-alone cause of CFAP, or CFAP may result from the same type of brain-gut nervous system disorder that underlies IBS. As with IBS, low doses of antidepressants have been found useful in controlling the pain of CFAP.

IRRITABLE BOWEL SYNDROME (IBS)

Irritable bowel syndrome (IBS) is a symptom-based diagnosis. It is characterized by chronic abdominal pain, discomfort, bloating,
and alteration of bowel habits. Diarrhea or constipation and soiling may predominate, or they may alternate (classified as IBS-D, IBS-C, or IBS-A, respectively). As a functional gastrointestinal disorder (FGID), IBS has no known organic cause; however, excessive mast cell activation has a central pathophysiological role in the disorder. IBS is a disorder of the gut–brain axis.

Onset of IBS is more likely to occur after infections (postinfectious IBS-PI), or a stressful life event, but varies little with age. For at least some individuals, abnormalities in the gut flora occur, and it has been theorised that these abnormalities result in inflammation and altered bowel function. A diagnosis of IBS may be made on the basis of symptoms, in the absence of worrisome features such as age of onset greater than 50 years, weight loss, bloody stool, signs of infection or colitis, or family history of inflammatory bowel disease.

Routine testing yields no abnormalities, although the bowels may be more sensitive to certain stimuli, like balloon insufflation testing. Several conditions may present similarly, including coeliac disease, non-celiac gluten sensitivity, fructose malabsorption, mast cell activation disorders, parasitic infections, inflammatory bowel disease, bile acid malabsorption, functional chronic constipation, small intestinal bacterial overgrowth, and chronic functional abdominal pain.

Although no cure for IBS is known, treatments to relieve symptoms exist. This including dietary adjustments, medication, and psychological interventions. Patient education and good doctor–patient relationships are also significant. Dietary measures that have been found to be effective include increasing soluble fiber intake.

IBS has no direct effect on life expectancy. IBS also does not harm intestines. It is, however, a source of chronic pain, fatigue, and other symptoms, and contributes to work absenteeism. It is common and its effects on quality of life make it a disease with a high social cost. Psychiatric disorders such as anxiety and major depression are common in IBS.
Classification

IBS can be classified as either diarrhea-predominant (IBS-D), constipation-predominant (IBS-C), or with alternating stool pattern (IBS-A) or pain-predominant. In some individuals, IBS may have an acute onset and develop after an infectious illness characterized by two or more of: fever, vomiting, diarrhea, or positive stool culture. This postinfective syndrome has consequently been termed “postinfectious IBS” (IBS-PI).

Primary Signs and Symptoms

The primary symptoms of IBS are abdominal pain or discomfort in association with frequent diarrhea or constipation and a change in bowel habits. There may also be urgency for bowel movements, a feeling of incomplete evacuation (tenesmus), bloating, or abdominal distension. In few cases, the symptoms are relieved by bowel movements. People with IBS, more commonly than others, have gastroesophageal reflux, symptoms relating to the genitourinary system, chronic fatigue syndrome, fibromyalgia, headache, backache, and psychiatric symptoms such as depression and anxiety. About a third of men and women who have IBS also report sexual dysfunction typically in the form of a reduction in libido. Some studies indicate up to 60% of people with IBS also have a psychological disorder, typically anxiety or depression.

Causes

While the causes of IBS are still untraced, it is believed that the entire gut–brain axis is affected. Recent evidence connotes that there are abnormal levels of mast cell expression and activation in specific parts of the gastrointestinal tract which are unique to each subtype of IBS. The risk of developing IBS increases six-fold after acute gastrointestinal infection. Postinfection, further risk factors are young age, prolonged fever, anxiety, and depression. Antibiotic use also appears to increase the risk of developing IBS. Research has found that genetic defects in innate immunity and epithelial homeostasis increase the risk of developing both post-infectious as well as other forms of IBS.
**Post-infectious**

Almost 10 percent of IBS cases are triggered by an acute gastroenteritis infection. Genetic defects relating to the innate immune system and epithelial barrier as well as high stress and anxiety levels appear from evidence to increase the risk of developing post-infectious IBS. Post-infectious IBS generally manifests itself as the diarrhea predominant subtype. Evidence has demonstrated that the release of high levels of proinflammatory cytokines during acute enteric infection causes increased gut permeability leading to translocation of the commensal bacteria across the epithelial barrier resulting in huge damage to local tissues which is likely to result in chronic gut abnormalities in sensitive individuals. However, increased gut permeability is strongly related to IBS regardless of whether IBS was initiated by an infection or not.

**Stress**

Publications suggesting the role of brain-gut “axis” appeared in the 1990s and childhood physical and psychological abuse is generally associated with the development of IBS. Given the high levels of anxiety seen in IBS patients and the overlap with conditions such as fibromyalgia and chronic fatigue syndrome, a potential model of IBS involves a disruption of the stress system.

The stress response in the body involves the HPA axis and the sympathetic nervous system, both of which have been shown to operate abnormally in IBS patients. Psychiatric illness or anxiety precedes IBS symptoms in two-thirds of patients, and psychological traits predispose previously healthy people to developing IBS after gastroenteritis.

**Small intestinal bacterial Overgrowth**

Small intestinal bacterial overgrowth occurs with greater frequency in patients who have been diagnosed with IBS compared to healthy controls. SIBO is most common in diarrhea predominant IBS but also occurs in constipation predominant IBS more frequently than healthy controls. Symptoms of SIBO include bloating,
abdominal pain, diarrhea or constipation among others. IBS may be the result of the immune system interacting abnormally with gut microbiota resulting in an abnormal cytokine signalling profile.

**Fungal dysbiosis**

There is growing evidence that alterations of gut microbiota (dysbiosis) is related to the intestinal manifestations of IBS, but also with the psychiatric morbidity that coexists in up to 80% of patients with IBS. The role of the gut mycobiota, and especially of the abnormal proliferation of the yeast *Candida albicans* in some patients with IBS, is under investigation.

**Protozoa**

Protozoal infections can cause symptoms that mirror specific IBS subtypes, e.g., infection by certain subtypes of *blastocystis hominis* (blastocystosis) has a great (possibly causal) relationship with IBS-D; certain protozoal infections also occur more frequently in IBS patients. *Dientamoeba fragilis* has also been considered a possible organism to study, though it is also found in people without IBS.

**Mechanism**

There is proof that abnormalities are found in the gut flora of individuals who suffer from IBS such a loss of diversity with a decrease in Bacteroidetes. The changes in gut flora are most profound in individuals who have diarrhoea predominant IBS. Antibodies against common components (namely flagellin) of the commensal gut flora are a common occurrence in IBS affected individuals. Chronic low-grade inflammation commonly occurs in IBS affected individuals with abnormalities found including increased enterochromaffin cells, intraepithelial lymphocytes, and mast cells resulting in chronic immune mediated inflammation of the gut mucosa.

Genetic, environmental, and psychological factors seem to be important in the development of IBS. Studies have shown that IBS has a genetic component even though there is a predominant
influence of environmental factors. IBS has been reported in greater quantities in multigenerational families with IBS than in the regular population. This suggests a heritability factor. This factor does not follow classic Mendelian but is of the complex/multifactorial variety. 286 genes have been identified that are variably expressed in IBS-D patients. Some research suggests the consumption of spicy foods is directly associated with IBS, especially in women. Changes in serotonin metabolisms are thought to play a role in IBS development. One study found increased levels of serotonin transporter in the ileum of patients suffering from IBS. Another study suggested that an increased expression of apoptotic genes in IBS can lead to an increase in mast cells in the intestine. This may lead to internalization of cellular adhesion proteins such as ZO-1 and occludin.

**Diagnosis**

To diagnose irritable bowel syndrome no specific laboratory or imaging test can be performed. Diagnosis involves excluding conditions that produce IBS-like symptoms, and then following a procedure to categorize the patient’s symptoms. Ruling out parasitic infections, lactose intolerance, small intestinal bacterial overgrowth, and celiac disease is recommended for all patients before a diagnosis of irritable bowel syndrome is made. In patients over 50 years old, they are recommended to undergo a screening colonoscopy. IBS sufferers are at increased risk of being given inappropriate surgeries such as appendectomy, cholecystectomy, and hysterectomy due to their IBS symptoms being misdiagnosed as other medical conditions.

**Differential Diagnosis**

Colon cancer, inflammatory bowel disease, thyroid disorders, and giardiasis can all feature abnormal defecation and abdominal pain. Less common causes of this symptom profile are carcinoid syndrome, microscopic colitis, bacterial overgrowth, and eosinophilic gastroenteritis; IBS is, however, a common presentation, and testing for these conditions would yield low
numbers of positive results, so it is considered difficult to justify the expense.

A number of patients, managed for years for IBS, may have indeed non-celiac gluten sensitivity (NCGS). Gastrointestinal symptoms of IBS are clinically indistinguishable from those of NCGS, but the presence of any of the following non-intestinal manifestations suggest a possible NCGS: headache or migraine, “foggy mind”, chronic fatigue, fibromyalgia, joint and muscle pain, leg or arm numbness, tingling of the extremities, dermatitis (eczema or skin rash), atopic disorders, allergy to one or more inhalants, foods or metals (such as mites, graminacea, parietaria, cat or dog hair, shellfish, or nickel), depression, anxiety, anemia, iron-deficiency anemia, folate deficiency, asthma, rhinitis, eating disorders, neuropsychiatric disorders (like schizophrenia, autism, peripheral neuropathy, ataxia, attention deficit hyperactivity disorder) or autoimmune diseases.

An improvement with a gluten-free diet of immune-mediated symptoms, including autoimmune diseases, once reasonably ruled out coeliac disease and wheat allergy, is another way to realize a differential diagnosis. Because various causes of diarrhea give IBS-like symptoms, the American Gastroenterological Association published a set of guidelines for tests to be performed to rule out other causes for these symptoms. These include gastrointestinal infections, lactose intolerance, and coeliac disease. Research has suggested these guidelines are not always followed. Once other causes have been excluded, the diagnosis of IBS is performed using a diagnostic algorithm. Well-known algorithms include the Manning criteria, the obsolete Rome I and II criteria, and the Kruis criteria, and studies have compared their reliability.

The more recent Rome III process was published in 2006. Physicians may choose to use one of these guidelines or may simply choose to rely on their own anecdotal experience with past patients. The algorithm may include additional tests to guard against misdiagnosis of other diseases as IBS. Such “red flag” symptoms may include weight loss, gastrointestinal bleeding,
anemia, or nocturnal symptoms. However, red flag conditions may not always contribute to accuracy in diagnosis; for instance, as many as 31% of IBS patients have blood in their stool, many possibly from hemorrhoidal bleeding. The diagnostic algorithm identifies a name that can be applied to the patient’s condition based on the combination of the patient’s symptoms of diarrhea, abdominal pain, and constipation. For instance, the statement “50% of returning travelers had developed functional diarrhea while 25% had developed IBS” would mean half the travelers had diarrhea while a quarter had diarrhea with abdominal pain. While some researchers believe this categorization system will help physicians understand IBS, others have questioned the value of the system and suggested all IBS patients have the same underlying disease but with diverse symptoms.

**Investigations**

To exclude other conditions investigations are performed:

- Stool microscopy and culture (to exclude infectious conditions)
- Blood tests: Full blood examination, liver function tests, erythrocyte sedimentation rate, and serological testing for coeliac disease
- Abdominal ultrasound (to exclude gallstones and other biliary tract diseases)
- Endoscopy and biopsies (to exclude peptic ulcer disease, coeliac disease, inflammatory bowel disease, and malignancies)
- Hydrogen breath testing (to exclude fructose and lactose malabsorption)

**Misdiagnosis**

Some common instances of misdiagnosis include infectious diseases, coeliac disease, *Helicobacter pylori*, parasites (non-protozoal).

Coeliac disease in particular is generally misdiagnosed as IBS. The American College of Gastroenterology recommends all patients
with symptoms of IBS be tested for coeliac disease. Bile acid malabsorption is also sometimes missed in patients with diarrhea-predominant IBS. SeHCAT tests suggest around 30% of D-IBS patients have this condition, and most respond to bile acid sequestrants.

Chronic use of certain sedative-hypnotic drugs, especially the benzodiazepines, may cause irritable bowel-like symptoms that can lead to a misdiagnosis of irritable bowel syndrome.

**Comorbidities**

Various medical conditions, or comorbidities, appear with greater frequency in patients diagnosed with IBS.

- **Neurological/Psychiatric:** A study of 97,593 individuals with IBS identified comorbidities such as headache, fibromyalgia, and depression. IBS occurs in 51% of chronic fatigue syndrome patients and 49% of fibromyalgia patients, and psychiatric disorders occur in 94% of IBS patients.

- **Inflammatory bowel disease:** IBS may be a type of low-grade inflammatory bowel disease. Researchers have suggested IBS and IBD are interrelated diseases, noting that patients with IBD experience IBS-like symptoms when their IBD is in remission. A three-year study found that patients diagnosed with IBS were 16.3 times more likely to be diagnosed with IBD during the study period. Serum markers associated with inflammation have also been found in patients with IBS.

- **Abdominal surgery:** IBS patients were at increased risk of having unnecessary gall bladder removal surgery not due to an increased risk of gallstones, but rather to abdominal pain, awareness of having gallstones, and inappropriate surgical indications. These patients also are 87% more likely to undergo abdominal and pelvic surgery and three times more likely to undergo gallbladder surgery. Also, IBS patients were twice as likely to undergo hysterectomy.

- **Endometriosis:** One study reported a statistically significant link between migraine headaches, IBS, and endometriosis.
• Other chronic disorders: Interstitial cystitis may be associated with other chronic pain syndromes, such as irritable bowel syndrome and fibromyalgia. The connection between these syndromes is unknown.

Management

Various type of treatments have been found to be effective including: fiber, talk therapy, antispasmodic and antidepressant medication, and peppermint oil.

Diet

Studies have shown that up to 70% of IBS patients benefited from eating a low FODMAP diet. Symptoms most likely to improve from such a diet include urgency, flatulence, bloating, abdominal pain, and altered stool output. One national guideline advises a low FODMAP diet for managing IBS when other dietary and lifestyle measures have been unsuccessful. This diet restricts various carbohydrates which are poorly absorbed in the small intestine, as well as fructose and lactose, which are similarly poorly absorbed in those with intolerances to them. Reduction of fructose and fructan has been shown to reduce IBS symptoms in a dose-dependent manner in patients with fructose malabsorption and IBS.

Some IBS patients believe they have some form of dietary intolerance; however, tests attempting to predict food sensitivity in IBS have proven disappointing. A small study reported that an IgG antibody test was somewhat effective in determining food sensitivity in IBS patients, with patients on the elimination diet experiencing 10% greater symptom-reduction than those on a sham diet. However, more research is necessary before IgG testing can be recommended.

FODMAPs diet

A diet restricted in fermentable oligo-di- and monosaccharides and polyols (FODMAPs) now has an evidence base sufficiently strong to recommend its widespread application in conditions such as IBS and IBD. They also state the restriction of FODMAPs
globally, rather than individually, controls the symptoms of functional gut disorders (e.g., IBS), and the majority of IBD patients respond just as well. It is more successful than restricting only fructose and fructans, which are also FODMAPs, as is recommended for those with fructose malabsorption. Longer-term compliance with the diet was high.

**Fiber**

Some evidence suggests soluble fiber supplementation (e.g., psyllium/ispagula husk) is effective. It acts as a bulking agent, and for many IBS-D patients, allows for a more consistent stool. For IBS-C patients, it seems to allow for a softer, moister, more easily passable stool. However, insoluble fiber (e.g., bran) has not been found to be effective for IBS. In some people, insoluble fiber supplementation may aggravate symptoms.

Fiber might be beneficial in those who have a predominance of constipation. In people who have IBS-C, soluble fiber can reduce overall symptoms, but will not reduce pain. The research supporting dietary fiber contains conflicting, small studies complicated by the heterogeneity of types of fiber and doses used.

One meta-analysis found only soluble fiber improved global symptoms of irritable bowel, but neither type of fiber reduced pain. An updated meta-analysis by the same authors also found soluble fiber reduced symptoms, while insoluble fiber worsened symptoms in some cases. Positive studies have used 10–30 grams per day of psyllium. One study particularly examined the effect of dose, and found 20 g of ispaghula husk were better than 10 g and equivalent to 30 g per day.

**Medication**

Medications may include stool softeners and laxatives in IBS-C and antidiarrheals (e.g., opiate, opioid, or opioid analogs such as loperamide, codeine, diphenoxylate) in IBS-D for mild symptoms and stronger opiates such as morphine and oxycodone for severe cases. Drugs affecting serotonin (5-HT) in the intestines can help reduce symptoms. On the other hand, many IBS-D patients report
that SSRI-type medications exacerbate spasms and diarrhea. This is thought to be due to the large number of serotonin receptors in the gut. 5HT3 antagonists such as ondansetron are effective in postinfectious IBS and diarrhoea-dominant IBS because of their blockade of serotonin on 5HT3 receptors in the gut; the reason for their benefit is believed to be that excessive serotonin in the gut is thought to play a role in the pathogenesis of some subtypes of IBS. Certain atypical antipsychotic medications, such as clozapine and olanzapine, may also provide relief due to serotonergic properties these agents possess, acting on the same receptors as other medications in this specific category.

Advantages may include reduced diarrhoea, reduced abdominal cramps, and improved general well-being. Any nausea present may also respond to 5HT3 antagonists owing to their antiemetic properties. Serotonin stimulates the gut motility and so agonists can help constipation-predominant irritable bowel, while antagonists can help diarrhea-predominant irritable bowel.

Selective serotonin reuptake inhibitors, SSRIs, frequently prescribed for panic and/or anxiety disorder and depression, affect serotonin in the gut, as well as the brain. The bowels are highly dependent on serotonin for neural communication. “Selective serotonin reuptake inhibitor antidepressants seem to promote global well-being in some patients with irritable bowel syndrome and, possibly, some improvement in abdominal pain and bowel symptoms, but this effect appears to be independent of improved depression. Further research is required.” Mast cells and the compound that they secrete are central to the pathophysiology and implicated in the treatment of IBS; some of the secreted mast cell mediators (and associated receptors) which have been implicated in symptoms of IBS or specific subtypes include: histamine (HRH1, HRH2, HRH3), tryptase and chymase (PAR2), serotonin (5-HT3), PGD2 (DP1).

Histamine also causes epithelial secretion of chloride ions and water (associated with secretory diarrhea) by signaling through a receptor or ligand-gated ion channel that has not been identified
as of 2015. A 2015 review noted that both H1-antihistamines and mast cell stabilizers have shown efficacy in reducing pain related to visceral hypersensitivity in IBS; other lower quality studies have also suggested the benefit of these agents for IBS. In a related review on idiopathic mast cell activation syndromes (including IBS), a combined treatment approach using antileukotrienes, H1/H2-antihistamines, and a mast cell stabilizer are suggested.

Laxatives

For patients who decline to respond adequately to dietary fiber, osmotic laxatives such as polyethylene glycol, sorbitol, and lactulose can help avoid “cathartic colon” which has been associated with stimulant laxatives. Among the osmotic laxatives, doses of 17–26 g/d of polyethylene glycol have been well studied. Lubiprostone (Amitiza) is a gastrointestinal agent used for the treatment of idiopathic chronic constipation and constipation-predominant IBS. It is well tolerated in adults, including elderly patients.

As of July 20, 2006, lubiprostone had not been studied in pediatric patients. Lubiprostone is a bicyclic fatty acid (prostaglandin E1 derivative) that acts by specifically activating ClC-2 chloride channels on the apical aspect of gastrointestinal epithelial cells, producing a chloride-rich fluid secretion. These secretions soften the stool, increase motility, and promote spontaneous bowel movements. Unlike many laxative products, lubiprostone does not show signs of tolerance, dependency, or altered serum electrolyte concentration.

Antispasmodics

The use of antispasmodic drugs (e.g., anticholinergics such as hyoscymamine or dicyclomine) may help patients, particularly those with cramps or diarrhea. A meta-analysis by the Cochrane Collaboration concludes if seven patients are treated with antispasmodics, one patient will benefit. Antispasmodics can be divided into two groups: neurotropics and musculotropics.

• Neurotropics — for instance, phenobarbital — act at the nerve fibre of the
parasympathicus, but also affect other nerves, causing side effects in many patients.

- Musculotropics, like mebeverine, act directly at the smooth muscle of the gastrointestinal tract, relieving spasm without affecting normal gut motility. Since this action is not mediated by the autonomic nervous system, the usual anticholinergic side effects are absent.

**Discontinuation of proton pump inhibitors**

Proton pump inhibitors (PPIs) used to suppress stomach acid production may cause bacterial overgrowth leading to IBS symptoms. Discontinuation of PPIs in selected individuals has been recommended as it may lead to an improvement or resolution of IBS symptoms.

**Tricyclic antidepressants**

Strong evidence indicates low doses of tricyclic antidepressants can be effective for IBS. However, the evidence is less robust as to the effectiveness of other antidepressant classes such as SSRIs.

**Serotonin agonists**

- Tegaserod (Zelnorm), a selective 5-HT4 agonist for IBS-C, is available for relieving IBS constipation in women and chronic idiopathic constipation in men and women. On March 30, 2007, the FDA requested Novartis Pharmaceuticals to voluntarily discontinue marketing of tegaserod based on the recently identified finding of an increased risk of serious cardiovascular adverse events (heart problems) associated with use of the drug. Novartis agreed to voluntarily suspend marketing of the drug in the United States and in many other countries. On July 27, 2007, the FDA approved a limited-treatment IND program for tegaserod in the US to allow restricted access to the medication for patients in need if no comparable alternative drug or therapy is available to treat the disease. The FDA had issued two previous warnings about the serious consequences of tegaserod. In 2005, it was rejected as an IBS medication by the European Union. Tegaserod,
marketed as Zelnorm in the United States, was the only agent approved to treat the multiple symptoms of IBS (in women only), including constipation, abdominal pain, and bloating.

- Selective serotonin reuptake inhibitor antidepressants (SSRIs), because of their serotonergic effect, would seem to help IBS, especially patients who are constipation predominant. Initial crossover studies and randomized controlled trials support this role.

**Serotonin antagonists**

Alosetron, a selective 5-HT3 antagonist for IBS-D and cilansetron (also a selective 5-HT3 antagonist) were trialed for IBS. Due to severe adverse effects, namely ischemic colitis and severe constipation, they are not available or recommended.

**Other agents**

Magnesium aluminum silicates and alverine citrate drugs can be effective for IBS.

About the benefit of antidepressants in IBS evidence is conflicting. Some meta-analyses have found a benefit, while others have not. A meta-analysis of randomized controlled trials of mainly TCAs found three patients have to be treated with TCAs for one patient to improve. A separate randomized controlled trial found TCAs are best for patients with IBS-D.

As an effective treatment for abdominal bloating and flatulence, giving more credibility to the potential role of bacterial overgrowth in some patients with IBS rifaximin can be used. Domperidone, a dopamine receptor blocker and a parasympathomimetic, has been shown to reduce bloating and abdominal pain as a result of an accelerated colon transit time and reduced faecal load, that is, a relief from ‘hidden constipation’; defecation was similarly improved. The use of opioids is controversial due to the potential risk of tolerance, physical dependence, and addiction, but can be the only relief for some diarrhea-predominant cases when other treatment has been ineffective.
SIBO therapy

Statistically great reduction in IBS symptoms occurs following antibiotic therapy for small intestinal bacterial overgrowth. However, recent research has shown that the lactulose hydrogen breath test does not actually measure SIBO, and that SIBO is unlikely to be the cause of IBS.

Psychological therapies

The mind-body or brain-gut interactions has been proposed for IBS, and is gaining increasing research attention. Hypnosis can improve mental well-being, and cognitive behavioural therapy can provide psychological coping strategies for dealing with distressing symptoms, as well as help suppress thoughts and behaviours that increase the symptoms of IBS, although the evidence base for effectiveness of psychotherapy and hypnosis is weak and such therapies are in general not recommended. However, in treatment resistant cases where pharmacological therapies over a period of at least 12 months have failed to give relief, NICE clinical guidelines recommend that consideration should be given to psychological treatment strategies such as cognitive behavioural therapy [CBT], hypnotherapy and/or psychological therapy.

Stress relief

Reducing stress may reduce the frequency and severity of IBS symptoms. Techniques that may be helpful include:
- Relaxation techniques such as meditation
- Physical activities such as yoga or tai chi
- Regular exercise such as swimming, walking, or running

Probiotics

Probiotics can prove advantageous in the treatment of IBS; taking 10 billion to 100 billion beneficial bacteria per day is recommended for beneficial results. However, further research is needed on individual strains of beneficial bacteria for more refined recommendations. Probiotics have positive effects such as
enhancing the intestinal mucosal barrier, providing a physical barrier, bacteriocin production (resulting in reduced numbers of pathogenic and gas-producing bacteria), reducing intestinal permeability and bacterial translocation, and regulating the immune system both locally and systemically among other beneficial effects. Probiotics may also have positive effects on the gut-brain axis by their positive effects countering the effects of stress on gut immunity and gut function.

Different types of probiotics have been found to be effective, including *Lactobacillus plantarum* and *Bifidobacteria infantis*; but one review found only *Bifidobacteria infantis* showed efficacy. *B. infantis* may have effects beyond the gut via it causing a reduction of proinflammatory cytokine activity and elevation of blood tryptophan levels, which may cause an improvement in symptoms of depression. Some yogurt is made using probiotics that may help ease symptoms of IBS. A probiotic yeast called *Saccharomyces boulardii* has some evidence of effectiveness in the treatment of irritable bowel syndrome.

Some probiotics have different effects on certain symptoms of IBS. For example, *Bifidobacterium breve*, *B. longum*, and *Lactobacillus acidophilus* have been found to alleviate abdominal pain. *B. breve*, *B. infantis*, *L. casei*, or *L. plantarum* species alleviated distension symptoms. *B. breve*, *B. infantis*, *L. casei*, *L. plantarum*, *B. longum*, *L. acidophilus*, *L. bulgaricus*, and *Streptococcus salivarius ssp.thermophilus* have all been found to affect flatulence levels. Most clinical studies show probiotics do not improve straining, sense of incomplete evacuation, stool consistency, fecal urgency, or stool frequency, although a few clinical studies did find some benefit of probiotic therapy. The evidence is conflicting for whether probiotics improve overall quality of life scores.

Probiotics may exert their beneficial effects on IBS symptoms via preserving the gut microbiota, normalisation of cytokine blood levels, improving the intestinal transit time, decreasing small intestine permeability, and by treating small intestinal bacterial overgrowth of fermenting bacteria.
Herbal Remedies

Peppermint oil appears useful. Safety during pregnancy has not been established, however, and caution is required not to chew or break the enteric coating; otherwise, gastroesophageal reflux may occur as a result of lower esophageal sphincter relaxation. Occasionally, nausea and perianal burning occur as side effects. Iberogast, a multi-herbal extract, was found to be superior in efficacy to placebo. Commiphora mukul and Plantago ovata Only limited evidence exists for the effectiveness of other herbal remedies for IBS. As with all herbs, it is wise to be aware of possible drug interactions and adverse effects.

Epidemiology

The prevalence of IBS varies by country and by age range examined. The bar graph at right shows the percentage of the population reporting symptoms of IBS in studies from various geographic regions. The following table contains a list of studies performed in different countries that measured the prevalence of IBS and IBS-like symptoms:

Table: Percentage of population reporting symptoms of IBS in various studies from various geographic areas

<table>
<thead>
<tr>
<th>Country</th>
<th>Prevalence</th>
<th>Author/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>6%</td>
<td>Boivin, 2001</td>
</tr>
<tr>
<td>Japan</td>
<td>10%</td>
<td>Quigley, 2006</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>8.2%</td>
<td>Ehlin, 2003</td>
</tr>
<tr>
<td></td>
<td>10.5%</td>
<td>Wilson, 2004</td>
</tr>
<tr>
<td>United States</td>
<td>14.1%</td>
<td>Hungin, 2005</td>
</tr>
<tr>
<td>United States</td>
<td>15%</td>
<td>Boivin, 2001</td>
</tr>
<tr>
<td>Pakistan</td>
<td>14%</td>
<td>Jafri, 2007</td>
</tr>
<tr>
<td>Pakistan</td>
<td>34%</td>
<td>Jafri, 2005</td>
</tr>
<tr>
<td>Mexico City</td>
<td>35%</td>
<td>Schmulson, 2006</td>
</tr>
<tr>
<td>Brazil</td>
<td>43%</td>
<td>Quigley, 2006</td>
</tr>
<tr>
<td>Mexico</td>
<td>46%</td>
<td>Quigley, 2006</td>
</tr>
</tbody>
</table>
Gender

Women are around two to three times more likely to be diagnosed with IBS and four to five times more likely to seek specialty care for it than men. These differences likely reflect a combination of both biological (sex) and social (gender) factors. People diagnosed with IBS are usually younger than 45 years old. Studies of female patients with IBS show symptom severity often fluctuates with the menstrual cycle, suggesting hormonal differences may play a role. Endorsement of gender-related traits has been associated with quality of life and psychological adjustment in IBS. Gender differences in healthcare-seeking may also play a role. Gender differences in trait anxiety may contribute to lower pain thresholds in women, putting them at greater risk for a number of chronic pain disorders. Finally, sexual trauma is a major risk factor for IBS, with as many as 33% of all patients reporting such abuse. Because women are at higher risk of sexual abuse than men, gender-related risk of abuse may contribute to the higher prevalence of IBS in women.

History

One of the first references to the concept of an “irritable bowel” appeared in the Rocky Mountain Medical Journal in 1950. The term was used to categorize patients who developed symptoms of diarrhea, abdominal pain, and constipation, but where no well-recognized infective cause could be found. Early theories suggested the irritable bowel was caused by a psychosomatic or mental disorder.

Economics

In the US

The aggregate cost of irritable bowel syndrome in the United States has been estimated at $1.7–10 billion in direct medical costs, with an additional $20 billion in indirect costs, for a total of $21.7–30 billion. A study by a managed care company comparing medical costs of IBS patients to non-IBS controls identified a 49% annual
increase in medical costs related to a diagnosis of IBS. IBS patients incurred average annual direct costs of $5,049 and $406 in out-of-pocket expenses in 2007. A study of workers with IBS found that they reported a 34.6% loss in productivity, corresponding to 13.8 hours lost per 40 hour week. A study of employer-related health costs from a Fortune 100 company conducted with data from the 1990s found IBS patients incurred US $4527 in claims costs vs. $3276 for controls.

A study on Medicaid costs conducted in 2003 by the University of Georgia’s College of Pharmacy and Novartis found IBS was associated in an increase of $962 in Medicaid costs in California, and $2191 in North Carolina. IBS patients had higher costs for physician visits, outpatients visits, and prescription drugs. The study suggested the costs pertaining of IBS were comparable to those found in asthma patients.

Research

Individuals with IBS have been found to have decreased diversity and numbers of bacteroidetes microbiota. Preliminary research into the effectiveness of fecal microbiota transplant in the treatment of IBS has been very favourable with a ‘cure’ rate of between 36 percent and 60 percent with remission of core IBS symptoms persisting at 9 and 19 months follow up. There is increasing evidence for the effectiveness of mesalazine an aminosalicylate drug in the treatment of IBS. Mesalazine is a drug with anti-inflammatory properties that has been reported to significantly reduce immune mediated inflammation in the gut of IBS affected individuals with mesalazine therapy resulting in improved IBS symptoms as well as feelings of general wellness in IBS affected people. It has also been observed that mesalazine therapy helps to normalise the gut flora which is generally abnormal in people who have IBS. The therapeutic benefits of mesalazine may be the result of improvements to the epithelial barrier function. An IgG-mediated food intolerance diet led to a 24% greater deterioration in symptoms compared to those on the elimination
diet and food elimination based on IgG antibodies may be effective in reducing IBS symptoms and is worthy of further biomedical research.

The chief problem with this study was that the differences in symptoms were only observed in exclusion diets is limited, treatment based on “abnormally” high IgG antibodies cannot be recommended. Differences in visceral sensitivity and intestinal physiology have been noted in IBS.

Mucosal barrier reinforcement in response to oral 5-HTP was absent in IBS compared to controls. IBS/IBD individuals are less often HLA DQ2/8 positive than in upper functional gastrointestinal disease and healthy populations. A questionnaire in 2006 designed to identify patients’ perceptions about IBS, their preferences on the type of information they need, and educational media and expectations from health care providers revealed misperceptions about IBS developing into other conditions, comprising colitis, malnutrition, and cancer. The survey found IBS patients were most interested in learning about foods to avoid (60%), causes of IBS (55%), medications (58%), coping strategies (56%), and psychological factors related to IBS (55%). The respondents indicated they wanted their physicians to be available by phone or e-mail following a visit (80%), have the ability to listen (80%), and provide hope (73%) and support (63%).

**FUNCTIONAL BOWEL DISORDERS: DEFINITION AND IMPACT**

A functional gastrointestinal disorder includes symptoms arising in the mid or lower gastrointestinal tract that are not attributable to anatomic or biochemical defects. The symptoms comprise abdominal pain, early satiety, nausea, bloating, distention, and various symptoms of disordered defecation. The 3 most common functional bowel disorders are irritable bowel syndrome (IBS), constipation, and functional dyspepsia. IBS, the most common functional bowel disorder, is characterized by chronic or recurrent symptoms of lower abdominal pain related to bowel movements,
change in bowel habit (diarrhea, constipation, or alternating), a
sense of incomplete rectal evacuation, passage of mucus with
stool, and abdominal bloating and distention. The prevalence of
this disorder in most countries is approximately 10%. Constipation
is defined in various ways and perceived very differently among
patients. It is clear that a frequency definition of constipation is
insufficient, although a bowel movement frequency of less than
1 every 3 days is generally regarded as being outside the normal
range. However, most patients perceive that they are constipated
when they have to strain excessively or have difficulty passing
stool from the rectum or completing the evacuation of stool. With
such a variety of definitions, the prevalence of constipation in the
community is difficult to ascertain, with estimates ranging from
3% to 20%.

There is increasing evidence that a considerable proportion
(perhaps as high as 50% in tertiary centers) of patients with
constipation have a disorder of the process of rectal evacuation.
Normal defecation requires coordination of colonic contractions,
volutional rise in intra-abdominal pressure, and relaxation of the
pelvic floor and anal sphincters.

Functional dyspepsia is also a common problem (prevalence
estimated at 20% in a US community), and this disorder is
characterized by chronic or recurrent symptoms of upper
abdominal pain or “discomfort,” which is a summary term for
such symptoms as early satiety, nausea, bloating, and vomiting.

In IBS, functional dyspepsia, and constipation, no structural
or biochemical abnormalities are identified. Around 30% of patients
with IBS have symptoms consistent with functional dyspepsia,
either concurrently or at other times.

There is also overlap in the clinical symptomatology of patients
with constipation-predominant IBS and those who have
constipation that results from an evacuation disorder. In patients
with suspected IBS, careful evaluation of the dynamics of defecation
is essential for excluding a disorder of rectal evacuation, to provide
the best treatment, and to avoid greater direct and indirect costs resulting from mismanagement.

**Societal and Economic Impact**

One of the most significant societal perspectives resulting from functional bowel disorders is the degree of absenteeism that is recorded among patients with these conditions. For instance, it has been estimated that patients with IBS recorded work or school absences of up to 13 days per year compared with a control population, who reported 5 days of absence per year. This level of absenteeism is equivalent to that related to the common cold and flu and presents a significant burden to any nation’s economy. Indeed, it is estimated that 0.1% to 0.5% of healthcare expenditures in industrialized countries are attributable to IBS, and that 66% to 75% of all the economic burden from functional gastrointestinal disorders results from indirect costs secondary to loss of days at work or school.

Functional bowel disorders constitute a significant economic burden in the form of direct costs. It has been estimated that annual charges for healthcare delivery for IBS in the United States are around $8 billion. More recently, however, the annual costs incurred by 8 major industrialized countries were estimated at approximately $41 billion, including $25 billion in the United States and over $4 billion each in Japan and Germany.

**Irritable Bowel Syndrome**

**Pathogenesis**

IBS is a biopsychosocial disorder in which psychosocial, motility, and sensation disturbances result in abdominal pain and disorders of defecation (ie, constipation, diarrhea, or alternating bowel habits). In community studies, the prevalence of this disorder is around 10% and the incidence, is estimated at 1% to 2% per year. A fourth possible etiologic factor that has recently received much attention is prior infection. Thus, 25% to 33% of patients with diarrhea-predominant IBS give a positive history of a previous
“enteritis” episode. However, the persistence of symptoms seems to be more closely related to the occurrence of stressful life events and hypochondriasis than to changes in physiologic function.

Motor dysfunction may, as previously indicated, also contribute to some of the symptoms in IBS. In this setting, the prominent colonic response to feeding results in urgency, abdominal pain, and require to have a bowel movement in the early postprandial period. Abnormal transit profiles such as accelerated small bowel and colonic transit in diarrhea-predominant IBS may require the use of medications such as opioids (loperamide, diphenoxylate) that help restore normal function. Patients with urgency and diarrhea develop high-amplitude, rapidly propagated colonic contractions (HAPCs), especially postprandially. From our improved appreciation of the role of the pelvic floor and anal sphincter muscles in the process of evacuation and of disturbances in the dynamics of defecation, it is clear that pelvic floor disorders may produce a syndrome virtually identical to the so-called constipation-predominant IBS. Therefore, a history of excessive straining, a sense of incomplete evacuation, or the need to digitate the rectum or vagina to facilitate emptying of the rectum are all features related to pelvic floor or anal sphincter dysfunction.

In patients with constipation, it is essential to perform a careful rectal examination that comprises assessments of the anal sphincter tone at rest, the ability of the puborectalis to relax during straining, and the descent of the perineum during straining. Simple screening tests, such as the balloon expulsion test and measurement of perineal descent, are available to confirm the clinical diagnosis. The differentiation between evacuation disorders and IBS-constipation has important practical implications. For example, a prokinetic agent for constipation is unlikely to work in patients with evacuation disorders.

Much direct and indirect expenditure attributable to IBS might be avoided then if more attention were placed on the rectal examination of these patients. Another component of motor
dysfunction that may contribute to heightened sensitivity of the colon is spasm. While this event is well appreciated by radiologists during colon radiography, it has been difficult to objectively demonstrate motor disturbances in the descending or sigmoid colon in patients with IBS. Hence, pharmacologic approaches aimed at correcting motor dysfunction have been empirically based (ie, involve use of antimuscarinic or, more recently, antiserotonergic agents).

In IBS patients with diarrhea and urgency colonic and rectal hypersensitivity are very relevant. Hypersensitivity has been proposed as a biologic marker of the condition; however, the lack of responsiveness of rectal hypersensitivity in clinical trials and its poor correlation with clinical responses challenge whether this symptom can be used as a biologic marker.

Anxiety, psychosensory function, and limbic system activation may contribute to the increased rectocolonic sensitivity. To be concluded, the evidence for hypersensitivity in IBS is considerable, but the proof of its clinical relevance will depend on the development of effective therapies and documentation of clinical benefit by restoring normal sensation.

**Treatment**

Various novel approaches to treatment of IBS are based on these improved insights into motor and sensory functions of the colon and rectum. Thus, novel 5HT₄ agonists that stimulate colonic transit and motor function (ie, prucalopride, tegaserod) are currently in development for constipation and pain-predominant IBS. Achieving consistent relief of pain — without associated side effects — has always presented a great challenge in the treatment of patients with IBS. In the past, anticholinergic agents have been used, but these drugs tend to induce systemic effects and lose efficacy. Recognition of the role of 5HT₃ receptors in visceral afferents, as well as demonstration that 5HT₃ antagonists can reduce the gastrocolonic motor response to meal ingestion, have led to large phase II and phase III clinical trials with the novel 5HT₃ antagonist alosetron.
This agent provides adequate relief of pain and discomfort while reducing frequency and urgency and improving consistency of stool in female diarrhea-predominant IBS patients. To date, limited studies have not demonstrated the drug to be efficacious in male IBS patients. Kappa opioid (peripheral) agonists reduce the pain sensation arising in the gut without inducing any central effects. Alpha-2 adrenergic agents modulate motor and sensory functions of the bowel, especially the sensation of pain arising during mechanical distention of the colon. Over the next 5 to 10 years, we should witness further validation of these concepts for the purpose of treating IBS.

Pathogenesis and Management

Constipation is a very common clinical problem, and a questionnaire-based study in Olmsted County, Minnesota, demonstrated that up to 20% of patients report symptoms consistent with functional constipation. About 40% of such patients have historic evidence of needing to strain excessively to evacuate the bowel. This suggests that these patients may also have a component of an evacuation disorder, although the questionnaire-based data do not allow sufficient distinction between an evacuation problem and slow-transit constipation.

In a tertiary center study, 50% of patients (N=70) with severe, unresponsive constipation referred to a single gastroenterologist over a 3-year period had impaired evacuation; the remaining patients had either normal or slow-transit constipation.

Physiologic characterization of constipated patients is important for several reasons. First, among patients with slow-transit constipation, drug-induced constipation, or evacuation disorders, supplementation of up to 30 grams of fiber per day does not result in any improvement in symptoms. Second, it is significant to identify evacuation disorders because a biofeedback treatment program with muscle relaxation of anal sphincters and the puborectalis can result in a 70% or greater cure rate for the constipation. Also significant to note is that surgical and other
aggressive strategies previously employed in the treatment of evacuation disorders have been shown to be either unnecessary or damaging to patients, resulting in incontinence. Finally, characterization of pelvic floor function and transit profiles by radiopaque markers or scintigraphy facilitates a more physiologic approach to relieving constipation.

Thus, the appropriate characterization of these patients can guide the management strategy — individuals with slow-transit constipation tend to benefit from fiber, osmotic laxatives, and stimulant laxatives (eg, bisacodyl), whereas patients with evacuation disorders usually do not need medication other than fiber supplementation following pelvic floor retraining.

Pathogenesis and Clinical Presentation

Functional dyspepsia is also a biopsychosocial disorder; disturbances in psychosocial function, altered motility, and altered sensation interact to induce the condition. Whereas much time and effort has been spent exploring the role of infectious organisms such as *Helicobacter pylori* in the context of nonulcer dyspepsia over the past decade, it is now clear from eradication and outcome studies that, in the vast majority of individuals, the organism is perhaps an “innocent bystander” in the absence of ulceration. Depending on how the disorder is defined in various epidemiologic studies, the prevalence of functional dyspepsia ranges from 5% to 25%. As with IBS, this functional disorder results in considerable disturbance in quality of life, social function, and healthcare utilization. Among adults with nonulcer dyspepsia, approximately 30% have impaired gastric emptying of solids; these patients respond to prokinetic medications. A second major motor abnormality associated with this disorder is impaired postprandial gastric accommodation, which results in early satiety and weight loss. The other major pathophysiologic disturbance of functional dyspepsia is gastric hypersensitivity. In this setting, although the elastic properties (compliance) of the stomach are unimpaired, patients experience pain or discomfort at lower
thresholds. Thus, the visceral afferents are considered hypersensitive. Dyspeptic patients also have evidence of hyperalgesia, because the same stimulus produces higher pain scores in this population than in healthy volunteers.

**Treatment**

In recent past wide studies performed have noted a lack of gastric accommodation in association with hypersensitivity during the fasting or postprandial periods.

This lack of accommodation may suggest that a pharmacologic relaxation of the stomach would improve the dyspeptic symptoms in these patients. Relatively simple tests — such as a water-load or nutrient drink test — can assess the degree of accommodation and hypersensitivity. However, only 50% of dyspeptic patients demonstrate hypersensitivity by these noninvasive methods.

Pharmacologically induced relaxation of the stomach alone may not necessarily reduce postprandial pain. Studies involving the inflation of an intragastric balloon at different pressures, such as the study by Tack and colleagues, have shown that while cisapride results in increased accommodation of the stomach, it lowers (rather than raises) the threshold pressures for the induction of discomfort.

Similarly, the nitric oxide donor, nitroglycerin, results in marked, dose-related relaxation of the stomach but no change in pain sensation in response to balloon distention. In fact, these patients experienced a worsening sensation of nausea. By contrast, clonidine, an alpha-2 adrenergic agonist with central antinociceptive action, was related to a reduction in pain perception during gastric distention (without affecting accommodation or emptying); relaxation in gastric wall tension due to clonidine accounted for about 40% of the variance in pain sensation.

These data suggest that novel approaches to therapy for functional dyspepsia will require a visceral antinociceptive effect rather than an exclusive relaxatory action.
DIAGNOSIS OF SUSPECTED FUNCTIONAL BOWEL DISORDERS: SYMPTOMS

Symptoms

As there are no organic changes that characterize FBDs, symptom-based diagnostic criteria are used to define patients who have an FBD. The first symptom-based diagnostic criteria for FBDs to be developed were the Manning criteria in 1978, followed by the Rome I criteria, Rome II criteria, and the current Rome III criteria.

Even though the diagnosis of separate functional gastrointestinal disorders is made on the basis of different combinations of symptoms, upper and lower gastrointestinal symptoms generally overlap, and many patients fulfill diagnostic criteria for several functional gastrointestinal disorders.

Moreover, there is also considerable instability in symptoms over time and patients who have predominant IBS symptoms at one point in time generally have functional upper gastrointestinal symptoms a couple of years later. In fact, the overlap in symptoms and symptom instability probably supports the diagnosis of a functional gastrointestinal disorder, even though this assumption has not formally been validated.

Gastrointestinal symptoms are often found in the general population and most individuals who report symptoms have a functional gastrointestinal disorder.

According to the Rome III criteria for FBDs, symptom onset must have occurred at least 6 months before diagnosis and symptoms must have been present on 3 days or more per month during the 3 months preceding diagnosis. This specification separates FBDs from transient gut symptoms and demonstrates current activity.

Irritable Bowel Syndrome

The diagnostic criteria for IBS include recurrent abdominal pain or discomfort associated with altered bowel habits. Supportive
symptoms comprise abnormal stool frequency, hard or loose stools, defecation straining, urgency, the feeling of incomplete bowel movement, passing mucus and bloating—the more of these symptoms the patient has the more likely it is that they have IBS.

There is also a significant overlap of IBS symptoms with those of functional dyspepsia, and symptoms of nausea, epigastric pain, postprandial fullness and early satiety are, therefore, also common in patients with IBS.

Psychiatric disorders such as depression, anxiety and somatization are also associated with IBS, and somatization has a role in the association between IBS and extraintestinal symptoms. Lethargy, backache, headache, urinary tract symptoms and female dyspareunia are all more common in patients who have IBS than in the general population.

The presence of extraintestinal symptoms enables a more confident diagnosis of IBS to be made, and should normally lead to fewer rather than more investigations.

Patients with IBS are subgrouped according to the Rome III criteria on the basis of predominant stool form alone. The previous Rome II subgrouping was, in addition to predominant stool form, also based on stool frequency and the presence of urgency and incomplete bowel emptying, and was highly unstable over time.

Whether the subgrouping of patients with IBS according to the Rome III criteria also proves unstable remains to be seen. From a clinical point of view, subgrouping is relevant to the treatment of choice and also to diagnostic evaluation.

**Functional Bloating**

Functional bloating is defined as the presence of both the recurrent feeling of bloating or visible abdominal distension and insufficient criteria for a diagnosis of functional dyspepsia, IBS or other functional gastrointestinal disorders. Typically the symptoms worsen after meal intake and throughout the day and improve
overnight. An objective finding of increased abdominal girth is seen in some, but not all, patients and the correlation of increased abdominal girth with symptoms is rather poor.

Functional Constipation

Among patients the definition of constipation differs widely and it is of great importance to evaluate what the patient means by constipation.

A large proportion of patients who consider themselves constipated fulfill the diagnostic criteria for IBS. Other patients instead have what is known as functional constipation.

Functional constipation is defined as the presence of two or more of the following symptoms: at least 25% of the time during defecation is spent straining, passing lumpy or hard stools, a sensation of incomplete evacuation, a sensation of anorectal obstruction, or defecation fewer than three times per week. In addition, the passing of loose stools without the use of laxatives should rarely be present and the criteria for IBS should not be fulfilled.

Functional Diarrhea

Functional diarrhea refers to the passage of loose (mushy) or watery stools in the absence of abdominal pain or discomfort. Often the stool frequency is also increased and urgency is a prominent problem, but these findings are not prerequisites for a diagnosis of functional diarrhea.

A more thorough diagnostic work-up is generally required in patients who have suspected functional diarrhea before a confident diagnosis of an FBD can be made, since organic gastrointestinal diseases like IBD, microscopic colitis and bile-acid malabsorption have very similar symptoms.

Functional Abdominal Pain Syndrome

Functional abdominal pain syndrome is a pain syndrome attributed to the abdomen poorly related to gut function. In the Rome III criteria, functional abdominal pain syndrome is not
included among the FBDs but is considered to be an entity in its own right, one that is generally related to complex psychiatric problems. This pain syndrome is characterized by continuous or nearly continuous pain that is unrelated to physiological events such as eating or defecation.

The high symptom severity means that diagnosis is often preceded by several investigations, but thereafter it seems to be of great importance to abstain from further diagnostic testing and concentrate on establishing an effective physician-patient relationship.
Human Gastrointestinal Tract (GIT)

The human gastrointestinal tract (GI tract or GIT) is an organ system which is responsible for transporting and digesting foodstuffs, absorbing nutrients, and expelling waste.

The tract comprises the stomach and intestines, and is divided into the upper and lower gastrointestinal tracts. The GI tract includes all structures between the mouth and the anus, forming a continuous passageway that comprises the main organs of digestion, namely, the stomach, small intestine, and large intestine. In contrast, the human digestive system comprises the gastrointestinal tract plus the accessory organs of digestion (the tongue, salivary glands, pancreas, liver, and gallbladder). The tract may also be divided into foregut, midgut, and hindgut, reflecting the embryological origin of each segment. The whole human GI tract is about nine metres (30 feet) long at autopsy. It is very shorter in the living body because the intestines, which are tubes of smooth muscle tissue, maintain constant muscle tone, somewhat like a slinky that maintains itself in a halfway-tense state but can relax in spots to allow for local distention, peristaltis, and so on. The GI tract releases hormones from enzymes to help regulate the digestive process. These hormones, including gastrin, secretin, cholecystokinin, and ghrelin, are mediated through either intracrine or autocrine mechanisms, indicating that the cells
releasing these hormones are conserved structures throughout evolution.

**STRUCTURE**

The structure and function can be described both as gross anatomy and as microscopic anatomy or histology. The tract itself is divided into upper and lower tracts, and the intestines small and large parts.

**Upper gastrointestinal Tract**

The upper gastrointestinal tract comprises the buccal cavity, pharynx, esophagus, stomach, and duodenum. The exact demarcation between the upper and lower tracts is the suspensory muscle of the duodenum. This delineates the embryonic borders between the foregut and midgut, and is also the division commonly used by clinicians to describe gastrointestinal bleeding as being of either “upper” or “lower” origin. Upon dissection, the duodenum may appear to be a unified organ, but it is divided into four segments based upon function, location, and internal anatomy. The four segments of the duodenum are as follows (starting at the stomach, and moving toward the jejunum): bulb, descending, horizontal, and ascending. The suspensory muscle attaches the superior border of the ascending duodenum to the diaphragm.

The suspensory muscle is an important anatomical landmark which shows the formal division between the duodenum and the jejunum, the first and second parts of the small intestine, respectively. This is a thin muscle which is derived from the embryonic mesoderm.

**Lower gastrointestinal Tract**

The lower gastrointestinal tract comprises most of the small intestine and all of the large intestine. In human anatomy, the intestine (bowel, or gut) is the segment of the gastrointestinal tract extending from the pyloric sphincter of the stomach to the anus and, in humans and other mammals, consists of two segments, the small intestine and the large intestine. In humans, the small intestine
is further subdivided into the duodenum, jejunum and ileum while the large intestine is subdivided into the cecum, colon, rectum, and anal canal.

**Small intestine**

The small intestine starts at the duodenum, which receives food from the stomach. It is a tubular structure, usually between 6 and 7 m long. The area of the human, adult small intestinal mucosa is about 30 m. Its main function is to absorb the products of digestion (including carbohydrates, proteins, lipids, and vitamins) into the bloodstream. It has three major divisions:

1. **Duodenum**: A short structure (about 20–25 cm long) which receives chyme from the stomach, together with pancreatic juice containing digestive enzymes and bile from the gall bladder. The digestive enzymes break down proteins, and bile emulsifies fats into micelles. The duodenum contains Brunner’s glands, which produce a mucus-rich alkaline secretion containing bicarbonate. These secretions, in combination with bicarbonate from the pancreas, neutralizes the stomach acids contained in the chyme.

2. **Jejunum**: This is the midsection of the small intestine, connecting the duodenum to the ileum. It is about 2.5 m long, and contains the circular folds, and villi that increase its surface area. Products of digestion (sugars, amino acids, and fatty acids) are absorbed into the bloodstream here.

3. **Ileum**: The final section of the small intestine. It is about 3 m long, and contains villi similar to the jejunum. It absorbs mainly vitamin B12 and bile acids, as well as any other remaining nutrients.

**Large Intestine**

The large intestine also called the colon, comprises of the cecum, rectum, and anal canal. It also includes the appendix, which is attached to the cecum. The colon is further divided into:

1. **Cecum (first portion of the colon) and appendix**
2. **Ascending colon (ascending in the back wall of the abdomen)**
3. Right colic flexure (flexed portion of the ascending and transverse colon apparent to the liver)
4. Transverse colon (passing below the diaphragm)
5. Left colic flexure (flexed portion of the transverse and descending colon apparent to the spleen)
6. Descending colon (descending down the left side of the abdomen)
7. Sigmoid colon (a loop of the colon closest to the rectum)
8. Rectum
9. Anus.

The chief function of the large intestine is to absorb water. The area of the large intestinal mucosa of an adult human is about 2 m².

Development

The gut is an endoderm-derived structure. At approximately the sixteenth day of human development, the embryo begins to fold ventrally (with the embryo’s ventral surface becoming concave) in two directions: the sides of the embryo fold in on each other and the head and tail fold toward one another. The result is that a piece of the yolk sac, an endoderm-lined structure in contact with the ventral aspect of the embryo, starts to be pinched off to become the primitive gut. The yolk sac remains connected to the gut tube via the vitelline duct. Generally this structure regresses during development; in cases where it does not, it is known as Meckel’s diverticulum.

During fetal life, the primitive gut is gradually patterned into three segments: foregut, midgut, and hindgut. Although these terms are often used in reference to segments of the primitive gut, they are also used regularly to describe regions of the definitive gut as well. Each segment of the gut is further specified and gives rise to specific gut and gut-related structures in later development. Components derived from the gut proper, including the stomach and colon, develop as swellings or dilatations in the cells of the primitive gut.
In contrast, gut-related derivatives — that is, those structures that derive from the primitive gut but are not part of the gut proper, in general develop as out-pouchings of the primitive gut. The blood vessels supplying these structures remain constant throughout development.

**Histology**

![General structure of the gut wall](image)

- 1: **Mucosa**: Epithelium
- 2: **Mucosa**: Lamina propria
- 3: **Mucosa**: Muscularis mucosae
- 4: Lumen
- 5: Lymphatic tissue
- 6: Duct of gland outside tract
- 7: Gland in mucosa
- 8: **Submucosa**
- 9: Glands in submucosa
- 10: Meissner’s submucosal plexus
- 11: Vein
- 12: **Muscularis**: Circular muscle
- 13: **Muscularis**: Longitudinal muscle
- 14: **Serosa**: Areolar connective tissue
- 15: **Serosa**: Epithelium
- 16: Auerbach’s myenteric plexus
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- 17: Nerve
- 18: Artery
- 19: Mesentry

The gastrointestinal tract has a form of general histology with some differences that reflect the specialization in functional anatomy. The GI tract can be divided into four concentric layers in the following order:

- Mucosa
- Submucosa
- Muscular layer
- Adventitia or serosa

**Mucosa**

The mucosa is the innermost layer of the gastrointestinal tract that is surrounding the lumen, or open space within the tube. This layer comes in direct contact with digested food (chyme). The mucosa is made up of:

- Epithelium - innermost layer. Responsible for most digestive, absorptive and secretory processes.
- Lamina propria - a layer of connective tissue. Unusually cellular compared to most connective tissue
- Muscularis mucosae - a thin layer of smooth muscle that aids the passing of material and enhances the interaction between the epithelial layer and the contents of the lumen by agitation and peristalsis.

The mucosae are very specialized in each organ of the gastrointestinal tract to deal with the different conditions. The most variation is seen in the epithelium.

**Submucosa**

The submucosa includes a dense irregular layer of connective tissue with large blood vessels, lymphatics, and nerves branching into the mucosa and muscularis externa. It contains the submucosal plexus, an enteric nervous plexus, situated on the inner surface of the **muscularis externa**.
Muscular layer

The muscular layer comprises an inner circular layer and a longitudinal outer layer. The circular layer prevents food from traveling backward and the longitudinal layer shortens the tract. The layers are not truly longitudinal or circular, rather the layers of muscle are helical with different pitches. The inner circular is helical with a steep pitch and the outer longitudinal is helical with a much shallower pitch. The coordinated contractions of these layers is known as peristalsis and propels the food through the tract.

Food in the GI tract is called a bolus (ball of food) from the mouth down to the stomach. After the stomach, the food is partially digested and semi-liquid, and is referred to as chyme. In the large intestine the remaining semi-solid substance is referred to as faeces. Between the two muscle layers is the myenteric plexus. This controls peristalsis. Activity is initiated by the pacemaker cells, (myenteric interstitial cells of Cajal). The gut has intrinsic peristaltic activity (basal electrical rhythm) due to its self-contained enteric nervous system. The rate can be modulated by the rest of the autonomic nervous system.

Adventitia and Serosa

The outermost layer of the gastrointestinal tract consists of several layers of connective tissue. Intraperitoneal parts of the GI tract are covered with serosa. These include most of the stomach, first part of the duodenum, all of the small intestine, caecum and appendix, transverse colon, sigmoid colon and rectum.

In these sections of the gut there is clear boundary between the gut and the surrounding tissue. These parts of the tract have amesentery.

Retroperitoneal parts are covered with adventitia. They blend into the surrounding tissue and are fixed in position. For example, the retroperitoneal section of the duodenum generally passes through the transpyloric plane. These comprise the esophagus, pylorus of the stomach, distal duodenum, ascending colon,
descending colon and anal canal. In addition, the oral cavity has adventitia.

**FUNCTION**

The time taken for food or other ingested objects to transit through the gastrointestinal tract varies depending on various factors, but roughly, it takes less than an hour after a meal for 50% of stomach contents to empty into the intestines and total emptying of the stomach takes around 2 hours. Subsequently, 50% emptying of the small intestine takes 1 to 2 hours. In the last, transit through the colon takes 12 to 50 hours with wide variation between individuals.

**Immune function**

**Immune barrier**

The gastrointestinal tract is also a significant part of the immune system. The surface area of the digestive tract is estimated to be the surface area of a football field. With such a large exposure, the immune system must work hard to prevent pathogens from entering into blood and lymph. The low pH (ranging from 1 to 4) of the stomach is fatal for many microorganisms that enter it. Similarly, mucus (containing IgA antibodies) neutralizes many of these microorganisms. Other factors in the GI tract help with immune function as well, including enzymes in saliva and bile. Enzymes such as Cyp3A4, along with the antiporter activities, also are instrumental in the intestine’s role of detoxification of antigens and xenobiotics, such as drugs, involved in first phase metabolism.

Health-enhancing intestinal bacteria of the gut flora serve to prevent the overgrowth of potentially harmful bacteria in the gut. These two types of bacteria compete for space and “food,” as there are limited resources within the intestinal tract. A ratio of 80-85% beneficial to 15-20% potentially harmful bacteria usually is considered normal within the intestines. Microorganisms also are kept at bay by an extensive immune system comprising the gut-associated lymphoid tissue (GALT).
**Immune system homeostasis**

Beneficial bacteria also can contribute to the gastrointestinal system homeostasis. A case in point is the relationship between human gut and Clostridia, one of the most predominant bacterial groups in the gastrointestinal tract. Clostridia play an significant role influencing the dynamics of our immune system in the gut. It has been demonstrated that the intake of a high fiber diet could be the responsible for the induction of Treg cells. This is because of the production of short-chain fatty acids during the fermentation of plant derived nutrients like butyrate and propionate. Basically, the butyrate induces the differentiation of Treg cells by enhancing histone H3 acetylation in the promoter and conserved non-coding sequence regions of the Foxp3 locus, and thus regulating the T cells, having as a result the reduction of the inflammatory response and allergies.

**Intestinal microbiota**

The large intestine hosts various kinds of bacteria that deal with molecules the human body is not able to break down itself. This is an example of symbiosis. These bacteria also account for the production of gases at host-pathogen interface, inside our intestine(this gas is released as flatulence when eliminated through the anus). However the large intestine is mainly related to the absorption of water from digested material (which is regulated by the hypothalamus) and the re absorption of sodium, as well as any nutrients that may have escaped primary digestion in the ileum.

**CLINICAL SIGNIFICANCE**

**Disease**

There are a various kind of diseases and conditions affecting the gastrointestinal system, including:

- Infection. Gastroenteritis is an inflammation of the stomach and small intestine. It occurs more frequently than any other disease of the intestines.
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- Cancer may occur at any point in the gastrointestinal tract, and includes mouth cancer, tongue cancer, oesophageal cancer, stomach cancer, and colorectal cancer.
- Inflammatory conditions. Ileitis is an inflammation of the ileum, colitis is an inflammation of the large intestine.
- Appendicitis is inflammation of the vermiform appendix located at the caecum. This is a potentially fatal condition if left untreated; most cases of appendicitis require surgical intervention.

Diverticular disease is a condition that is very common in older people in industrialized countries. It usually affects the large intestine but has been known to affect the small intestine as well. Diverticulosis occurs when pouches form on the intestinal wall. Once the pouches become inflamed it is known as diverticulitis.

Inflammatory bowel disease is an inflammatory condition affecting the bowel walls, and includes the subtypes Crohn’s disease and ulcerative colitis. While Crohn’s can affect the entire gastrointestinal tract, ulcerative colitis is limited to the large intestine. Crohn’s disease is widely regarded as an autoimmune disease. Although ulcerative colitis is often treated as though it were an autoimmune disease, there is no consensus that it actually is such.

Symptoms

Many symptoms are used to indicate problems with the gastrointestinal tract:

- Vomiting, which may include regurgitation of food or the vomiting of blood
- Diarrhoea, or the passage of liquid or more frequent stools
- Constipation, which refers to the passage of fewer and hardened stools
- Blood in stool, which includes fresh red blood, maroon-coloured blood, and tarry-coloured blood

Treatment

Surgery of the gastrointestinal tract can often be performed
in the outpatient setting. In the United States in 2012, operations on the digestive system accounted for 3 of the 25 most common ambulatory surgery procedures and constituted 9.1 percent of all outpatient ambulatory surgeries.

**Imaging**

A number of methods of imaging the gastrointestinal tract include the upper and lower gastrointestinal series:

- Radioopaque dyes may be swallowed to produce a barium swallow
- Parts of the tract may be visualised by camera. This is known as endoscopy if examining the upper gastrointestinal tract, and colonoscopy or sigmoidoscopy if examining the lower gastrointestinal tract. Capsule endoscopy is where a capsule is swallowed in order to examine the tract. Biopsies may also be taken when examined.
- To examine the lower gastrointestinal tract an abdominal x-ray may be used.

**Other**

- Cholera
- Enteric duplication cyst
- Giardiasis
- Pancreatitis
- Peptic ulcer disease
- Yellow fever
- *Helicobacter pylori* is a gram-negative spiral bacterium. Over half the world’s population is infected with it, mainly during childhood, it is not certain as to how the disease is transmitted. It colonizes the gastrointestinal system, predominantly the stomach. The bacterium has specific survival conditions that our gastric microenvironment: it is both capnophilic and microaerophilic. *Helicobacter* also exhibits a tropism for gastric epithelial lining and the gastric mucosal layer about it.
• Gastric colonization of this bacterium triggers a robust immune response leading to moderate to severe inflammation. This inflammatory response triggers a cascade of mucosal changes that can persist from chronic gastritis, duodenal cancer, metaplasia, dysplasia, carcinoma, to mucosal associated lymphoid tissue lymphoma (MALT lymphoma). Many individuals go through life without realizing they are infected because they were exposed young and their body sees it as normal flora. However, signs and symptoms are gastritis, burning abdominal pain, weight loss, loss of appetite, bloating, burping, nausea, bloody vomit, and black tarry stools. Infection is easy enough to detect: GI X-rays, endoscopy, blood tests for anti-Helicobacter antibodies, a stool test, and a urease breath test (which is a by-product of the bacteria). If caught soon enough, it can be treated with three doses of different proton pump inhibitors as well as two antibiotics, taking about a week to cure. If not caught soon enough, surgery may be required.

• Intestinal pseudo-obstruction is a syndrome caused by a malformation of the digestive system, characterized by a severe impairment in the ability of the intestines to push and assimilate. Symptoms comprise daily abdominal and stomach pain, nausea, severe distension, vomiting, heartburn, dysphagia, diarrhea, constipation, dehydration and malnutrition. There is no cure for intestinal pseudo-obstruction. Various types of surgery and treatment managing life-threatening complications such as ileus and volvulus, intestinal stasis which lead to bacterial overgrowth, and resection of affected or dead parts of the gut may be needed. Several patients need parenteral nutrition.

• Ileus is a blockage of the intestines.

• Coeliac disease is a common form of malabsorption, affecting up to 1% of people of northern European descent. An autoimmune response is triggered in intestinal cells by digestion of gluten proteins. Ingestion of proteins found
in wheat, barley and rye, causes villous atrophy in the small intestine. Lifelong dietary avoidance of these foodstuffs in a gluten-free diet is the only treatment.

- Enteroviruses are named by their transmission-route through the intestine (enteric meaning intestinal), but their symptoms aren’t mainly associated with the intestine.

- Irritable bowel syndrome (IBS) is the most common functional disorder of the intestine. Functional constipation and chronic functional abdominal pain are other disorders of the intestine that have physiological causes, but do not have identifiable structural, chemical, or infectious pathologies. They are aberrations of normal bowel function but not diseases.

- Endometriosis can affect the intestines, with resemble symptoms to IBS.

- Bowel twist (or similarly, bowel strangulation) is a comparatively rare event (usually developing sometime after major bowel surgery). It is, however, hard to diagnose correctly, and if left uncorrected can lead to bowel infarction and death. (The singer Maurice Gibb is understood to have died from this.)

- Angiodysplasia of the colon
- Chronic functional abdominal pain
- Constipation
- Diarrhea
- Hirschsprung’s disease (aganglionosis)
- Intussusception
- Polyp (medicine)
- Pseudomembranous colitis
- Ulcerative colitis and toxic megacolon.
INTRODUCTION

The human digestive system comprises the gastrointestinal tract plus the accessory organs of digestion (the tongue, salivary glands, pancreas, liver, and gallbladder). In this system, the process of digestion has many stages, the first of which starts in the mouth (oral cavity). Digestion involves the breakdown of food into smaller and smaller components which can be absorbed and assimilated into the body. The secretion of saliva helps to produce a bolus which can be swallowed to pass down the oesophagus and into the stomach. Saliva also contains a catalytic enzyme called amylase which starts to act on food in the mouth. Another digestive enzyme called lingual lipase is secreted by some of the lingual papillae on the tongue and also from serous glands in the main salivary glands.

Digestion is helped by the mastication of food by the teeth and also by the muscular actions of peristalsis and segmentation contractions. Gastric juice in the stomach is essential for the continuation of digestion as is the production of mucus in the stomach. Peristalsis is the rhythmic contraction of muscles that starts in the oesophagus and continues along the wall of the stomach and the rest of the gastrointestinal tract. This initially results in the production of chyme which when fully broken down in the small intestine is absorbed as chyle into the lymphatic
system. Most of the digestion of food takes place in the small intestine. Water and some minerals are reabsorbed back into the blood, in the colon of the large intestine. The waste products of digestion are defecated from the anus via the rectum.

DIGESTIVE SYSTEM COMPONENTS

There are many organs and other components involved in the digestion of food. The organs known as the accessory digestive glands are the liver, gall bladder and pancreas. Other components include the mouth, teeth and epiglottis.

The largest structure of the digestive system is the gastrointestinal tract (GI tract). This starts at the mouth and ends at the anus, covering a distance of about nine (9) metres. The largest part of the GI tract is the colon or large intestine. Water is absorbed here and remaining waste matter is stored prior to defecation.

In the small intestine most of the digestion of food takes place. A major digestive organ is the stomach. Within its mucosa are millions of embedded gastric glands. Their secretions are vital to the functioning of the organ.

There are various specialised cells of the GI tract. These include the various cells of the gastric glands, taste cells, pancreatic duct cells, enterocytes and microfold cells.

Mouth

The mouth is the first part of the gastrointestinal tract and is equipped with several structures that begin the first processes of digestion. These include salivary glands, teeth and the tongue. The mouth consists of two regions, the vestibule and the oral cavity proper. The vestibule is the area between the teeth, lips and cheeks, and the rest is the oral cavity proper. Most of the oral cavity is lined with oral mucosa, a mucous membrane that produces a lubricating mucus, of which only a small amount is needed. Mucous membranes vary in structure in the different regions of the body but they all produce a lubricating mucus, which is either
secreted by surface cells or more usually by underlying glands. The mucous membrane in the mouth continues as the thin mucosa which lines the bases of the teeth.

The main component of mucus is a glycoprotein called mucin and the type secreted varies according to the region involved. Mucin is viscous, clear, and clinging. Underlying the mucous membrane in the mouth is a thin layer of smooth muscle tissue and the loose connection to the membrane gives it its great elasticity. It covers the cheeks, inner surfaces of the lips, and floor of the mouth. The roof of the mouth is termed the palate and it separates the oral cavity from the nasal cavity. The palate is hard at the front of the mouth since the overlying mucosa is covering a plate of bone; it is softer and more pliable at the back being made of muscle and connective tissue, and it can move to swallow food and liquids. The soft palate ends at the uvula.

The surface of the hard palate allows for the pressure needed in eating food, to leave the nasal passage clear. The lips are the mouth’s front boundary and the fauces (the passageway between the tonsils, also called the throat), mark its posterior boundary. At either side of the soft palate are the palatoglossus muscles which also reach into regions of the tongue. These muscles raise the back of the tongue and also close both sides of the fauces to enable food to be swallowed. Mucus helps in the mastication of food in its ability to soften and collect the food in the formation of the bolus.

**Salivary glands**

There are three pairs of main salivary glands and between 800 and 1,000 minor salivary glands, all of which mainly serve the digestive process, and also play an important role in the maintenance of dental health and general mouth lubrication, without which speech would be impossible.

The chief glands are all exocrine glands, secreting via ducts. All of these glands terminate in the mouth. The largest of these are the parotid glands – their secretion is mainly serous. The next pair are underneath the jaw, the submandibular glands, these
produce both serous fluid and mucus. The serous fluid is produced by serous glands in these salivary glands which also produce lingual lipase. They produce about 70% of the oral cavity saliva. The third pair are the sublingual glands located underneath the tongue and their secretion is mainly mucous with a small percentage of saliva. Within the oral mucosa (a mucous membrane) lining the mouth and also on the tongue and palates and mouth floor, are the minor salivary glands; their secretions are mainly mucous and are innervated by the facial nerve (the seventh cranial nerve). The glands also secrete amylase a first stage in the breakdown of food acting on the carbohydrate in the food to transform the starch content into maltose.

There are other glands on the surface of the tongue that encircle taste buds on the back part of the tongue and these also produce lingual lipase. Lipase is a digestive enzyme that catalyses the hydrolysis of lipids (fats). These glands are termed Von Ebner’s glands which have also been shown to have another function in the secretion of histatins which offer an early defense (outside of the immune system) against microbes in food, when it makes contact with these glands on the tongue tissue. Sensory information can stimulate the secretion of saliva providing the necessary fluid for the tongue to work with and also to ease swallowing of the food.

**Saliva**

Saliva in the digestive system functions initially to moisten and soften food into the formation of a bolus. The bolus is further helped by the lubrication provided by the saliva in its passage from the mouth into the oesophagus. Also of significance is the presence in saliva of the digestive enzymes amylase and lipase. Amylase starts to work on the starch carbohydrates, breaking it down into the simple sugars of maltose and dextrose that can be further broken down in the small intestine. Saliva in the mouth can account for 30% of this initial starch digestion. Lipase starts to work on breaking down fats. Lipase is further produced in the pancreas where it is released to continue this digestion of fats. The
presence of salivary lipase is of prime importance in young babies whose pancreatic lipase has yet to be developed. As well as its role in supplying digestive enzymes, saliva has a cleansing action for the teeth and mouth. It also has an immunological role in supplying antibodies to the system, such as immunoglobulin A. This is seen to be key in preventing infections of the salivary glands, importantly that of parotitis.

Saliva also contains a glycoprotein called haptocorrin which is a binding protein to vitamin B₁₂. It binds with the vitamin in order to carry it safely through the acidic content of the stomach. When it reaches the duodenum, pancreatic enzymes break down the glycoprotein and free the vitamin which then binds with intrinsic factor.

**Tongue**

Food enters the mouth where the first stage in the digestive process takes place, with the action of the tongue and the secretion of saliva. The tongue is a fleshy and muscular sensory organ, and the very first sensory information is received via the taste buds on its surface. If the taste is agreeable the tongue will go into action, manipulating the food in the mouth which stimulates the secretion of saliva from the salivary glands. The liquid quality of the saliva will help in the softening of the food and its enzyme content will start to break down the food whilst it is still in the mouth. The first part of the food to be broken down is the starch.
of carbohydrates. The tongue is attached to the floor of the mouth
by a ligamentous band called the frenum and this gives it great
mobility for the manipulation of food (and speech); the range of
manipulation is optimally controlled by the action of several
muscles and limited in its external range by the stretch of the
frenum. The tongue’s two sets of muscles, are four intrinsic muscles
that originate in the tongue and are involved with its shaping, and
four extrinsic muscles originating in bone that are involved with
its movement.

**Taste**

_Taste is a form of chemoreception that takes place in the_
_specialised receptors of taste cells, contained in structures called_
taste buds in the mouth. Taste buds are mainly on the upper
surface (dorsum) of the tongue. Taste perception is vital to help
prevent harmful or rotten foods from being consumed. This is a_
function of the gustatory system where the taste buds are at the
forefront. There are taste buds elsewhere in the mouth not just on
the surface of the tongue. The taste buds are innervated by a_
branch of the facial nerve the chorda tympani, and the
glossopharyngeal nerve. Taste messages are sent via these cranial
nerves to the brain. The brain can distinguish between the chemical
qualities of the food. The five basic tastes are referred to as those
of saltiness, sourness, bitterness and sweetness, and the most
recent addition of a certain savouriness termed umami.

The detection of saltiness and sourness enables the control of
salt and acid balance. The detection of bitterness warns of poisons
- many of a plant’s defences are of poisonous compounds that are bitter. Sweetness guides to those foods that will supply energy; the initial breakdown of the energy-giving carbohydrates by salivary amylase creates the taste of sweetness since simple sugars are the first result. The taste of umami is thought to signal protein-rich food. Sour tastes are acidic which is often found in bad food. The brain has to decide very quickly whether to eat the food or not. It was the findings in 1991, describing the first olfactory receptors that helped to prompt the research into taste. The olfactory receptors are located on cell surfaces in the nose which bind to chemicals enabling the detection of smells. It is assumed that signals from taste receptors work together with the signals from those in the nose, to form an idea of complex food flavours.

**Teeth**

Teeth are complex structures made of materials specific to them. They are made of a bone-like material called dentin, which is covered by the hardest tissue in the body—enamel. Teeth have different shapes to deal with different aspects of mastication employed in tearing and chewing pieces of food into smaller and smaller pieces. This results in a much larger surface area for the action of digestive enzymes. The teeth are named after their particular roles in the process of mastication—incisors are used for cutting or biting off pieces of food; canines, are used for tearing, premolars and molars are used for chewing and grinding. Mastication of the food with the help of saliva and mucus results in the formation of a soft bolus which can then be swallowed to make its way down the upper gastrointestinal tract to the stomach. The digestive enzymes in saliva also help in keeping the teeth clean by breaking down any lodged food particles.

**Epiglottis**

The epiglottis is a flap that is made of elastic cartilage and attached to the entrance of the larynx. It is covered with a mucous membrane and there are taste buds on its lingual surface which faces into the mouth. Its laryngeal surface faces into the larynx.
The epiglottis functions to guard the entrance of the glottis, the opening between the vocal folds. It is normally pointed upward during breathing with its underside functioning as part of the pharynx, but during swallowing, the epiglottis folds down to a more horizontal position, with its upper side functioning as part of the pharynx. In this manner it prevents food from going into the trachea and instead directs it to the oesophagus, which is posterior. During swallowing, the backward motion of the tongue forces the epiglottis over the glottis’ opening to prevent any food that is being swallowed from entering the larynx which leads to the lungs; the larynx is also pulled upwards to assist this process. Stimulation of the larynx by ingested matter produces a strong cough reflex in order to protect the lungs.

**Pharynx**

The pharynx is a part of the conducting zone of the respiratory system and also a part of the digestive system. It is the part of the throat immediately behind the nasal cavity at the back of the mouth and above the oesophagus and larynx. The pharynx is made up of three parts. The lower two parts—the oropharynx and the laryngopharynx—are involved in the digestive system. The laryngopharynx connects to the oesophagus and it serves as a passageway for both air and food. Air enters the larynx anteriorly but anything swallowed has priority and the passage of air is temporarily blocked. The pharynx is innervated by the pharyngeal plexus of the vagus nerve. Muscles in the pharynx push the food into the oesophagus. The pharynx joins the oesophagus at the oesophageal inlet which is located behind the cricoid cartilage.

**Oesophagus**

The oesophagus commonly known as the gullet, is an organ which consists of a muscular tube through which food passes from the pharynx to the stomach. The oesophagus is continuous with the laryngeal part of the pharynx. It passes through the posterior mediastinum in the thorax and enters the stomach through a hole in the thoracic diaphragm—the oesophageal hiatus, at the level of
the tenth thoracic vertebra (T10). Its length averages 25 cm, varying
with height. It is divided into cervical, thoracic and abdominal
parts. The pharynx joins the oesophagus at the oesophageal inlet
which is behind the cricoid cartilage.

At rest the oesophagus is closed at both ends, by the upper
and lower oesophageal sphincters. The opening of the upper
sphincter is triggered by the swallowing reflex so that food is
allowed through. The sphincter also serves to prevent back flow
from the oesophagus into the pharynx. The oesophagus has a
mucous membrane and the epithelium which has a protective
function is continuously replaced due to the volume of food that
passes inside the oesophagus. During swallowing, food passes
from the mouth through the pharynx into the oesophagus. The
epiglottis folds down to a more horizontal position so as to prevent
food from going into the trachea, instead directing it to the
oesophagus.

Once in the oesophagus, the bolus travels down to the stomach
via rhythmic contraction and relaxation of muscles known as
peristalsis. The lower oesophageal sphincter is a muscular sphincter
surrounding the lower part of the oesophagus. The junction
between the oesophagus and the stomach (the gastroesophageal
junction) is controlled by the lower oesophageal sphincter, which
remains constricted at all times other than during swallowing and
vomiting to prevent the contents of the stomach from entering the
oesophagus. As the oesophagus does not have the same protection
from acid as the stomach, any failure of this sphincter can lead
to heartburn. The oesophagus has a mucous membrane of
epithelium which has a protective function as well as providing
a smooth surface for the passage of food. Due to the high volume
of food that is passed over time, this membrane is continuously
renewed.

**Diaphragm**

The diaphragm is a significant part of the body’s digestive
system. The diaphragm separates the thoracic cavity from the
abdominal cavity where most of the digestive organs are located. The suspensory muscle attaches the ascending duodenum to the diaphragm. This muscle is thought to be of help in the digestive system in that its attachment offers a wider angle to the duodenojejunal flexure for the easier passage of digesting material. The diaphragm also attaches to the bare area of the liver, which it anchors. The oesophagus enters the abdomen through a hole in the diaphragm at the level of T10.

**Stomach**

Gastric acid (informally *gastric juice*), produced in the stomach plays a vital role in the digestive process, it chiefly contains hydrochloric acid and sodium chloride. A peptide hormone gastrin produced by G cells in the gastric glands, stimulates the production of gastric juice which activates the digestive enzymes. Pepsinogen is a precursor enzyme (zymogen) produced by the gastric chief cells and gastric acid activates this to the enzyme pepsin which begins the digestion of proteins.

As these two chemicals would damage the stomach wall, mucus is secreted by innumerable gastric glands in the stomach, to provide a slimy protective layer against the damaging effects of the chemicals. At the same time that protein is being digested, mechanical churning occurs through the action of peristalsis, waves of muscular contractions that move along the stomach wall. This permits the mass of food to further mix with the digestive enzymes. Gastric lipase secreted by the chief cells in the fundic glands in the gastric mucosa of the stomach, is an acidic lipase, in contrast with the alkaline pancreatic lipase. This breaks down fats to some degree though is not as efficient as the pancreatic lipase.

The pylorus, the lowest section of the stomach which attaches to the duodenum via the pyloric canal, contains countless glands which secrete digestive enzymes including gastrin. After an hour or two, a thick semi-liquid called chyme is produced. When the pyloric sphincter, or valve opens, chyme enters the duodenum where it mixes further with digestive enzymes from the pancreas,
and then passes through the small intestine, where digestion continues.

When the chyme is fully digested, it is absorbed into the blood. 95% of absorption of nutrients occurs in the small intestine. Water and minerals are reabsorbed back into the blood in the colon of the large intestine, where the environment is slightly acidic. Some vitamins, such as biotin and vitamin K produced by bacteria in the gut flora of the colon are also absorbed. The parietal cells in the fundus of the stomach, produce a glycoprotein called intrinsic factor which is essential for the absorption of vitamin B12. Vitamin B12 (cobalamin), is carried to, and through the stomach, bound to a glycoprotein secreted by the salivary glands - transcobalamin I also called haptocorrin, which protects the acid-sensitive vitamin from the acidic stomach contents.

Once in the more neutral duodenum, pancreatic enzymes break down the protective glycoprotein. The freed vitamin B12 then binds to intrinsic factor which is then absorbed by the enterocytes in the ileum. The stomach is a distensible organ and can normally expand to hold about one litre of food. The stomach of a newborn baby will only be able to expand to retain about 30 ml.

**Spleen**

The spleen breaks down both red and white blood cells that are spent. This is why it is sometimes called the ‘graveyard of red blood cells’. A product of this digestion is the pigment bilirubin which is sent to the liver and secreted in the bile. Another product is iron which is used in the formation of new blood cells in the bone marrow. Western medicine treats the spleen solely as belonging to the lymphatic system, though it is acknowledged that the full range of its important functions is not yet understood. In contrast to this view, traditional Chinese medicine sees the spleen to be of greater significance in the digestive system. The role of the spleen is seen to affect the health and vitality of the body in its turning of digested material from the stomach into usable nutrients and energy.
Symptoms that include poor appetite, indigestion, bloating and jaundice, are seen to be indications of an imbalance in the spleen. The spleen is further seen to play a part in the metabolism of water, in ridding the body of excess fluid. In the west, the spleen is seen to be paired with the stomach but in Chinese medicine, reference is made to the spleen system, which involves the pancreas. Fluids in the body are seen in traditional Chinese medicine to be under the control of the spleen.

Fluids include digestive enzymes, saliva, mucus, fluid in the joints, tears, sweat and urine. They are categorised as thin and thick and together they are seen as nourishing all tissues and organs. In acupuncture two widely used acupuncture points - the stomach, (close to the knee) and the spleen, (halfway down from the knee) have long been seen to be connected and involved in digestive issues.

Liver

After the skin the liver is the second largest organ and is an accessory digestive gland which plays a role in the body’s metabolism. The liver has many functions some of which are important to digestion. The liver can detoxify various metabolites; synthesise proteins and produce biochemicals needed for digestion. It regulates the storage of glycogen which it can form from glucose (glycogenesis).

The liver can also synthesise glucose from certain amino acids. Its digestive functions are largely involved with the breaking down of carbohydrates. It also maintains protein metabolism in its synthesis and degradation. In lipid metabolism it synthesises cholesterol. Fats are also produced in the process of lipogenesis. The liver synthesises the bulk of lipoproteins. The liver is located in the upper right quadrant of the abdomen and below the diaphragm to which it is attached at one part. This is to the right of the stomach and it overlies the gall bladder. The liver produces bile, an important alkaline compound which aids digestion.
Bile

Bile is produced by the liver and made up of water (97%), bile salts, mucus and pigments, 1% fats and inorganic salts. Bilirubin is its major pigment. Bile acts partly as a surfactant which lowers the surface tension between either two liquids or a solid and a liquid and helps to emulsify the fats in the chyme. Food fat is dispersed by the action of bile into smaller units called micelles. The breaking down into micelles creates a much larger surface area for the pancreatic enzyme, lipase to work on. Lipase digests the triglycerides which are broken down into two fatty acids and a monoglyceride. These are then absorbed by villi on the intestinal wall. If fats are not absorbed in this way in the small intestine problems can arise later in the large intestine which is not equipped to absorb fats.

Bile also helps in the absorption of vitamin K from the diet. Bile is collected and delivered through the common hepatic duct. This duct joins with the cystic duct to connect in a common bile duct with the gallbladder. Bile is stored in the gallbladder for release when food is discharged into the duodenum and also after a few hours.

Gallbladder

The gallbladder is a hollow part of the biliary system that sits just beneath the liver, with the gallbladder body resting in a small depression. It is a small organ where the bile produced by the liver is stored, before being released into the small intestine. Bile flows from the liver through the bile ducts and into the gallbladder for storage.

The bile is released in response to cholecystokinin (CKK) a peptide hormone released from the duodenum. The production of CKK (by endocrine cells of the duodenum) is stimulated by the presence of fat in the duodenum. It is divided into three sections, a fundus, body and neck. The neck tapers and connects to the biliary tree via the cystic duct, which then joins the common hepatic duct to form the common bile duct. At this junction is a
mucosal fold known as Hartmann’s pouch, where gallstones commonly get stuck. The muscular layer of the body is of smooth muscle tissue that helps the gallbladder contract, so that it can discharge its bile into the bile duct. The gallbladder requires to store bile in a natural, semi-liquid form at all times. Hydrogen ions secreted from the inner lining of the gallbladder keep the bile acidic enough to prevent hardening. To dilute the bile, water and electrolytes from the digestion system are added. Also, salts attach themselves to cholesterol molecules in the bile to keep them from crystallising. If there is too much cholesterol or bilirubin in the bile, or if the gallbladder doesn’t empty properly the systems can fail.

This is how gallstones form when a small piece of calcium gets coated with either cholesterol or bilirubin and the bile crystallises and forms a gallstone. The basic objective of the gallbladder is to store and release bile, or gall. Bile is released into the small intestine in order to help in the digestion of fats by breaking down larger molecules into smaller ones. After the fat is absorbed, the bile is also absorbed and transported back to the liver for reuse.

**Pancreas**

The pancreas is a major organ functioning as an accessory digestive gland in the digestive system. It is both an endocrine gland and an exocrine gland. The endocrine part secretes insulin when the blood sugar becomes high; insulin moves glucose from the blood into the muscles and other tissues for use as energy. The endocrine part releases glucagon when the blood sugar is low; glucagon allows stored sugar to be broken down into glucose by the liver in order to re-balance the sugar levels. The pancreas produces and releases important digestive enzymes in the pancreatic juice that it delivers to the duodenum.

The pancreas lies below and at the back of the stomach. It connects to the duodenum via the pancreatic duct which it joins near to the bile duct’s connection where both the bile and pancreatic juice can act on the chyme that is released from the stomach into
the duodenum. Aqueous pancreatic secretions from pancreatic duct cells contain bicarbonate ions which are alkaline and help with the bile to neutralise the acidic chyme that is churned out by the stomach. The pancreas is also the main source of enzymes for the digestion of fats and proteins. Some of these are released in response to the production of CCK in the duodenum. (The enzymes that digest polysaccharides, by contrast, are primarily produced by the walls of the intestines.) The cells are filled with secretory granules containing the precursor digestive enzymes. The major proteases, the pancreatic enzymes which work on proteins, are trypsinogen and chymotrypsinogen. Elastase is also produced. Smaller amounts of lipase and amylase are secreted.

The pancreas also secretes phospholipase A2, lysophospholipase, and cholesterol esterase. The precursor zymogens, are inactive variants of the enzymes; which avoids the onset of pancreatitis caused by autodegradation. Once released in the intestine, the enzyme enteropeptidase present in the intestinal mucosa activates trypsinogen by cleaving it to form trypsin; further cleavage results in chymotripsin.

**Lower gastrointestinal Tract**

The lower gastrointestinal tract (GI), includes the small intestine and all of the large intestine. The intestine is also called the bowel or the gut. The lower GI starts at the pyloric sphincter of the stomach and finishes at the anus. The small intestine is subdivided into the duodenum, the jejunum and the ileum. The caecum marks the division between the small and large intestine. The large intestine includes the rectum and anal canal.

**Small Intestine**

Food begins to arrive in the small intestine one hour after it is eaten, and after two hours the stomach has emptied. Until this time the food is termed a bolus. It then becomes the partially digested semi-liquid termed chyme. In the small intestine, the pH becomes crucial; it needs to be finely balanced in order to activate digestive enzymes. The chyme is very acidic, with a low pH,
having been released from the stomach and needs to be made much more alkaline. This is achieved in the duodenum by the addition of bile from the gall bladder combined with the bicarbonate secretions from the pancreatic duct and also from secretions of bicarbonate-rich mucus from duodenal glands known as Brunner’s glands.

The chyme arrives in the intestines having been released from the stomach through the opening of the pyloric sphincter. The resulting alkaline fluid mix neutralises the gastric acid which would damage the lining of the intestine.

The mucus component lubricates the walls of the intestine. When the digested food particles are reduced enough in size and composition, they can be absorbed by the intestinal wall and
carried to the bloodstream. The first receptacle for this chyme is
the duodenal bulb. From here it passes into the first of the three
sections of the small intestine, the duodenum. (The next section
is the jejunum and the third is the ileum).

The duodenum is the first and shortest section of the small
intestine. It is a hollow, jointed C-shaped tube connecting the
stomach to the jejunum. It starts at the duodenal bulb and ends
at the suspensory muscle of duodenum.

The attachment of the suspensory muscle to the diaphragm
is thought to help the passage of food by making a wider angle
at its attachment. Most food digestion takes place in the small
intestine. In the duodenum, pancreatic lipase is secreted together
with a co-enzyme, colipase to further digest the fat content of the
chyme. From this breakdown, smaller particles of emulsified fats
called chylomicrons are produced. There are also digestive cells
called enterocytes lining the intestines (the majority being in the
small intestine). They are unusual cells in that they have villi on
their surface which in turn have innumerable microvilli on their
surface. All these villi make for a greater surface area, not only
for the absorption of chyme but also for its further digestion by
large numbers of digestive enzymes present on the microvilli. The
chylomicrons are small enough to pass through the enterocyte villi
and into their lymph capillaries called lacteals. A milky fluid
called chyle consisting mainly of the emulsified fats of the
chylomicrons results from the absorbed mix with the lymph in the
lacteals.

Chyle is then transported through the lymphatic system to the
rest of the body. The suspensory muscle marks the end of the
duodenum and the division between the upper gastrointestinal
tract and the lower GI tract. The digestive tract continues as the
jejunum which continues as the ileum.

The jejunum, the midsection of the small intestine contains
circular folds, flaps of doubled mucosal membrane which partially
encircle and sometimes completely encircle the lumen of the
intestine. These folds together with villi serve to increase the surface area of the jejunum enabling an increased absorption of digested sugars, amino acids and fatty acids into the bloodstream. The circular folds also slow the passage of food giving more time for nutrients to be absorbed.

The last part of the small intestine is the ileum. This also contains villi and vitamin B12; bile acids and any residue nutrients are absorbed here. When the chyme is exhausted of its nutrients the remaining waste material changes into the semi-solids called faeces, which pass to the large intestine, where bacteria in the gut flora further break down residual proteins and starches.

**Caecum**

The caecum is a pouch marking the division between the small intestine and the large intestine. The caecum receives chyme from the last part of the small intestine, the terminal ileum, and connects to the ascending colon of the large intestine. At this junction there is a sphincter or valve, the ileocecal valve which slows the passage of chyme from the ileum, allowing further digestion. It is also the site of the appendix attachment.

**Large Intestine**

In the large intestine, the passage of the digesting food in the colon is a lot slower, taking from 12 to 50 hours until it is removed by defecation. The colon chiefly serves as a site for the fermentation of digestible matter by the gut flora. The time taken varies significantly between individuals. The remaining semi-solid waste is termed faeces and is removed by the coordinated contractions of the intestinal walls, termed peristalsis, which propels the excreta forward to reach the rectum and exit via defecation from the anus. The wall has an outer layer of longitudinal muscles, the taeniae coli, and an inner layer of circular muscles.

The circular muscle keeps the material moving forward and also prevents any back flow of waste. Also of help in the action of peristalsis is the basal electrical rhythm that determines the frequency of contractions. The taeniae coli can be seen and are
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responsible for the bulges (hastra) present in the colon. Most parts of the GI tract are covered with serous membranes and have a mesentery. Other more muscular parts are lined with adventitia.

BLOOD SUPPLY

The digestive system is supplied by the celiac artery. The celiac artery is the first major branch from the abdominal aorta, and is the only major artery that nourishes the digestive organs.

There are three main divisions – the left gastric artery, the common hepatic artery and the splenic artery.

The celiac artery supplies the liver, stomach, spleen and the upper 1/3 of the duodenum (to the sphincter of Oddi) and the pancreas with oxygenated blood. Most of the blood is returned to the liver via the portal venous system for further processing and detoxification before returning to the systemic circulation via the hepatic portal vein.

The next branch from the abdominal aorta is the superior mesenteric artery, which supplies the regions of the digestive tract derived from the midgut, which includes the distal 2/3 of the duodenum, jejunum, ileum, caecum, appendix, ascending colon, and the proximal 2/3 of the transverse colon.

The final branch which is important for the digestive system is the inferior mesenteric artery, which supplies the regions of the digestive tract derived from the hindgut, which comprises the distal 1/3 of the transverse colon, descending colon, sigmoid colon, rectum, and the anus above the pectinate line.
Innervation

The enteric nervous system comprises some one hundred million neurons that are embedded in the peritoneum, the lining of the gastrointestinal tract extending from the oesophagus to the anus. These neurons are collected into two plexuses - the myenteric (or Auerbach’s) plexus that lies between the longitudinal and the smooth muscle layers, and the submucosal (or Meissner’s) plexus that lies between the circular smooth muscle layer and the mucosa. Parasympathetic innervation to the ascending colon is supplied by the vagus nerve. Sympathetic innervation is supplied by the splanchnic nerves that join the celiac ganglia.

Most of the digestive tract is innervated by the two large celiac ganglia, with the upper part of each ganglion joined by the greater splanchnic nerve and the lower parts joined by the lesser splanchnic nerve. It is from these ganglia that many of the gastric plexuses arise.

Clinical Importance

Each part of the digestive system is subject to a wide range of disorders. Various problems comprising malnutrition and anemia can arise from malabsorption, the abnormal absorption of nutrients in the GI tract. Malabsorption can have many causes ranging from infection, to enzyme deficiencies such as exocrine pancreatic insufficiency. It can also arise as a result of other gastrointestinal diseases such as coeliac disease. Coeliac disease is an autoimmune disorder of the small intestine. This can cause vitamin deficiencies due to the improper absorption of nutrients in the small intestine. In the oesophagus Schatzki rings can restrict the passageway, causing difficulties in swallowing. They can also completely block the oesophagus. A common disorder of the bowel is diverticulitis. Diverticula are small pouches that can form inside the bowel wall, which can become inflamed to give diverticulitis. This disease can have complications if an inflamed diverticulum bursts and infection sets in. Any infection can spread further to the lining of the abdomen (peritoneum) and cause potentially fatal
peritonitis. Crohn’s disease is a common chronic inflammatory bowel disease (IBD), which can affect any part of the GI tract, but it mostly starts in the terminal ileum.

Ulcerative colitis an ulcerative form of colitis, is the other major inflammatory bowel disease which is restricted to the colon and rectum. Both of these IBDs can give an increased risk of the development of colorectal cancer. Ulcerative colitis is the most common of the IBDs Irritable bowel syndrome (IBS) is the most common of the functional gastrointestinal disorders. These are idiopathic disorders that the Rome process has helped to define.

Giardiasis is a disease of the small intestine caused by a protist parasite *Giardia lamblia*. This does not spread but remains confined to the lumen of the small intestine. It can generally be asymptomatic, but as often can be indicated by a variety of symptoms. Giardiasis is the most common pathogenic parasitic infection in humans.

There are diagnostic tools mostly involving the ingestion of barium sulphate to investigate disorders of the GI tract. These are called upper gastrointestinal series that enable imaging of the pharynx, larynx, oesophagus, stomach and small intestine and lower gastrointestinal series for imaging of the colon.
Digestive System Surgery

Digestive system surgery, or gastrointestinal surgery, can be divided into upper GI surgery and lower GI surgery.

Subtypes

**Upper Gastrointestinal**

Upper gastrointestinal surgery, generally referred to as upper GI surgery, refers to a practise of surgery that focuses on the upper parts of the gastrointestinal tract. There are several operations relevant to the upper gastrointestinal tract that are best done only by those who keep constant practise, owing to their complexity. Consequently, a general surgeon may specialise in ‘upper GI’ by attempting to maintain currency in those skills.

Upper GI surgeons would have an interest in, and may exclusively perform, the following operations:
- Pancreatectoduodenectomy
- Esophagectomy
- Liver resection.

**Lower gastrointestinal**

Lower gastrointestinal surgery surgery comprises colorectal surgery as well as surgery of the small intestine.

Academically, it is the fers to a sub-specialisation of medical practise whereby a general surgeon focuses on the lower
gastrointestinal tract. A lower GI surgeon might specialise in the below given operations:

- Colectomy
- Low or ultralow resections for rectal cancer, etc.

**PANCREATICODUODENECTOMY**

A pancreaticoduodenectomy, pancreateoduodenectomy, Whipple procedure, or Kausch-Whipple procedure, is a majorsurgical operation involving the pancreas, duodenum, and other organs. This operation is performed to treat cancerous tumours on the head of the pancreas, malignant tumors involving the common bile duct, duodenal papilla, or duodenum near the pancreas, and also some cases of pancreatitis with or without a definitive cause.

**Anatomy involved in the Procedure**

The very common technique of a pancreaticoduodenectomy consists of the *en bloc* removal of the distal segment (antrum) of the stomach, the first and second portions of the duodenum, the head of the pancreas, the common bile duct, and the gallbladder. The fundamental concept behind the pancreaticoduodenectomy is that the head of the pancreas and the duodenum share the same arterial blood supply (the gastroduodenal artery). These arteries run through the head of the pancreas, so that both organs must be removed if the single blood supply is severed. If only the head of the pancreas were removed it would compromise blood flow to the duodenum, resulting in tissue necrosis.

**Medical Uses**

Today the Whipple procedure is very similar to Whipple’s original procedure. It consists of removal of the distal half of the stomach (antrectomy), the gall bladder and its cystic duct (cholecystectomy), the common bile duct (choledochectomy), the head of the pancreas, duodenum, proximal jejunum, and regional lymph nodes. Reconstruction comprises attaching the pancreas to
the jejunum (pancreaticojejunostomy) and attaching the hepatic duct to the jejunum (hepaticojejunostomy) to allow digestive juices and bilerespectively to flow into the gastrointestinal tract and attaching the stomach to the jejunum (gastrojejunostomy) to allow food to pass through. Whipple originally used the sequence: bile duct, pancreas and stomach, whereas presently the popular method of reconstruction is pancreas, bile duct and stomach, also known as Child’s operation.

Originally performed in a two-step process, Whipple refined his technique in 1940 into a one-step operation. Using modern operating techniques, mortality from a Whipple procedure is around 5% in the United States (less than 2% in high-volume academic centers).

Pancreaticoduodenectomy versus total pancreatectomy

Clinical trials have failed to demonstrate significant survival benefits of total pancreatectomy, mostly because patients who submit to this operation tend to develop a particularly severe form of diabetes mellitus known as brittle diabetes. Sometimes the pancreaticojejunostomy may not hold properly after the completion of the operation and infection may spread inside the patient. This may lead to another operation shortly thereafter in which the remainder of the pancreas (and sometimes the spleen) is removed to prevent further spread of infection and possible morbidity.

Pylorus-sparing pancreaticoduodenectomy

In very recent past, the pylorus-preserving pancreaticoduodenectomy (also known as Traverso-Longmire procedure/PPPD) is growing increasingly popular, especially among European surgeons. The main advantage of this technique is that the pylorus, and thus normal gastric emptying, is preserved. A recent meta-analysis included 27 studies with a total of 2,599 patients. The results showed that pylorus removal of pancreaticoduodenectomy doesn’t significantly prevent delayed gastric emptying. However, some doubts remain on whether it is an adequate operation from an oncological point of view. In
practice, it shows similar long-term survival as a Whipple’s (pancreatectoduodenectomy + hemigastrectomy), but patients benefit from improved recovery of weight after a PPPD, so this should be performed when the tumour does not involve the stomach and the lymph nodes along the gastric curvatures are not enlarged. Another controversial point is whether patients benefit from retroperitoneal lymphadenectomy.

**Pylorus-sparing pancreaticoduodenectomy versus standard Whipple procedure**

In comparison to the standard Whipple procedure, the pylorus preserving pancreaticoduodenectomy technique is associated with shorter operation time and less intraoperative blood loss, requiring less blood transfusion. Post-operative complications, hospital mortality and survival do not differ between the two methods.

**Morbidity and mortality**

Pancreatectoduodenectomy is considered, by any standard, to be a major surgical procedure.

Various studies have shown that hospitals where a given operation is performed more frequently have better overall results (especially in the case of more complex procedures, such as pancreatectoduodenectomy). A frequently cited study published in *The New England Journal of Medicine* found operative mortality rates to be four times higher (16.3 v. 3.8%) at low-volume (averaging less than one pancreatectoduodenectomy per year) hospitals than at high-volume (16 or more per year) hospitals.

Even at high-volume hospitals, morbidity has been found to vary by a factor of almost four depending on the number of times the surgeon has previously performed the procedure. de Wilde et al. have reported statistically significant mortality reductions concurrent with centralization of the procedure in the Netherlands. One study reported actual risk to be 2.4 times greater than the risk reported in the medical literature, with additional variation by type of institution.
History

Originally this procedure was described by Alessandro Codivilla, an Italian surgeon, in 1898. The first resection for a periampullary cancer was performed by the German surgeon Walther Kausch in 1909 and described by him in 1912. It is often called Whipple’s procedure or the Whipple procedure, after the American surgeon Allen Whipple who devised an improved version of the surgery in 1935 and subsequently came up with multiple refinements to his technique.

Nomenclature

Fingerhut et al. says that while the terms pancreatoduodenectomy and pancreaticoduodenectomy are generally used interchangeably in the medical literature, scrutinizing their etymology yields different definitions for the two terms. As a consequence, the authors prefer pancreatoduodenectomy over pancreaticoduodenectomy for the name of this procedure.

ESOPHAGECTOMY

Esophagectomy (US English) or Oesophagectomy (British English) is the surgical removal of all or part of the esophagus.

Medical Uses

The chief objective is to remove the esophagus, a part of the
gastrointestinal tract (“food pipe”). This procedure is usually done for patients with esophageal cancer. It is normally done to remove cancerous tumors from the body. It is normally done when esophageal cancer is detected early, before it has spread to other parts of the body.

Esophagectomy of early stage cancer represents much the best chance of a cure. Despite significant improvements in technique and postoperative care, the long-term survival for esophageal cancer is still poor.

Present multimodality treatment is needed (chemotherapy and radiation therapy) for advanced tumors. Esophagectomy is also occasionally performed for benign disease such as esophageal atresia in children, achalasia, or caustic injury. In those who have had an esophagectomy for cancer, omentoplasty appears to improve outcomes.

**Classification**

There are two main kinds of esophagectomy.

- A transhiatal esophagectomy (THE) is performed on the neck and abdomen simultaneously.
- A transthoracic esophagectomy (TTE) involves opening the thorax (chest).

In most of the cases, the stomach is transplanted into the neck and the stomach takes the place originally occupied by the esophagus. In some cases, the removed esophagus is replaced by another hollow structure, such as the patient’s colon.

Another option which is gradually becoming available is minimally invasive surgery (MIS) which is performed laparoscopically and thoracoscopically.

After surgery, patients may have trouble with a regular diet and may have to consume softer foods, avoid liquids at meals, and stay upright for 1–3 hours after eating. Dysphagia is common and patients are encouraged to chew foods very well or grind their food. Patients may complain of substernal pain that resolves by
sipping fluids or regurgitating food. Reflux-type symptoms can be severe, including intolerance to acidic foods and large, fatty meals. Jejunal feeding tubes may be placed during surgery to provide a temporary route of nutrition until oral eating resumes.

Fig. Diagram showing before and after an oesophago-gastrectomy

Process

Esophagectomy is a very complex operation that can take between 4 and 8 hours to perform. It is best done only by doctors who specialise in upper gastrointestinal surgery. Anesthesia for an esophagectomy is also complex, owing to the problems with managing the patient’s airway and lung function during the operation. Lung collapse is highly probable as well as losing function of diaphragm and possible injury of the spleen. Average mortality rates (deaths either in hospital or within 30 days of surgery) for the operation are around 10% in US hospitals. However, recognized major cancer hospitals typically report mortality rates under 5%. Major complications take place in 10-20% of patients, and some sort of complication (major and minor) occurs in 40%. Time in hospital is normally 1–2 weeks and recovery
time 3–6 months. It is possible for the recovery time to take up to a year.

**HEPATECTOMY**

Hepatectomy is the surgical resection of the liver. While the term is generally employed for the removal of the liver from a liver transplant DONOR, this chapter will focus on partial resections of hepatic tissue and hepatoporoenterostomy.

**History**

The first hepatectomies were reported by Ichio Honjo (Kyoto University) in 1949, and Jean-Louis Lortat-Jacob in 1952. In the latter case, the patient was a 58-year-old woman diagnosed with colorectal cancer which had metastasized to the liver.

**Indications**

Most hepatectomies are performed for the treatment of hepatic neoplasms, both benign or malignant. Benign neoplasms comprise hepatocellular adenoma, hepatic hemangioma and focal nodular hyperplasia. The most common malignant neoplasms (cancers) of the liver are metastases; those arising from colorectal cancer are among the most common, and the most amenable to surgical resection. The most common primary malignant tumour of the liver is the hepatocellular carcinoma. Hepatectomy may also be the procedure of choice to treat intrahepatic gallstones or parasitic cysts of the liver. Partial hepatectomies are also performed to remove a portion of a liver from a live donor for transplantation.

**Technique**

A hepatectomy is considered a major surgery done under general anesthesia. Access is accomplished by laparotomy, typically by a bilateral subcostal (“chevron”) incision, possibly with midline extension (Calne or “Mercedes-Benz” incision). An anterior approach, one of the most innovative, is made simpler by the liver hanging maneuver. Hepatectomies may be anatomic, i.e. the lines of resection match the limits of one or more functional segments.
of the liver as defined by the Couinaud classification (cf. liver#Functional anatomy); or they may be non-anatomic, irregular or “wedge” hepatectomies. Anatomic resections are generally preferred because of the smaller risk of bleeding and biliary fistula; however, non-anatomic resections can be performed safely as well in selected cases.

The Pringle manoeuvre is usually performed during a hepatectomy to minimize blood loss - however this can lead to reperfusion injury in the liver due to Ischemia.

Complications

Bleeding is the most feared technical complication and may be grounds for urgent reoperation. Biliary fistula is also a possible complication, albeit one more amenable to nonsurgical management. Pulmonary complications such as atelectasis and pleural effusion are commonplace, and dangerous in patients with underlying lung disease. Infection is relatively rare.

Liver failure poses a major hazard to patients with underlying hepatic disease; this is a major deterrent in the surgical resection of hepatocellular carcinoma in patients with cirrhosis. It is also a problem, to a lesser degree, in patients with previous hepatectomies (e.g. repeat resections for reincident colorectal cancer metastases).

Results

Liver surgery is safe when performed by experienced surgeons with appropriate technological and institutional support. As with most major surgical procedures, there is a marked tendency towards optimal results at the hands of surgeons with high caseloads in selected centres (typically cancer centres and transplantation centres). For optimal results, combination treatment with systemic or regionally infused chemo or biological therapy should be considered.

Prior to surgery, cytotoxic agents such as oxaliplatin given systemically for colorectal metastasis, or chemoembolization for hepatocellular carcinoma can significantly decrease the size of the
tumor bulk, allowing then for resections which would remove a segment or wedge portion of the liver only. These procedures can also be aided by application of liver clamp (Lin or Chu liver clamp; Pilling no.604113-61995) in order to minimize blood loss.

COLORECTAL SURGERY

Colorectal surgery is a field in medicine, dealing with disorders of the rectum, anus, and colon. The field is also called proctology, but the latter term is now used infrequently within medicine, and is most often employed to identify practices relating to the anus and rectum in particular. The word proctology is derived from the Greek words ὄνοστον proktos, meaning “anus” or “hindparts”, and -ία -logia, meaning “science” or “study”.

Physicians specializing in this field of medicine are called colorectal surgeons or proctologists. In the United States, to become colorectal surgeons, these surgical doctors have to complete a general surgery residency, as well as a colorectal surgery fellowship, upon which they are eligible to be certified in their field of expertise by the American Board of Colon and Rectal Surgery or the American Osteopathic Board of Proctology. In other countries, certification to practice proctology is given to surgeons at the end
of a 2–3 year subspecialty residency by the country’s board of surgery.

**Scope of the Specialty**

Colorectal surgical disorders include:

- varicosities or swelling, and inflammation of veins in the rectum and anus (Hemorrhoids)
- unnatural cracks or tears in the anus (Anal fissures)
- abnormal connections or passageways between the rectum or other anorectal area to the skin surface (Fistulas)
- severe constipation conditions
- fecal incontinence
- protrusion of the walls of the rectum through the anus (Rectal prolapse)
- birth defects such as the imperforate anus
- treatment of severe colic disorders, such as Crohn’s disease
- cancer of the colon and rectum (Colorectal cancer)
- repositioning of the rectal area if fallen out.
- anal cancer (rare)
- any injuries to the anus
- removal of objects deliberately inserted into anus

**Surgical treatment and diagnostic Procedures**

Surgical forms of treatment for these conditions comprise: colectomy, ileo/colostomy, polypectomy, strictureplasty, hemorrhoidectomy (in severe cases of hemorrhoids), anoplasty, and more depending on the condition the patient suffers from. Diagnostic procedures, like a colonoscopy, are very important in colorectal surgery, as they can tell the physician what type of diagnosis should be given and what procedure should be done to correct the condition. Other diagnostic procedures used by colorectal surgeons include: proctoscopy, defecating proctography, sigmoidoscopy. In recent times, the laparoscopic method of surgery has seen a surge of popularity, due to its lower risks, decreased recovery time, and smaller, more precise incisions achieved by
using laparoscopic instruments. Another new, revolutionary method of surgery, the CARP method (Compression Anastomotic Ring-locking Procedure) is underway in Europe. This new method is fast becoming the preferred choice because of exceptional benefits to patients in regards to faster healing process, reliability, and quick leak-detection potential. The reduced need for a protective stoma is another appealing attribute.

**Mechanical Bowel Preparation**

Mechanical bowel preparation (MBP) is a procedure lacking evidence in the literature, wherein fecal matter is expelled from the bowel lumen prior to surgery, most commonly by using sodium phosphate.
Rapid strides have been made in gastro-intestinal endoscopy (gastroscopy, colonoscopy, ERCP, and related techniques) in the last thirty years. Gastro-intestinal endoscopy, once largely diagnostic, has evolved such that therapeutic procedures are often performed at the same time. This may prevent the need for major surgery. Safe and effective sedation has been a major factor in the development of therapeutic endoscopy. However, not all patients require sedation for endoscopic procedures. Some patients are quite comfortable with no sedation, or only minimal sedation, depending on the type and duration of the procedure.

Patients usually have three major concerns prior to endoscopy - the outcome of the procedure (could it be cancer?), complications of the procedure, and most importantly the question “Doctor, how much will I feel the procedure?” or “Will it hurt?” With modern sedation and careful monitoring the great majority of patients will feel comfortable during the procedure.

COLONOSCOPY

What is the Purpose of Colonoscopy?

To examine the lower gastrointestinal tract (colon or large bowel), to remove polyps (small benign growths), inject bleeding
blood vessels, and to take samples of tissue (biopsies) for examination by a pathologist. Colonoscopy is the most reliable method of bowel examination but small abnormalities including cancers can very occasionally be missed.

Way of Preparation

Before the procedure you will be given a bowel preparation kit with instructions. The bowel preparation cleans the colon. Without this it is not possible to perform a full examination of the colon. Although the bowel preparation is unpleasant, it is very rare for it to be harmful. If you have had difficulties with the preparation in the past, or if you have severe heart, lung, or kidney disease you should discuss this with the doctor.

How to do Colonoscopy

A long, thin flexible tube is passed around the bowel from the anus. This takes about 15 minutes and is done under intravenous sedation (Midazolam, Fentanyl, and sometimes Propofol). Reactions to these medications are rare. After the procedure you must not drive or use machinery until the next day, or longer if you feel unsteady or tired the next day.

Colonoscopies are done in a hospital, normally on a day case basis. You would be required to attend the hospital for about 3 hours if you have sedation for your colonoscopy. You will need to arrange transport to and from the hospital.

Alternatives to Colonoscopy

A barium enema x-ray of the bowel will give similar information but it is not as accurate for certain problems, it does not allow biopsies or removal of polyps. It does not require sedation or hospital admission.

Complications

Colonoscopy and polypectomy are very safe. Serious complications are rare. These comprise:

- Reaction or sensitivity to medication used for sedation (this may affect your breathing briefly)
• Perforation (puncture) of the lining of the bowel (about 1 patient in 2000-5000)
• Bleeding - if blood vessels are injected or a polyp is removed (about 1 patient in 300-500)
• Infection of the bowel, blood, and other organs
• Heart attacks, cardiac arrest, blood clots, and breathing problems (very rare)
• There are other very rare complications - please advise if you wish to be given more details

To minimise the risk of these complications everything will be done. There are ways of detecting these complications early and specific treatments are available if they do arise. Very rarely there may be a need for hospitalisation, major surgery, intravenous feeding, or blood transfusion. Although death can result from complications of colonoscopy this is very rare.

ENDOSCOPIC RETROGRADE CHOLANGIO-PANCREATOGRAPHY (ERCP)

The nature of the test, including possible side-effects and complications, will be discussed with you before the test. If you wish to have more information please advise your doctor before the test.

Objective of ERCP

To examine the bile ducts and pancreatic ducts, to remove gallstones from the bile ducts, to dilate strictures in the bile ducts, to dilate or cut strictures due to a tumour of the duodenum, pancreas or bile ducts, and to keep open a stricture by the use of a plastic or metal tube called a stent. The procedure also allows samples of tissue (biopsies) to be taken for examination by a pathologist.

Sphincterotomy

Sphincterotomy comprises making a small cut in the lower part of the bile duct where the duct opens into the duodenum. This is done using an instrument passed through the endoscope. You
do not feel the cut. This procedure allows better access into the bile duct, removal of gallstones, and other procedures to be performed.

**Preparation**

Before the procedure you will asked not to eat or drink, usually for 8 hours. This is to allow a satisfactory examination and to minimise the risk of vomiting during the test. You will be asked to come to the hospital before the test to complete admission procedures, be admitted and checked for any medical problems, have an intravenous line inserted, and have any premedication and antibiotics if required.

**How to do ERCP**

The test is done in the X-Ray Department (you will be taken there from the Ward). After the sedation is given, a long, thin flexible tube is passed into the stomach via the mouth and a thin plastic tube inserted into the bile and pancreatic ducts. In about 5% of patients this is not successful. The procedure takes up to 45 minutes and you are under intravenous sedation throughout (Midazolam, Fentanyl, and sometimes Propofol). Reactions to these medications are rare. After the procedure you must not drive or use machinery until the next day, or longer if you feel unsteady or tired the next day.

**Alternatives to ERCP**

Similar information can be obtained by Percutaneous Cholangiography which is done by a Radiologist. This is generally a more difficult procedure with a slightly higher risk of complications. Removal of gallstones and treatment of strictures and tumours also can be done by open surgery, which involves an operation under general anaesthetic, a much longer stay in hospital, and higher risk of complications. If gallstones are left in the bile ducts, or if blockage of the bile ducts is not relieved, life-threatening problems may occur. Sometimes ultrasound, CT cholangiography, and MRI cholangiography can give very similar
information to that provided by ERCP, however these investigations do not allow therapeutic procedures to be performed.

Complications

ERCP, sphincterotomy, and stent insertion are generally safe procedures and are only done when other methods of diagnosis or treatment have failed. Complications (mostly minor) occur in about 5% of patients, including:

- Reaction or sensitivity to medication used for sedation (this may affect your breathing briefly)
- Pancreatitis (inflammation of the pancreas) (mild pancreatitis occurs in about 1 patient in 20)
- Bleeding following sphincterotomy (about 1 patient in 100)
- Perforation (puncture) of the lining of the duodenum or bile duct (about 1 patient in 1000)
- Infection of the bile ducts, blood, and other organs
- Incomplete removal of gallstones due to impaction, or to an instrument impacting in the bile duct
- Stent displacement with damage to bowel wall including perforation & bowel obstruction
- Heart attacks, cardiac arrest, and breathing problems (very rare)
- There are other very rare complications - please advise if you wish to be given more details

To minimise the risk of these complications everything will be done. There are ways of detecting these complications early and specific treatments are available if they do arise. Very rarely there may be a need for hospitalisation, major surgery, intravenous feeding, or blood transfusion. Although death can result from complications of ERCP this is rare.

Technically ERCP is a difficult procedure and in about 5% of patients there is a need to repeat the procedure at a later date for a variety of reasons e.g. to check that gallstone extraction has been successful, or to remove residual gallstones.
ENDOSCOPY SEDATION

Anaesthetic sedation for gastrointestinal Endoscopy

In the last thirty years rapid strides have been made in gastrointestinal endoscopy (gastroscopy, colonoscopy, ERCP, and related techniques). Gastro-intestinal endoscopy, once largely diagnostic, has evolved such that therapeutic procedures are often performed at the same time. This may prevent the need for major surgery. Safe and effective sedation has been a major factor in the development of therapeutic endoscopy. However, not all patients require sedation for endoscopic procedures. Some patients are quite comfortable with no sedation, or only minimal sedation, depending on the type and duration of the procedure.

Patients normally have three major concerns prior to endoscopy - the outcome of the procedure (could it be cancer?), complications of the procedure, and most significantly the question “Doctor, how much will I feel the procedure?” or “Will it hurt?” With modern sedation and careful monitoring the great majority of patients will feel comfortable during the procedure.

Before the Endoscopy

It is very likely that you will have your endoscopy in a day surgery unit in a public or private hospital. During the procedure an anaesthetist or sedationist (doctor or nurse trained in sedation and resuscitation) will be present throughout the procedure to provide monitoring of your level of consciousness, your cardiorespiratory state and provide the right amount of anaesthetic sedation to keep you comfortable throughout.

Before to the procedure, you will meet the doctor giving the sedation. You will be asked (by the doctor or nursing staff) to provide your medical history, including the reason you are having the test, whether you have heart or lung disease (including asthma, angina or heart failure), liver or kidney disease, gastro-intestinal bleeding or other bleeding problems, or anaemia. The anaesthetist will wish to ensure you have fasted (i.e. not had food or drink)
for the required number of hours before the procedure. A brief physical examination may be performed. If you are dehydrated, intravenous fluids may be administered. The doctor will wish to know your allergies and a list of your medications.

This is the time to ask any questions you may have regarding the sedation. An intravenous cannula or needle will be placed in the back of the hand or forearm. This is for the administration of intravenous sedative drugs.

**During the Endoscopy**

When you are taken to the procedure room, you will be connected to monitoring equipment which is essential when sedative agents are to be used. Monitoring detects early signs of impaired lung or heart function resulting from the sedatives, permitting early correction, thus maximising patient safety. Years ago, the anaesthetist would monitor the patient by checking skin colour, pulse rate, and rate of breathing. Modern equipment, in combination with careful clinical observation, can do much better than this.

You will also be given a mask or some type of oxygen delivery system to increase the level of oxygen in the air that you are breathing - this is now standard for endoscopic procedures. Oxygen will continue throughout the procedure. When you are asleep you may be aware of suction in the mouth or throat, which is used to remove any unwanted secretions.

**Pulse Oximetry**

Pulse oximeters are the most significant monitors to have been developed in the last fifteen years. They should be used in every endoscopy procedure room, and be available in recovery areas.

The pulse oximeter measures the differential absorption of red and infra-red light by oxygenated and deoxygenated haemoglobin. A light emitting diode, located in a fingertip probe, sends a light wave through the tissues and monitors the reflected wavelengths coming back as the blood passes through the capillaries. The pulse rate and oxygen level (saturation) of haemoglobin in the blood can
be measured. All healthy patients will have an oxygen saturation greater than 96% when breathing room air. If the oxygen saturation in the blood drops, the machine will alarm, and the anaesthetist will undertake measures to correct the situation to avoid an emergency.

Blood Pressure and ECG Monitoring

These measures are also frequently used when sedative agents are given, especially in elderly patients or patients who have a cardiac history. The ECG is useful for detecting cardiac rhythm abnormalities (arrhythmias) and insufficiency of blood supply to the heart muscle (cardiac ischaemia).

A typical print-out from a patient monitor is shown below. The top tracing is an ECG, the bottom tracing the pulse rate. The monitor also shows continuously the pulse rate, the last blood pressure recording, and the oxygen saturation.

Sedative and Anaesthetic Agents Used in Endoscopy

In the ideal situation, the patient should be lightly sedated (i.e. drowsy but still able to be woken), pain free and cooperative, unable to remember the procedure, and free of anxiety and fear.

The features of an ideal drug for sedation for endoscopy include:

• Anxiolytic (reduces anxiety)
• Amnestic (reduces memory of the procedure)
• Analgesic (takes away pain)
• Rapid onset of action
• Predictable sedative effects, in proportion to the dose
• Safe over a wide range of doses
• Water soluble and free of pain or irritation on injection
• Rapid recovery with no hangover

No single agent has all these properties, and therefore 2 or even 3 drugs are commonly used. Sedation is often achieved using a benzodiazepine, in combination with an opioid for pain relief and a barbiturate-like hypnotic agent if deeper sedation is required.
All the agents used cause a mild temporary depression of lung function, and some mild temporary effects on the heart, particularly when used in combination. This reinforces the need for adequate monitoring by direct observation and monitoring equipment.

**Benzodiazepines**

These cause sedation but have no effect on pain. The original benzodiazepine used in day surgery and endoscopy was diazepam. However, the plasma elimination half-life for diazepam has been estimated at between 24 and 57 hours, and its breakdown metabolites also have sedative properties. This means that it takes a long time to recover from the effects, which often last until the next day. It is therefore an unsuitable agent for day procedures.

A newer sedative agent, known as MIDAZOLAM, is now very commonly used. This is a short-acting benzodiazepine with useful amnesia for events during the procedure (it does not cause amnesia for events before or after the procedure). The plasma elimination half-life is one tenth that of diazepam, and therefore it is cleared from the blood very quickly. Furthermore the breakdown products (metabolites) are short lived, and have no sedative properties. The dosages range from 1mg to about 10mg.

Midazolam has some side effects and if they occur they are very rarely serious. Depression of breathing is the most important. Others include an itchy nose, rash, dizziness, anxiety, irritability, vivid dreams, twitching movements. Midazolam should not be used in patients with myasthenia gravis, acute glaucoma, and patients known to be allergic to this class of drug. It should be used with caution in patients with serious lung diseases particularly chronic obstructive airways disease.

Pregnancy: while midazolam is not thought to cause fetal malformations in humans, it should be avoided in the first 3 months of pregnancy unless the potential benefits outweigh the risks.

Lactation: midazolam is excreted in breast milk and should be avoided in breastfeeding mothers. Alternatively a breast pump
can be used and the milk discarded for the first few hours after
the procedure.

**Opioids**

These are for pain relief. The short acting opioid fentanyl (or
its relative alfentanil) is often used in combination with midazolam.
The effect of fentanyl lasts for about thirty minutes and provides
good relief from pain. The major side effect is depression of
breathing. The rate and depth of breathing decreases within a
minute or so of the drug being injected. A drop in pulse rate
(bradycardia) may also occur.

Dosage is in the range 1 - 1.5 μg/kg, with lower doses in the
elderly or in impaired renal function or hepatic function. Lower
doses may be required in patients with lung and heart diseases
and in patients on the newer type 2 MAOI drugs (a type of
antidepressant medications). Fentanyl is contraindicated in patients
taking the older type 1 MAOI drugs.

Pregnancy: the safe use of fentanyl has not been established
in the first 3 months of pregnancy, and therefore it should be used
only where the potential benefits outweigh possible risks.

Lactation: it is not known if fentanyl is excreted in breast milk
and fentanyl should be avoided in breastfeeding mothers, or
precautions taken to prevent the baby receiving any fentanyl.

**Propofol and other hypnotic agents**

For many years Barbiturates have been used to put people to
sleep at the start of an operation (often called ‘induction’). Propofol
is a newer non-barbiturate short acting anaesthetic induction drug
which, due to its rapid onset of action and short recovery period,
is ideally suited for endoscopy sedation. It amplifies the sedative
effects of the other analgesic and hypnotic agents, and causes
profound sedation, depending on the dose.

Summarily, propofol is a ‘stronger’ drug than midazolam in
producing sedation, which makes it very useful, but a greater level
of monitoring is required. Propofol causes pain in the arm on
injection in about 30% of patients but this passes off in a minute or so.

Pregnancy: in pregnancy propofol should not be used.

Lactation: propofol should not be used in breastfeeding mothers.

Reversal of Sedation

Generally the recovery from the effects of the above agents is gradual and pleasant. However, specific antagonists for the benzodiazepines and for opioid narcotics are available for use in emergencies and (rarely) electively - these reverse the effects of the above drugs very quickly. Flumazenil is a specific benzodiazepine receptor antagonist which acts within seconds. Naloxone is an opioid antagonist which reverses the respiratory and analgesic effects of opioids.

After the endoscopy

Generally you will be regaining conscious awareness just as you are being wheeled to the recovery area. You may be attached to the same monitors as were used in the procedure area. You will be closely monitored at this time by experienced nursing staff, who will check your blood pressure and vital signs frequently. This is a time to relax and gradually awaken. A long awaited cup of tea and a light meal may be provided about an hour after your procedure. Generally it is wise to eat only lightly for the rest of the day following an endoscopic procedure. You will be fit for discharge when you are wide awake, have had some food, and are able to get up, get dressed, and walk around without any unsteadiness. Another person should accompany you home. You must not drive or use machinery for the remainder of the day.

GASTROSCOPY

(Upper Gastrointestinal Endoscopy)

Upper gastrointestinal endoscopy (gastroscopy) is a commonly performed procedure allowing direct visual examination of the
inside of the upper gastrointestinal tract (oesophagus, stomach and duodenum) using a flexible instrument through which a live image passes. Current endoscopes transmit the image electronically whereas earlier instruments transmitted the image along fibreoptic bundles.

**Purpose of Gastroscopy**

Gastroscopy has many purposes. It allows an examination of the upper gastrointestinal tract for abnormalities, which may be recorded on photograph. This procedure also allows the removal of polyps (small benign growths), injection of bleeding blood vessels, the taking of samples of tissue (biopsies) for examination by a pathologist, and dilatation of strictures in the oesophagus (gullet). Gastroscopy also allows insertion of a feeding tube into the stomach through the abdominal wall (PEG tube) for patients who are unable to eat. If any of these additional procedures are planned as part of your gastroscopy they should be discussed with you in advance.

**Your Preparation**

Prior to the procedure you will be asked not to eat or drink. This is to allow a satisfactory examination and to minimise the risk of vomiting during the test.

**How to do Gastroscopy**

A soft, thin flexible tube is passed into the stomach via the mouth. This takes about 5 minutes and is done under intravenous sedation (medication which may be used include midazolam, fentanyl, and propofol). Reactions to these medications are rare. After the procedure you must not drive or use machinery until the next day, or longer if you feel unsteady or tired the next day. If you object to the use of sedation you should discuss this with your doctor. Some patients tolerate gastroscopy without sedation.

Gastroscopies are normally done in a hospital, usually on a day case basis. You would be required to attend the hospital for about 3 hours if you have sedation for your gastroscopy. You will require to arrange transport to and from the hospital.
Are There Alternatives to Gastroscopy?

A barium meal x-ray of the stomach will give similar information but it is not as accurate in detecting ulcers and other abnormalities, and it does not allow biopsies to be taken. It does not require sedation or hospital admission.

Complications

Gastroscopy is very safe, however complications very occasionally occur. Complications are more common where a therapeutic procedure is performed such as dilatation of a stricture in the gullet, removal of polyps (polypectomy) from the stomach, or insertion of a PEG feeding tube.

Some complications of gastroscopy and related procedures comprise:

• Reaction or sensitivity to medication used for sedation (this may affect your breathing briefly)
• Perforation (puncture) of the lining of the gullet, stomach, or duodenum
• Infection in the neck, chest or abdominal cavity following a perforation
• Bleeding - if blood vessels are injected or a polyp is removed
• Lung infections due to vomiting and aspiration during the procedure
• Heart attacks, cardiac arrest, and breathing problems (very rare)
• There are other very rare complications - please advise your doctor if you wish to be given more details

To minimise the risk of these complications everything will be done. There are ways of detecting these complications early and specific treatments are available if they do arise. Very rarely there may be a need for hospitalisation, major surgery, intravenous feeding, or blood transfusion. Although death can result from complications of gastroscopy & oesophageal dilatation this is extremely rare.
LIVER BIOPSY

A liver biopsy involves your doctor taking a small piece of tissue from your liver so that they can examine it to see if there is any damage or disease to the liver.

The reasons why your doctor may want to do a liver biopsy could be that your liver function tests (LFTs) may be abnormal, possibly suggesting that your liver is not working properly or you may have an enlarged liver. For the doctor to accurately determine what is wrong with your liver, a liver biopsy may be the best approach.

Before you have your liver biopsy, the doctor will do some tests to ensure that the risks of the biopsy are kept to a minimum. First, your doctor will take some blood to see if it clots properly (since the liver produces some of the factors that help blood to clot). Your doctor will also ask you what medications you take. Make sure you mention blood thinning medications, including aspirin. One week before surgery, it is recommended that you stop taking aspirin, ibuprofen and anticoagulants (such as warfarin). You have to go to the hospital for a liver biopsy. For the biopsy, you will be lying on a hospital bed and the nurse will put in an intravenous (IV) line so that you can be given medication for the procedure. When you have the biopsy, you will be lying on your back or turned slightly on your left side, with your right arm above your head. You will be given some local anaesthetic with a needle to numb the area and then the doctor will make a small incision (cut) in your right side, near your ribcage.

The doctor will then put a biopsy needle in and take out a small piece of your liver within the needle. Sometime the doctor may use an ultrasound image of your liver to help guide the needle to the right spot. The doctor will ask you to hold your breath for 5-10 seconds while they put the needle into your liver. You might feel a dull pain when this happens. The actual procedure should take only a few minutes. After the biopsy, you will get a bandage put over the incision and you will have to lie on your
right side, pressed up against a towel, for at least 2 hours. Sometime patients may need to stay in hospital for up to 24 hours after the biopsy to recover from the sedative and to allow the medical staff to check for complications before you can go home.

Since you may be having a sedative, you will need to arrange for someone to drive you home, as you can’t drive after having a sedative. You have to go directly home and remain in bed for 8-12 hours, depending on what your doctor tells you. And to make sure that the incision and you liver can heal, you shouldn’t exert yourself too much for the next week. You might get a little bit of soreness at the incision site and you might get some pain in your right shoulder.

There are some risks involved in having a liver biopsy, such as puncture of the lung or gallbladder, infection, bleeding and pain, but these complications are rare. You should ask the doctor about these complications, how to recognise them, and what action to take.

**ABDOMINAL ANGIOGRAM**

An angiogram is an imaging test that uses X-rays to look at your blood vessels. It is done to check for conditions such as:

- Weak, stretched portion of a blood vessel (aneurysm)
- Narrowing of a blood vessel (stenosis)
- Blockages

An abdominal angiogram looks at the blood vessels in your belly (abdomen). It may be used to check blood flow to the organs of the abdomen, such as the liver and spleen. It may also be used to deliver medicine to treat cancer or bleeding in the abdomen.

Fluoroscopy is often used during an abdominal angiogram. This is a kind of X-ray “movie.”

Contrast dye is used to cause the blood vessels to appear solid on the X-ray image. This lets the radiologist see the blood vessels more clearly. Dye is injected into specific blood vessels to look at a certain area of blood flow more closely.
For an abdominal angiogram, contrast dye is generally injected into a large artery in your groin. Then the radiologist takes a series of X-ray pictures. These X-ray images show the blood flow in the abdomen.

**Need of abdominal angiogram why?**

You may require an abdominal angiogram to find problems of the blood vessels in the abdomen. Problems include:

- Aneurysms
- Stenosis or spasms of the blood vessel (vasospasm)
- A connection between the arteries and veins that isn’t normal (arteriovenous malformation)
- A blood clot within a blood vessel or blockage of a blood vessel

Other conditions that may be found by include tumors, bleeding, liver disease, gallstones, and inflammation. Angiography may be used to deliver medicine directly into tissue or an organ. This might include clotting medicine to the site of bleeding or cancer medicine into a tumor.

Your health care provider may have other reasons to recommend an abdominal angiogram.

**Risks of an abdominal Angiogram**

You may want to ask your health care provider about the amount of radiation used during the test. Also ask about the risks as they apply to you.

Consider writing down all X-rays you get, including past scans and X-rays for other health reasons. Show this list to your provider. The risks of radiation exposure may be tied to the number of X-rays you have and the X-ray treatments you have over time.

Tell your provider if:

- You are pregnant or think you may be pregnant. Radiation exposure during pregnancy may lead to birth defects.
- You are allergic to or sensitive to medicines, contrast dyes, local anesthesia, iodine, or latex
Because the procedure involves the blood vessels and blood flow of the abdomen, there is a small risk for complications involving the abdomen. These include:

- Bleeding because of puncture of a blood vessel
- Injury to nerves
- Blood clot in the blood vessel
- Area of swelling caused by a buildup of blood
- Infection
- Organ damage

You may have other risks depending on your specific health condition. Be sure to talk with your provider about any concerns you have before the procedure.

How do I get ready for an abdominal angiogram?

- Your health care provider will explain the procedure to you. Ask him or her any questions you have about the procedure.
- You may be asked to sign a consent form that gives permission to do the procedure. Read the form carefully and ask questions if anything is not clear.
- Tell your health care provider if you have ever had a reaction to any contrast dye, or if you are allergic to iodine.
- Tell your health care provider if you are sensitive to or are allergic to any medicine, latex, tape, and anesthesia.
- You will need to fast for a certain period before the procedure. Your health care provider will tell you how long to fast, whether for a few hours or overnight.
- Tell your health care provider if you are pregnant or think you may be.
- Tell your health care provider of all medicines (prescribed and over-the-counter) and herbal supplements that you are taking.
- Tell your health care provider if you have a history of bleeding disorders or if you are taking any anticoagulant (blood-thinning) medicines, aspirin, or other medicines.
that affect blood clotting. You may be told to stop these medicines before the procedure.

- Your health care provider may request a blood test before the procedure to find out how long it takes your blood to clot. Other blood tests may be done as well.
- You may get a sedative before the procedure if needed. You may also get an anticholinergic medicine, which acts to slow down the production of saliva in the mouth. It also slows the production of acid in the stomach, and the activities of the intestinal tract, among other effects. If you get this medicine, you may notice that your mouth feels dry.
- Depending on the site used for injection of the contrast dye, the recovery period may last up to 12 to 24 hours. You may need to spend the night.
- Based on your condition, your health care provider may ask for other preparations.

**What happens during an abdominal angiogram?**

You may have an abdominal angiogram as an outpatient or as part of a hospital stay. The way the test is done may vary depending on your condition and your health care provider’s practices.

Generally, an abdominal angiogram follows this process:

- You will need to remove any clothing, jewelry, or other objects that may get in the way of the test.
- You will be given a gown to wear.
- You will be asked to empty your bladder before the start of the procedure.
- You will be positioned on the X-ray table.
- An intravenous (IV) line will be inserted in your arm or hand.
- You may be connected to a heart monitor that records the electrical activity of the heart and monitors the heart during the procedure. Your vital signs (heart rate, blood pressure, and breathing rate) will be monitored during the procedure.
• The radiologist will check your pulses below the injection site for the contrast dye and mark them with a marker so that the blood flow to the limb below the site can be checked after the procedure.

• A line will be inserted into an artery in your groin after the skin is cleansed and a local anesthetic is injected. Sometimes an artery in the elbow area of the arm may be used. If the groin or arm site is used, the site will be shaved before insertion of the line. If the arm site is used, a blood pressure cuff will be applied to the arm below the site and inflated to prevent flow of the contrast dye into the lower arm.

• Once the needle has been placed, a catheter (a long, thin tube) will be inserted into the artery at the groin or arm site. Fluoroscopy may be used to check the location of the catheter within the abdomen.

• An injection of contrast dye will be given. You may have some effects when the dye is injected into the line. These effects include a flushing sensation, a salty or metallic taste in the mouth, a brief headache, or nausea and/or vomiting. These effects usually last for a few moments.

• Tell the radiologist if you have any breathing trouble, sweating, numbness, or heart palpitations.

• After the contrast dye is injected, a series of X-rays will be taken. The first series of X-rays shows the arteries, and the second series shows capillary and venous blood flow.

• There may be one or more injections of contrast dye.

• The catheter will be removed and pressure will be applied over the area to keep the artery from bleeding.

• After the site stops bleeding, a dressing will be applied to the site. A sandbag or other heavy item may be placed over the site for a time to prevent further bleeding or the formation of a hematoma at the site.

**What happens after an abdominal angiogram?**

After the procedure, you will be taken to the recovery room for observation. Medical staff will watch the blood flow and feeling
in your leg where the injection catheter was inserted. A nurse will check your vital signs and the injection site. You will stay flat in bed in a recovery room for several hours after the procedure. The leg or arm on the side of the injection site will be kept straight for up to 12 hours.

You may be given pain medicine for pain or discomfort of the injection site. You will be urged to drink water and other fluids to help flush the contrast dye from your body.

You may go back to your usual diet and activities after the procedure, unless your health care provider advises you otherwise. After recovery, you may go back to your hospital room or discharged to your home. If this procedure was done as an outpatient, plan to have someone drive you home.

Once at home, you should check the injection site for bleeding. A small bruise is normal, as is an occasional drop of blood at the site. Watch the leg or arm for changes in temperature or color, pain, numbness, tingling, or loss of function of the limb.

Drink plenty of fluids to prevent dehydration and to help pass the contrast dye. You may be told to avoid heavy activity and not to take a hot bath or shower for a period of time after the procedure.

Call your health care provider right away if any of these occur:

- Fever or chills
- Increased pain, redness, swelling, or bleeding or other drainage from the groin injection site
- Coolness, numbness and/or tingling, or other changes in the affected arm or leg

Your health care provider may give you other instructions after the procedure, depending on your situation.

**MR ENTEROGRAPHY**

**Procedure overview**

Magnetic resonance enterography, or MR enterography, is a minimally invasive imaging test that allows your doctor to obtain
detailed pictures of your small bowel. It can pinpoint areas of inflammation (swelling and irritation), bleeding, and other small bowel conditions.

The procedure uses a magnetic field to create detailed images of your organs. These can then be analyzed on a computer and copied to a printer or CD. In MR enterography, an oral contrast dye is used to highlight the small bowel, also known as the small intestine.

This is not an X-ray procedure, so it does not involve any kind of radiation. The oral contrast material does not contain any radioactive material. The images produced by this procedure are quite detailed. The procedure may take around 45 minutes to complete.

Reasons for the procedure

MR enterography may be recommended to:

- Find internal bleeding
- Find areas of irritation and swelling
- Find abscesses, which are pus filled pockets, in the intestinal walls
- Find small tears in the intestine wall
- Find any blockages or obstructions
- Help track how well certain treatments are working

MR enterography is often recommended when you have Crohn’s disease and are likely to need many follow-up imaging tests. Crohn’s disease tends to strike young people, who are at particular risk from X-ray radiation. MR enterography can help avoid getting unnecessary doses of X-rays, also called ionizing radiation. Also, the procedure is better than CT scans for subtle soft-tissue problems. It captures excellent images of fluid and swelling, as well as active inflammation, bowel obstructions, abscesses, and fistulas, or abnormal passageways between organs.

Risks of the procedure

MR enterography carries some risks:
• The magnetic field may change the way any implanted medical devices work.
• It may damage the kidneys, particularly in people whose kidneys are not working well.
• Some patients have an allergic reaction to the contrast dye.

There may be other risks, depending on your specific medical condition. Be sure to discuss any concerns with your doctor before the procedure.

**Before having the procedure**

Before having MR enterography, you will likely require to:

• Complete any blood tests or other tests ordered by your doctor.
• Let your doctor know if you are or could be pregnant.
• Let your doctor know if you have any implanted medical devices or use any devices regularly, such as hearing aids. Some types of devices may disqualify you from this procedure. For instance, if you have an implanted defibrillator or pacemaker, a cochlear ear implant, a clip for a brain aneurysm, or a metal coil in your blood vessels, you should not have this procedure or enter the MRI area unless instructed to do so by your radiologist.
• Ensure you understand why the procedure was recommended.
• Ask your doctor if you should stop taking any of your regular medications or supplements. You may need to stop taking medications or other agents that could thin your blood before the procedure.
• Ask your doctor when to stop eating and drinking or whether you should avoid certain foods for this test. You may be asked not to eat or drink for six hours before the test.
• Let your doctor know about any allergies or other health conditions, such as diabetes or kidney disease.
• Talk with your radiologist or doctor about whether you might need a sedative to relax during the test.
• Do not wear any jewelry or body piercings, or bring any valuable personal items to the procedure.
• Do not carry any metal objects into the exam room. This includes hairpins and metal zippers.
• If you have sensitive hearing, ask for earplugs to wear during the procedure. The MRI machine can make loud noises that some people may find disturbing.
• If you will be discharged the same day, make sure you have an adult who can drive you home, in case you are given a sedative before the procedure.

Before the Procedure

• A gown will be given to you to change into and wear during the procedure, and you may be given a sedative to help you relax.
• You’ll be given water and a contrast material to drink quickly and steadily in advance of the procedure. Your procedure will begin about 45 minutes after you start drinking.
• Medical staff will help position and secure you on a table in the exam room. The more still you are, the better the images will be.
• A nurse may start an IV so that you can be given fluids and injected contrast material in addition to the swallowed contrast.
• The MRI machine will scan your body before the contrast dye is injected and afterward. You will be alone in the room, but you can talk to the people operating the machine. The machine may make some humming, bumping, or pinging noises as it scans you. This is normal.
• You may be asked to briefly hold your breath.
• You may need to stay in place while the images are reviewed. If necessary, additional images will be created.

After the procedure
Some people experience mild nausea, cramping, or diarrhea from the contrast material ingested. Let your doctor know if you have any serious or ongoing discomfort.

PANCREAS SCAN

Procedure overview
Pancreas scan: What it is?
A pancreas scan is a specialized radiology procedure used to assess the pancreas for the presence of a specific type of tumor. A pancreas scan is a type of nuclear radiology procedure. This means that a tiny amount of a radioactive substance is used during the procedure to assist in the examination of the pancreas. A pancreas scan may also be used to treat certain malignant tumors of the pancreas.

In various nuclear medicine procedures, the radioactive substance is referred to as a radionuclide. However, the radioactive substance used in a pancreas scan is called a radiopeptide, because the compound to which the radioactive material is attached is a synthetic peptide (an organic compound which is a component of protein). Because tumor cells readily bind with certain peptides, nuclear medicine radiologists have developed highly specific radiopeptides that bind with tumor cells and thus make certain tumors visible with nuclear imaging techniques. In addition, radiopeptides may be used to treat certain types of tumors by using specific therapeutic radioactive substances attached to the
radiopeptide. Once the radiopeptide has bonded with the peptide receptor cells of tumors, the radiopeptide emits a type of radiation, called gamma radiation. The gamma radiation is detected by a scanner, which processes the information into an image of the tumor. Other concerned procedures that may be used to diagnose problems of the pancreas include abdominal X-rays, computed tomography (CT scan) of the abdomen or pancreas, or an endoscopic retrograde cholangiopancreatography (ERCP).

**Anatomy of the pancreas**

![Diagram of the pancreas and surrounding organs]

The pancreas is an elongated, tapered organ located across the back of the abdomen, behind the stomach. The right side of the organ (called the head) is the widest part of the organ and lies in the curve of the duodenum (the first section of the small intestine). The tapered left side extends slightly upward (called the body of the pancreas) and ends near the spleen (called the tail).

The pancreas is made up of 2 types of glands:
- Exocrine. The exocrine gland secretes digestive enzymes. These enzymes are secreted into a network of ducts that
join the main pancreatic duct, which runs the length of the pancreas and connects to the duodenum.

• Endocrine. The endocrine gland, which consists of the islets of Langerhans, secretes hormones into the bloodstream.

**Pancreas: Its Functions**

The pancreas has digestive and hormonal functions:

• The enzymes secreted by the exocrine gland in the pancreas help break down carbohydrates, fats, proteins, and acids in the duodenum. These enzymes travel down the pancreatic duct into the bile duct in an inactive form. When they enter the duodenum, they are activated. The exocrine tissue also secretes bicarbonate to neutralize stomach acid in the duodenum.

• The hormones secreted by the endocrine gland in the pancreas are insulin and glucagon (which regulate the level of glucose in the blood), and somatostatin (which prevents the release of the other 2 hormones).

**Reasons behind procedure**

A pancreas scan may be performed to screen for primary or metastatic cancer of the pancreas. A pancreas scan may be used to assess response to therapy for pancreatic cancer and/or to monitor the course of the cancer.

There may be other reasons for your doctor to recommend a pancreas scan.

**Extent of Risks of Procedure**

The amount of the radiopeptide injected into your vein for the procedure is small enough that there is no need for precautions against radioactive exposure. The injection of the radiopeptide may cause some slight discomfort. Allergic reactions to the radiopeptide are rare, but may occur. For some patients, having to lie still on the scanning table for the length of the procedure may cause some discomfort or pain.
Patients who are allergic to or sensitive to medications, contrast dyes, or latex should notify their doctor. If you are pregnant or suspect that you may be pregnant, you should notify your health care provider due to the risk of injury to the fetus from a pancreas scan.

If you are lactating, or breastfeeding, you should notify your health care provider due to the risk of contaminating breast milk with the radiopeptide. There may be other risks depending on your specific medical condition. Be sure to discuss any concerns with your doctor prior to the procedure.

Certain factors or conditions may interfere with the accuracy of a pancreas scan. These factors include, but are not limited to, the following:

• Presence of a radionuclide in the body from a previous nuclear medicine procedure within a certain period of time
• Barium remaining in the gastrointestinal (GI) tract from a recent barium procedure

Before the procedure

• Your doctor will explain the procedure to you and offer you the opportunity to ask any questions that you might have about the procedure.
• You will be asked to sign a consent form that gives your permission to do the procedure. Read the form carefully and ask questions if something is not clear.
• Generally, no prior preparation, such as fasting or sedation, is required prior to a pancreas scan.
• Notify the radiologist or technologist if you are allergic to or sensitive to medications, local anesthesia, contrast dyes, iodine, or latex.
• If you are pregnant or suspect you may be pregnant, you should notify your doctor.
• Based on your medical condition, your doctor may request other specific preparation.
During the procedure

A pancreas scan may be performed on an outpatient basis or as part of your stay in a hospital. Procedures may vary depending on your condition and your doctor’s practices.

Generally, a pancreas scan follows this process:

- You will be asked to remove any clothing, jewelry, or other objects that may interfere with the procedure.
- If you are asked to remove clothing, you will be given a gown to wear.
- An intravenous (IV) line will be started in the hand or arm for injection of the radiopeptide.
- The radiopeptide will be injected into your vein. The radiopeptide will be allowed to concentrate in the pancreas tissue.
- You will be asked to lie still on a scanning table, as any movement may affect the quality of the scan.
- The scanner will be placed over the abdomen in order to detect the gamma rays emitted by the radiopeptide in the pancreas tissue.
- You may be repositioned during the scan in order to obtain views of all the surfaces of the pancreas.
- When the scan has been completed, the IV line will be removed.

While the pancreas scan itself causes no pain, having to lie still for the length of the procedure might cause some discomfort or pain, especially in the case of a recent injury or invasive procedure such as surgery. The technologist will use all possible comfort measures and complete the procedure as quickly as possible to minimize any discomfort or pain.

After the procedure

You should move gradually when getting up from the scanner table to avoid any dizziness or lightheadedness from lying flat for the length of the procedure. You may be instructed to drink plenty of fluids and empty your bladder frequently for about 24 hours.
after the procedure to help flush the remaining radionuclide from your body.

The IV site will be checked for any signs of redness or swelling. If you notice any pain, redness, and/or swelling at the IV site after you return home following your procedure, you should notify your doctor as this may indicate an infection or other type of reaction.

You may resume your usual diet and activities, unless your doctor advises you differently. Your doctor may give you additional or alternate instructions after the procedure, depending on your particular situation.

**Online resources**

The content provided here is for informational purposes only, and was not designed to diagnose or treat a health problem or disease, or replace the professional medical advice you receive from your doctor. Please consult your health care provider with any questions or concerns you may have regarding your condition.

**UPPER GI ENDOSCOPY**

**What is an EGD?**

An upper GI endoscopy or EGD (esophagogastrroduodenoscopy) is a procedure to diagnose and treat problems in your upper GI tract (gastrointestinal tract).

The upper GI tract includes your food pipe (esophagus), stomach, and the first part of your small intestine (the duodenum).

An EGD is done using a long, flexible tube called an endoscope. The tube has a tiny light and video camera on one end. The tube is put into your mouth and throat. Then it is slowly pushed through your esophagus and stomach, and into your duodenum. Video images from the tube are seen on a monitor.

Small tools may also be inserted into the endoscope. These tools can be used to:
• Take tissue samples for a biopsy
• Remove things such as food that may be stuck in the upper GI tract
• Inject air or fluid
• Stop bleeding
• Do procedures such as endoscopic surgery, laser therapy, or open (dilate) a narrowed area

Need of an EGD: Why?

An EGD can be used to diagnose and treat problems in your upper GI tract.

It is generally used to find the cause of unexplained symptoms such as:

• Trouble swallowing (dysphagia)
• Unexplained weight loss
• Upper belly pain or chest pain that is not heart-related
• Continuous vomiting for an unknown reason (intractable vomiting)
• Bleeding in the upper GI tract

An upper GI endoscopy can be used to identify disorders or problems such as:

• GERD (gastroesophageal reflux disease)
• Narrowing (strictures) or blockages
• Larger than normal veins in your esophagus (esophageal varices)
• Redness and swelling (inflammation) and sores (ulcers)
• Tumors, either cancerous (malignant) or not cancerous (benign)
• The stomach moving upward, either into or next to your esophagus (hiatal hernia)
• Damage caused by swallowing very harmful (caustic) substances, such as household detergents and chemicals

An EGD can also treat problems in the upper GI tract. The procedure can be used to:

• Control bleeding
• Remove tumors or growths (polyps)
• Open (dilate) narrowed areas
• Remove things that may be stuck
• Perform laser therapy
• Insert a tube used for tube feeding (a percutaneous gastrostomy tube) into the stomach

An endoscope can be used to take tissue samples (biopsies) or GI fluid samples. An EGD may also be done to check your stomach and duodenum after a surgery.

Your healthcare provider may have other reasons to recommend an EGD.

Risks of an EGD

Some possible complications that may occur with an EGD are:
• Infection
• Bleeding
• A tear in the lining (perforation) of the duodenum, esophagus, or stomach

You may have other risks that are unique to you. Be sure to discuss any concerns with your healthcare provider before the procedure.

Becoming get ready for an EGD: How?

• Your healthcare provider will explain the procedure to you. Ask him or her any questions you have about the procedure.
• You may be asked to sign a consent form that gives permission to do the procedure. Read the form carefully and ask questions if anything is not clear.
• Tell your healthcare provider if you are sensitive to or allergic to any medicines, latex, tape, and anesthesia medicines (local and general).
• You will be asked not to eat or drink for 8 hours before the test. This usually means no food or drink after midnight. You may be given additional instructions about following a special diet for 1 or 2 days before the procedure.
• Tell your provider if you are pregnant or think you may be pregnant.
• Tell your provider if you have a history of bleeding disorders. Let your provider know if you are taking any blood-thinning medicines, aspirin, ibuprofen, or other medicines that affect blood clotting. You may need to stop taking these medicines before the procedure.
• Your doctor will give you instructions on how to prepare your bowel for the test. You may be asked to take a laxative, an enema, or a rectal laxative suppository. Or you may have to drink a special fluid that helps prepare your bowel.
• If you have a heart valve disease, you may be given disease-fighting medicines (antibiotics) before the test.
• You will be awake during the procedure, but you will take medicine to relax you (a sedative) before the test. Someone will have to drive you home afterward.
• Follow any other instructions your provider gives you to get ready.

What happens during an EGD?

You may have an EGD as an outpatient or as part of your stay in a hospital.

The way the test is done may vary depending on your condition and your healthcare provider’s practices.

Generally, an EGD follows this process:
• You will be asked to remove any clothing, jewelry, or other objects that may interfere with the procedure. If you wear false teeth (dentures), you will be asked to remove them until the test is over.
• If you are asked to remove clothing, you will be given a gown to wear.
• An IV (intravenous) line will be started in your arm or hand. A medicine to relax you (a sedative) will be injected into the IV.
• Your heart rate, blood pressure, respiratory rate, and oxygen level will be checked during the procedure.
• You will lie on your left side on the X-ray table with your
  head bent forward.
• Numbing medicine will be sprayed into the back of your
  throat. This will stop you from gagging as the tube is
  passed down your throat into your stomach. The spray
  may have a bitter taste to it. Holding your breath while
  your provider sprays your throat may decrease the taste.
• You will not be able to swallow the saliva that may collect
  in your mouth during the procedure. This happens because
  the tube is in your throat. The saliva will be suctioned from
  your mouth from time to time.
• A mouth guard will be placed in your mouth. This will
  keep you from biting down on the tube. It will also protect
  your teeth.
• Once your throat is numbed and the sedative has relaxed
  you, your provider will put the tube in your mouth and
  throat. He or she will guide the tube down your esophagus,
  through your stomach, and into your duodenum.
• You may feel some pressure or swelling as the tube moves
  along. If needed, samples of fluid or tissue can be taken
  at any time during the test. Other procedures, such as
  removing a blockage, may be done while the tube is in
  place.
• After the exam and procedures are done, the tube will be
  taken out.

What happens after an EGD?

After the procedure, you will be taken to the recovery room
  to be watched. Once your blood pressure, pulse, and breathing are
  stable and you are awake and alert, you will be taken to your
  hospital room. Or you may be discharged to your home. If you
  are going home, someone must drive you.

You will not be allowed to eat or drink anything until your
  gag reflex returns. This is to prevent you from choking. You may
  have a sore throat and pain for a few days when you swallow.
  This is normal.
You may go back to your normal diet and activities, unless you have other instructions.

Call your healthcare provider if you have any of the following:
• Fever or chills
• Redness, swelling, or bleeding or other drainage from the IV site
• Belly pain, nausea, or vomiting
• Black, tarry, or bloody stools
• Trouble swallowing
• Throat or chest pain that gets worse

Your healthcare provider may give you other instructions, depending on your situation.

GASTRIC RESTRICTIVE SURGERY

What it is?

Gastric restrictive surgery is a type of bariatric surgery or weight loss surgery. It limits the amount of food you can eat. This surgery may be used to treat severe obesity when diet, exercise, and medication have failed.

In gastric restrictive procedures, the normal digestive process stays intact. None of the gastrointestinal tract is bypassed. There are 2 types of operations:
• One separates the stomach into two parts. One is a very small pouch that can hold only about one ounce.
• The second type removes about 80% of the stomach. The remaining stomach is much smaller.

Because the size of the stomach is reduced so much, these procedures are called “restrictive.”

After having a restrictive procedure, you can only eat about three-quarters to a cup of well-chewed food. Eating more than the stomach pouch can hold may cause nausea and vomiting.

Restrictive procedures have fewer risks than gastric bypass procedures. But they are also less successful. That’s because
continuous overeating can stretch the pouch so that it holds more food.

The kind of gastric restrictive procedures include:

- **Laparoscopic adjustable gastric banding (LAGB).** In this method, your doctor attaches an inflatable band around the top part of your stomach. The band is tightened like a belt. This separates the stomach into a small pouch. This pouch serves as a new, much smaller stomach. The rest of the stomach is below the band. The band creates a narrow channel between these two parts of the stomach. This slows the movement of the food from the upper small pouch to the lower stomach. After the procedure, the band can be adjusted if needed by your doctor. This is done by adding or removing saline (salt water). No staples are used.

- Like other restrictive procedures, LAGB may not help you reach significant weight loss.

- **Vertical exhibits gastrectomy (VSG).** This newer procedure uses staples to remove about 80% of the stomach. The remaining stomach, which is shaped like a “sleeve” will hold about one-quarter cup of liquid. Over time, the stomach can expand to hold one cup of food. You can potentially lose 1/3 to 1/2 of your excess body weight at one year after surgery. Since the rest of the stomach has been removed, this procedure is not reversible.

LAGB is generally done using a laparoscope rather than through an open incision. This method uses a few small incisions for the laparoscopic tools to reach the inside of the abdomen. The surgeon does the surgery while looking at a TV monitor. Laparoscopic gastric surgery usually reduces the length of the hospital stay. It also reduces the amount of scarring, and often results in quicker recovery than an “open” or standard method.

**Need of Gastric Restrictive Surgery?**

At present Bariatric surgery is the best option for lasting weight loss in people who are severely obese when nonsurgical methods
of weight loss have not worked. Potential candidates for bariatric surgery include:

- People with a body mass index (BMI) greater than 40
- Men who are 100 pounds over their ideal body weight
- Women who are 80 pounds over their ideal body weight
- People who have a BMI of 35 or more who have another serious weight-related condition such as type 2 diabetes, sleep apnea, heart disease, high blood pressure, or osteoarthritis

Since the surgery can have serious side effects, the long-term health benefits must be greater than the risks.

People with a BMI of 60 or more or those who have already had some type of abdominal surgery may not be able to have laparoscopic surgery.

Although not all risks are well known, bariatric surgery does help many people to reduce or get rid of some health-related obesity problems. It may help to:

- Lower blood sugar
- Lower blood pressure
- Reduce or eliminate sleep apnea
- Decrease the workload of the heart
- Lower cholesterol levels
- Minimize further worsening of osteoarthritis of lower back, hips, and knees

Surgery for weight loss is not for everybody. But these procedures can be highly effective in people who are motivated to follow their healthcare provider’s guidelines for nutrition and exercise after surgery. There may be other reasons for your healthcare provider to advise a gastric banding procedure.

**Risks of gastric restrictive Surgery**

As with any surgery, complications may occur. They may include:

- Infection
• Blood clots
• Pneumonia
• Bleeding ulcer
• Gallstones
• Obstruction or nausea when food is not well-chewed
• Poor eating habits
• Scarring inside the abdomen
• Vomiting due to eating more than the stomach pouch can hold, not chewing food well enough, or eating food too fast

In LAGB, the band can erode into the stomach or slip. This can block the flow of food through the band. Rarely, stomach juices may leak into the abdomen and emergency surgery may be needed. The most common long-term complication with LAGB is that the stomach pouch enlarges.

Laparoscopic banding procedure has fewer risks because there is no incision made into the stomach wall. There may be other risks based on your specific health condition. Be sure to discuss any concerns with your healthcare provider before the procedure.

**Preparation for gastric restrictive Surgery**

• Your healthcare provider will explain the procedure to you and ask if you have any questions.
• You will be asked to sign a consent form that shows that you understand the operation and its risks. It also gives your doctor permission to do the procedure. Read the form carefully and ask questions if something is not clear.
• You’ll have a physical exam to make sure you are in good health before having the procedure. You may have blood or other tests. You may also meet with a dietitian and often a psychologist.
• You will be asked to fast for 8 hours before the procedure, generally after midnight.
• If you are pregnant or think you might be, you should tell your healthcare provider.
• Tell your healthcare provider if you are sensitive to or are allergic to any medications, latex, iodine, tape, or anesthesia.

• Tell your healthcare provider of all medications (prescription and over-the-counter) and herbal supplements you take.

• Tell your healthcare provider if you have a history of bleeding problems. Also tell him or her if you are taking any anticoagulant (blood-thinning) medications such as warfarin, aspirin, ibuprofen, naprosyn, or other medicines that affect blood clotting. You may need to stop these medications before the procedure.

• You may be asked to start exercising and change your diet a few weeks before surgery.

• If you are a woman of childbearing age, you may get birth control counseling so that you do not become pregnant in your first year after surgery. Rapid weight loss can harm the fetus.

• You may be given a sedative before the procedure to help you relax.

• Based on your medical condition, your healthcare provider may request other specific preparation.

**Procedure of gastric restrictive Surgery**

Restrictive gastric surgery requires a stay in the hospital. Procedures may vary based on the type of procedure done and your healthcare provider.

These operations require you to be asleep under general anesthesia. Your healthcare provider will discuss this with you before.

Generally, the following process occurs:

• You will be asked to remove clothing and will be given a gown to wear.

• An intravenous (IV) line may be started in your arm or hand.

• You will be positioned lying on your back on the operating table.
• If there is excessive hair at the surgical site, it may be shaved off.
• A urinary catheter may be inserted.
• The anesthesiologist will monitor your heart rate, blood pressure, breathing, and blood oxygen level during the surgery.
• The skin over the surgical site will be cleansed.
• For a laparoscopic procedure, a series of small incisions (usually ½ to 1 inch long) will be made. For an open procedure, the surgeon will make a single larger incision in the abdominal area. Carbon dioxide gas is pumped into the abdomen. This inflates the abdominal cavity so that the stomach and intestines can easily be seen.
• For a laparoscopic adjustable gastric band procedure, a band is placed around the top end of the stomach encircling it to create the small pouch. A narrow passage through the band will connect to the rest of the stomach. The band will be inflated with a salt solution.
• For a vertical sleeve gastrectomy procedure, about 80% of the stomach will be removed, and a small sleeve of the stomach will be created with a line of staples.
• A drain may be placed in the incision site to remove fluid.
• The incision(s) will be closed with stitches or surgical staples.
• A clean bandage or dressing will be applied.

After the Procedure

After the procedure, you will be taken to the recovery room. Once your blood pressure, pulse, and breathing are stable and you are alert, you will be taken to your hospital room.

You may get pain medication as needed, either by a nurse or by giving it yourself through a device connected to your intravenous (IV) line.

You will be encouraged to move around while you are in bed, and then to get out of bed and walk around as your strength improves. The first time you get up, ask the nurse to help you,
so you do not fall or faint. It is important for you to move around soon after your surgery to prevent blood clots.

Firstly, you will get fluids through an IV. That evening or the next day, you will be given liquids such as broth or clear juice to drink. As you are able to take liquids, you may be given thicker liquids, such as pudding, milk, or cream soup. This is followed by foods that you do not have to chew, such as hot cereal or pureed foods.

Some surgeons recommend a liquid diet for 1 to 2 weeks. Your doctor will instruct you about how long to stay on liquid until it is time to progress to eat pureed foods after surgery. By 4 to 6 weeks after your procedure, you may be eating solid foods.

You will be instructed about taking nutritional supplements to replace the nutrients lost due to the reconstruction of the digestive tract. You will also be encouraged to maximize protein intake, often with protein drinks.

Before you are discharged from the hospital, follow-up visits are arranged.

**Calling of my healthcare Provider**

Report any of these symptoms to your doctor:

- Fever and/or chills
- Redness, swelling, or bleeding or other drainage from the incision site
- Increased pain around the incision site.

After surgery, your healthcare provider may give you other instructions, depending on your particular situation.

Once you are home, it will be important to keep the surgical area clean and dry. Your healthcare provider will give you bathing instructions. The stitches or surgical staples will be removed during a follow-up visit in a week or so.

The incision and abdominal muscles may ache, especially with deep breathing, coughing, and exertion. Take a pain reliever for soreness as advised by your healthcare provider. Aspirin or
certain other pain medications called nonsteroidal anti-inflammatory drugs (NSAIDs) may increase the chance of bleeding. Be sure to take only recommended medications.

Keep up the breathing exercises used in the hospital.

Gradually increase your physical activity as you are able. It may take several weeks to return to your previous levels of stamina.

You may be told to avoid lifting heavy items for a few weeks to months, depending on whether the operation was done laparoscopically or with an open technique. This will help prevent strain on your abdominal muscles and surgical incision.

Weight loss surgery can be emotionally difficult because you will be adjusting to new dietary habits and a body in the process of change. You may feel especially tired during the first 4 to 6 weeks after surgery. Exercise and going to a support group may be helpful at this time.

LAPAROSCOPIC ADJUSTABLE GASTRIC BANDING

What is laparoscopic adjustable gastric Banding?

Laparoscopic adjustable gastric banding (LAGB) is one of the least invasive operations available for obesity. It’s done with a few tiny abdominal cuts, instead of with one large cut. The surgeon puts instruments through the cuts. One of those instruments is a laparoscope, a tool with a tiny camera. The surgeon uses these tools to place a band around the top portion of the stomach, leaving a very small pouch available for food. The small pouch means that you feel full after eating only small amounts of food. This will help you lose weight. As its name suggests, the procedure can be adjusted and even reversed.

Need of a laparoscopic adjustable gastric banding: Why?

LAGB is used to treat severe obesity, which is linked to high blood pressure, high cholesterol, type 2 diabetes, sleep apnea, and arthritis. It is recommended for people who have tried other weight loss plans without long-term success. Once you lose a significant
amount of weight, your risk falls for these weight-related health problems. Adjustable gastric banding may help you live longer if you can’t lose weight in other ways.

Your doctor might recommend LAGB if you are severely obese with a body mass index (BMI) greater than 40. Your doctor might also recommend it if you have a BMI between 35 and 40 and a medical condition such as sleep apnea, high blood pressure, heart disease, or type 2 diabetes.

**Risks for laparoscopic adjustable gastric Banding**

Laparoscopic surgery carries fewer risk factors than open surgery because you don’t need a major cut, or incision. Although complications from surgery are less common with laparoscopic surgery, they could include life-threatening blood clots, bleeding, or infection. The procedure also carries the same risk of any general anesthetic for breathing problems and reactions to medication or anesthesia. Other LAGB complications can include band slippage, puncturing the stomach, or blocking the flow of food through the band.

After gastric band surgery food intolerance is common. For instance, you might not be able to digest red meat, a major source of dietary iron. This would put you at a higher risk for anemia.

Other complications comprise severe, life-threatening vitamin and mineral deficiencies such as beriberi (Vitamin B1 deficiency). This is particularly true if you don’t eat a high-protein diet and don’t take you daily supplements as prescribed. But, nutritional deficiencies can occur even if you closely follow the diet and supplements prescribed for you. Your doctor will typically order regular blood tests to watch your levels.

There may be other risks, depending upon your specific medical condition. Be sure to discuss any concerns with your doctor before the procedure.

**How do I get ready for laparoscopic adjustable gastric banding?**

- Your doctor will make sure that you are a good candidate for LAGB. You should also get surgical clearance from
your own health care provider. It is not unusual to have an office visit, blood work to test for nutritional deficiencies and other problems, and an electrocardiogram (ECG) to make sure you have no pre-existing problems.

- Your bariatric surgery center will ask you to enroll in a special pre-surgery program of education about healthy living and about the operation to prepare for the operation. Surgery isn’t recommended for people who are abusing drugs or alcohol, who may have other serious medical problems, or who are not willing to make a commitment to life-long diet and exercise programs.

- If you’re a smoker, you must quit before surgery and should not start again.

What happens during a laparoscopic adjustable gastric banding?

- You will have general anesthesia during the surgery.
- The surgeon will make several small cuts in your abdomen so he or she can put in the necessary surgical instruments.
- A gastric band made of a special rubber material will be put in place around your stomach and then tightened so that the upper part of the stomach forms a small pouch.
- The surgeon will leave a small port under the skin of your stomach. If the size of the pouch needs to be increased or decreased, a doctor can insert a needle into the port and inflate or deflate the band, which works like a balloon, and compresses the channel in the stomach around which the band has been placed.
- LAGB usually takes 30 to 60 minutes.

What happens after laparoscopic adjustable gastric banding?

You will typically be able to go home the day after the procedure. Your diet will be mostly liquids and pureed food for 2 to 3 weeks. You will then slowly begin adding soft foods, then regular foods. You can return to a regular (but smaller) diet after about 6 weeks.
As part of necessary lifestyle changes, you’ll need to eat smaller meals. You’ll need to chew your food slowly and repeatedly into a liquid slurry before swallowing. You also need to eat a healthy diet high in protein, vitamins, and minerals, and low in sugar.

LAGB does not make you lose weight suddenly. But it is a safer, less invasive procedure than other weight-loss surgery, including traditional gastric bypass. You’ll have to be prepared to eat appropriately and exercise. But you can expect long-term weight loss equaling one fourth to one third of your original weight. Because you’ll be at high risk for nutritional deficiencies for the rest of your life, you’ll need to take daily supplements as prescribed. You’ll also need to have life-long medical care to watch for any nutritional problems.

CT ENTEROGRAPHY

Computed tomography (CT) enterography: What is It?

CT enterography is an imaging test that uses CT imagery and a contrast material to view inside the small intestine. The procedure allows your doctor to determine what is causing your condition. He or she can also tell how well you’re responding to treatment for a health issue, such as Crohn’s disease.

A computerized tomography scan, or CT scan, is a type of X-ray that uses a computer to make cross-sectional images of your body.

CT enterography is a quick, accurate, and painless procedure.

Unlike regular X-ray images, CT enterography is able to provide detailed images of tissue and structures, such as bone and blood vessels.

Need of CT Enterography

This test is typically done to find:

- Inflammation
- Tumors
• Bowel obstructions or abscesses
• The source of bleeding

Risks of CT enterography

CT enterography uses X-ray technology, so there is minimal risk of radiation exposure. Talk with your doctor about this risk.

You should let your doctor know if you have any allergies, particularly if you have had an allergic reaction to contrast materials or dyes before.

If you are pregnant or think that you may be pregnant, tell your doctor.

There may be other risks, depending upon your specific medical condition. Be sure to discuss any concerns with your doctor before the procedure.

Getting ready for CT enterography

• Be sure to let your doctor know about any recent infections or illnesses, as well as any chronic conditions that you have, such as diabetes, asthma, heart disease, thyroid problems, and kidney disease.
• You will be asked to stop eating and drinking about four hours before the procedure.
• You may wear a gown during CT enterography, but you should wear comfortable, loose-fitting clothes the day of the procedure.
• Remember to remove all jewelry and other metal objects, and ask whether you need to remove any hearing aids and metal dental devices that can be taken out.

What happens during CT enterography?

• Before the test, you will need to drink a few glasses of liquid over the course of about an hour. The liquid includes the contrast material that will help the radiologist better see the inside of your small intestine on the CT scan. Instead of drinking a contrast solution, you may have it given by enema.
• After you have finished drinking the contrast liquid solution, you will lie on a table, probably on your back. As you lie on the table, it will slowly move through the CT scanning machine to capture the X-ray images.
• You will likely be asked to hold your breath for brief periods while the machine is scanning. The procedure is painless, but you will have to lie still for a period, which could be uncomfortable for some people.

What happens after CT enterography?

The CT enterography procedure doesn’t cause any lasting side effects. You won’t need recovery time because the test doesn’t require no incisions or sedation. You can resume your regular activities as soon as the procedure is completed.

COMPUTED TOMOGRAPHY (CT OR CAT) SCAN OF THE ABDOMEN

CT scan of the abdomen: What it is?

Computed tomography (CT scan or CAT scan) is a noninvasive diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce horizontal, or axial, images (often called slices) of the body. A CT scan shows detailed images of any part of the body, including the bones, muscles, fat, organs, and blood vessels. CT scans are more detailed than standard X-rays.

In standard X-rays, a beam of energy is aimed at the body part being studied. A plate behind the body part captures the variations of the energy beam after it passes through skin, bone, muscle, and other tissue. While much information can be obtained from a standard X-ray, a lot of detail about internal organs and other structures is not available.

In computed tomography, the X-ray beam moves in a circle around the body. This allows various different views of the same organ or structure. The X-ray information is sent to a computer that interprets the X-ray data and displays it in a two-dimensional
(2D) form on a monitor. CT scans may be done with or without “contrast.” Contrast refers to a substance taken by mouth or injected into an intravenous (IV) line that causes the particular organ or tissue under study to be seen more clearly. Contrast examinations may need you to fast for a certain period of time before the procedure. Your doctor will notify you of this prior to the procedure.

CT scans of the abdomen can provide more detailed information about abdominal organs and structures than standard X-rays of the abdomen, thus providing more information related to injuries and/or diseases of the abdominal organs.

CT scans of the abdomen may also be used to visualize placement of needles during biopsies of abdominal organs or tumors or during aspiration (withdrawal) of fluid from the abdomen. CT scans of the abdomen are useful in monitoring tumors and other conditions of the abdomen before and after treatment.

Other related procedures that may be used to diagnose abdominal problems include abdominal X-rays, pancreas scan, liver scan, gallbladder scan, kidney scan, endoscopy procedures such as colonoscopy, abdominal ultrasound, and abdominal angiogram.

**Reasons behind a CT scan of the Abdomen**

The abdomen contains organs of the gastrointestinal, urinary, endocrine, and reproductive systems. A CT scan of the abdomen may be performed to assess the abdomen and its organs for tumors and other lesions, injuries, intra-abdominal bleeding, infections, unexplained abdominal pain, obstructions, or other conditions, particularly when another type of examination, such as X-rays or physical examination, is not conclusive.

A CT scan of the abdomen may also be used to evaluate the effects of treatment on abdominal tumors. Another use of abdominal CT is to provide guidance for biopsies and/or aspiration of tissue from the abdomen.

There may be other reasons for your doctor to recommend a CT scan of the abdomen.
**Risks of a CT Scan**

You may want to ask your doctor about the amount of radiation used during the CT procedure and the risks related to your particular situation. It is a good idea to keep a record of your past history of radiation exposure, such as previous CT scans and other types of X-rays, so that you can inform your doctor. Risks pertaining to radiation exposure may be related to the cumulative number of X-ray examinations and/or treatments over a long period of time.

If you are pregnant or suspect that you may be pregnant, you should notify your health care provider. Radiation exposure during pregnancy may lead to birth defects.

If contrast media is used, there is a risk for allergic reaction to the media. Patients who are allergic to or sensitive to medications should notify their doctor. You will require to let your doctor know if you have ever had a reaction to contrast media, or kidney problems. A reported seafood allergy is not considered to be a contraindication for iodinated contrast. If you take metformin/ Glucophage, or a related medication, you may be asked to stop taking the medication for at least 48 hours after the contrast is administered, as it may cause a condition called metabolic acidosis, or an unsafe change in your blood pH.

Patients with kidney failure or other kidney problems should notify their doctor. In some cases, the contrast media can cause kidney failure, especially if the person is dehydrated or already has underlying kidney disease.

There may be other risks depending on your specific medical condition. Be sure to discuss any concerns with your doctor prior to the procedure.

Some factors or conditions may interfere with the accuracy of a CT scan of the abdomen. These factors include, but are not limited to, the following:

- Metallic objects within the abdomen, such as surgical clips
- Barium in the intestines from a recent barium study
• Stool and/or gas in the bowel
• Total hip replacement.

How to prepare for a CT scan?

If you are having a computed tomography angiography (CTA) or virtual colonoscopy with Johns Hopkins radiology, you will be given specific instructions when you make your appointment.

PRECAUTIONS: If you are pregnant or think you may be pregnant, please check with your doctor before scheduling the exam. Other options will be discussed with you and your doctor.

CLOTHING: You may be asked to change into a patient gown. If so, a gown will be provided for you. A locker will be provided to secure personal belongings. Please remove all piercings and leave all jewelry and valuables at home.

CONTRAST MEDIA: CT scans are most frequently done with and without a contrast media. The contrast media improves the radiologist’s ability to view the images of the inside of the body.

• Some patients should not have an iodine-based contrast media. If you have problems with your kidney function, please inform the access center representative when you schedule the appointment. You may be able to have the scan performed without contrast media or have an alternative imaging exam.

• You will be asked to sign a consent form that will detail the risks and side-effects associated with contrast media injected through a small tube places in a vein called an intravenous (IV) line.

• The most common type of CT scan with contrast is the double contrast study that will require you to drink a contrast media before your exam begins in addition to the IV contrast. The more contrast you are able to drink, the better the images are for the radiologist to visualize your digestive tract.

ALLERGY: Please inform the access center representative when you schedule your CT scan if you have had an allergic reaction
to any contrast media. IV contrast will not be administered if you have had a severe or anaphylactic reaction to any contrast media in the past. If you had mild to moderate reactions in the past, you will likely need to take medication prior to the CT scan. These plans will be discussed with you in detail when you schedule your exam. Any known reactions to a contrast media should be discussed with your personal physician.

EAT/DRINK: If your doctor ordered a CT scan without contrast, you can eat, drink and take your prescribed medications prior to your exam. If your doctor ordered a CT scan with contrast, do not eat anything three hours prior to your CT scan. You are encouraged to drink clear liquids. You may also take your prescribed medications prior to your exam.

DIABETICS: Diabetics should eat a light breakfast or lunch three hours prior to the scan time. Depending on your oral medication for diabetes, you may be asked to discontinue use of the medication for 48 hours after the CT scan. If you have a CT scan with Johns Hopkins radiology, detailed instructions will be given following your examination.

MEDICATION: All patients can take their prescribed medications as usual.

Based on your medical condition, your doctor may request other specific preparation.

**What happens during a CT scan?**

CT scans may be performed on an outpatient basis or as part of your stay in a hospital. Procedures may vary depending on your condition and your physician’s practices.

Generally, a CT scan follows this process:

- You may be asked to change into a patient gown. If so, a gown will be provided for you. A locked will be provided to secure all personal belongings. Please remove all piercings and leave all jewelry and valuables at home.
- If you are to have a procedure done with contrast, an
intravenous (IV) line will be started in the hand or arm for injection of the contrast media. For oral contrast, you will be given a liquid contrast preparation to swallow. In some situations, the contrast may be given rectally.

• You will lie on a scan table that slides into a large, circular opening of the scanning machine. Pillows and straps may be used to prevent movement during the procedure.

• The technologist will be in another room where the scanner controls are located. However, you will be in constant sight of the technologist through a window. Speakers inside the scanner will enable the technologist to communicate with and hear you. You may have a call button so that you can let the technologist know if you have any problems during the procedure. The technologist will be watching you at all times and will be in constant communication.

• As the scanner begins to rotate around you, X-rays will pass through the body for short amounts of time. You will hear clicking sounds, which are normal.

• The X-rays absorbed by the body’s tissues will be detected by the scanner and transmitted to the computer. The computer will transform the information into an image to be interpreted by the radiologist.

• It will be important that you remain very still during the procedure. You may be asked to hold your breath at various times during the procedure.
• If contrast media is used for your procedure, you may feel some effects when the dye is injected into the IV line. These effects include a flushing sensation, a salty or metallic taste in the mouth, a brief headache, or nausea and/or vomiting. These effects usually last for a few moments.
• You should notify the technologist if you feel any breathing difficulties, sweating, numbness or heart palpitations.
• When the procedure has been completed, you will be removed from the scanner.
• If an IV line was inserted for contrast administration, the line will be removed.

While the CT procedure itself causes no pain, having to lie still for the length of the procedure might cause some discomfort or pain, particularly in the case of a recent injury or invasive procedure such as surgery. The technologist will use all possible comfort measures and complete the procedure as quickly as possible to minimize any discomfort or pain.

What happens after a CT scan?

If contrast dye was used during your procedure, you may be monitored for a period of time for any side effects or reactions to the contrast dye, like itching, swelling, rash, or difficulty breathing.

If you realise any pain, redness, and/or swelling at the IV site after you return home following your procedure, you should notify your doctor as this could indicate an infection or other type of reaction.

Otherwise, there is no special type of care required after a CT scan of the abdomen. You may resume your usual diet and activities unless your doctor advises you differently. Your doctor may give you additional or alternate instructions after the procedure, depending on your particular situation.

GALLBLADDER SCAN

A gallbladder scan is a specialized radiology procedure used to assess the function and structure of the gallbladder. This
procedure may also be referred to as a liver-biliary scan because the liver often is examined as well due to its proximity and close functional relationship to the gallbladder.

A gallbladder scan is a type of nuclear medicine procedure. This means that a tiny amount of a radioactive substance is used during the procedure to assist in the examination of the gallbladder. The radioactive substance, called a radionuclide (radiopharmaceutical or radioactive tracer), is absorbed by normal gallbladder tissue.

The radionuclide used in gallbladder scans is generally a form of technetium. Once absorbed into the gallbladder tissue, the radionuclide emits a type of radiation, called gamma radiation. The gamma radiation is detected by a scanner, which processes the information into a picture of the gallbladder.

By measuring the behavior of the radionuclide in the body during a nuclear scan, the doctor can assess and diagnose various conditions, such as obstruction of bile ducts from gallstones, tumors, abscesses, hematomas, organ enlargement, or cysts. A nuclear scan may also be used to assess organ function.

The areas where the radionuclide collects in greater amounts are called “hot spots.” The areas that do not absorb the radionuclide and appear less bright on the scan image are referred to as “cold spots.”

Gallbladder disease may be caused by infection or by a blockage within the gallbladder or the ducts of the liver/gallbladder system (the biliary tree). If the gallbladder is infected or obstructed, the radionuclide cannot pass into the gallbladder. If there is a blockage within the biliary tree, passage of the radionuclide will stop at the point of the obstruction.

Other concerned procedures that may be used to diagnose problems of the gallbladder include abdominal X-rays, computed tomography (CT scan) of the liver and biliary tract, abdominal ultrasound, cholecystography, or endoscopic retrograde cholangiopancreatography (ERCP).
About the Gallbladder

The gallbladder is a pear-shaped organ located in the fissure between the right and left lobes of the liver. The gallbladder stores and concentrates bile, a substance produced by the liver and used to break down fat for digestion.

Reasons behind gallbladder Scan

A gallbladder scan may be performed in situations where gallbladder disease (cholecystitis) is suspected, such as with severe acute right upper abdominal quadrant pain or when jaundice (yellowed skin and/or eyes) is present. Elevated liver enzymes in a specific blood test may also indicate some type of gallbladder disease. A gallbladder scan may also be helpful in diagnosing biliary duct obstructions and determining gallbladder function.

There may be other reasons for your doctor to recommend a gallbladder scan.

Risks of a gallbladder Scan

The amount of the radionuclide injected into your vein for the procedure is small enough that there is no need for precautions against radioactive exposure. The injection of the radionuclide may cause some slight discomfort. Allergic reactions to the radionuclide are rare, but may occur. For some patients, having to lie still on the scanning table for the length of the procedure may cause some discomfort or pain. Patients who are allergic to or sensitive to medications, contrast dyes, or latex should notify their doctor.

If you are pregnant or suspect that you may be pregnant, you should notify your health care provider due to the risk of injury to the fetus from a gallbladder scan. If you are lactating, or breastfeeding, you should notify your health care provider due to the risk of contaminating breast milk with the radionuclide.

There may be other risks depending on your specific medical condition. Be sure to discuss any concerns with your doctor prior to the procedure. Some factors or conditions may interfere with
the accuracy of a gallbladder scan. These factors may include, but are not limited to, the following:

- Presence of a radionuclide in the body from a previous nuclear medicine procedure within a certain period of time
- Eating and/or drinking within two to eight hours of the procedure
- Prolonged period of fasting (generally greater than 24 hours)
- Administration of hyperalimentation (a form of IV nutrition)
- Liver disease

**Preparation for a gallbladder Scan**

**PRECAUTIONS:** If you are pregnant or think you might be pregnant, please check with your doctor before scheduling the exam. Other options will be discussed with you and your doctor.

**BREASTFEEDING:** If you are breastfeeding, you should notify your health care provider due to the risk of contaminating breast milk with the tracer.

**CLOTHING:** You may be asked to change into a patient gown. A gown will be provided for you. Lockers are provided to secure your personal belongings. Please remove all piercings and leave all jewelry and valuables at home.

**EAT/DRINK:** You will be asked to not eat or drink anything for up to eight hours. You should not fast any longer than the period specified by your doctor, as fasting for too long of time may affect the accuracy of the test as much as not fasting long enough.

**ALLERGIES:** Notify the radiologist or technologist if you are allergic to or sensitive to medications, contrast dyes or iodine. The injection of the radiotracer may cause some slight discomfort. Allergic reactions to the radiotracer are rare, but may occur.

**How to perform a gallbladder Scan?**

A gallbladder scan may be performed on an outpatient basis or as part of your stay in a hospital. Procedures may vary depending
on your condition and your doctor’s practices. Generally, a gallbladder scan follows this process:

- You will be asked to remove any jewelry, or other objects that may interfere with the procedure.
- You will be asked to remove clothing and will be given a gown to wear.
- An intravenous (IV) line will be started in the hand or arm for injection of the radionuclide.
- The radionuclide will be injected into your vein.
- You will be asked to lie still on a scanning table. You will need to remain still during the procedure, as any movement may affect the quality of the scan.
- The scanner will be placed over the abdominal area in order to detect the gamma rays emitted by the radionuclide in the gallbladder tissue. A series of images will be taken at intervals until the gallbladder is visualized.
- In some cases, you may receive an IV injection of morphine during the procedure to allow better visualization of the gallbladder during an indeterminate test.
- If the radionuclide does not enter the gallbladder within a certain period of time, the scan may be repeated within a few hours to determine if there is a complete or partial obstruction in the biliary tree.
- When the scan has been completed, the IV line will be removed.

While the gallbladder scan itself causes no pain, having to remain still for the length of the procedure might cause some discomfort or pain, particularly in the case of a recent injury or invasive procedure such as surgery. The technologist will use all possible comfort measures and complete the procedure as quickly as possible to minimize any discomfort or pain.

**What happens after the Performance of gallbladder scan?**

You should move gradually when getting up from the scanner table to avoid any dizziness or lightheadedness from lying flat for the length of the procedure. You may be instructed to drink plenty
of fluids and empty your bladder frequently for about 24 hours after the procedure to help flush the remaining radionuclide from your body.

The IV site will be checked for any signs of redness or swelling. If you notice any pain, redness, and/or swelling at the IV site after you return home following your procedure, you should notify your doctor as this may indicate an infection or other type of reaction. If you were asked to fast prior to the procedure, you may either be offered food and drink after the procedure or encouraged to have a meal, unless your doctor tells you differently.

You may resume your usual diet and activities, unless your doctor advises you differently. Your doctor may give you additional or alternate instructions after the procedure, depending on your particular situation.

**ABDOMINAL ULTRASOUND**

An abdominal ultrasound is a noninvasive procedure used to assess the organs and structures within the abdomen. This includes the liver, gallbladder, pancreas, bile ducts, spleen, and abdominal aorta. Ultrasound technology allows quick visualization of the abdominal organs and structures from outside the body. Ultrasound may also be used to assess blood flow to abdominal organs.

Ultrasound uses a transducer that sends out ultrasound waves at a frequency too high to be heard. The ultrasound transducer is placed on the skin, and the ultrasound waves move through the body to the organs and structures within. The sound waves bounce off the organs like an echo and return to the transducer. The transducer processes the reflected waves, which are then converted by a computer into an image of the organs or tissues being examined.

The sound waves travel at various speeds depending on the type of tissue encountered - fastest through bone tissue and slowest through air. The speed at which the sound waves are returned to
the transducer, as well as how much of the sound wave returns, is translated by the transducer as different types of tissue.

An ultrasound gel is placed on the transducer and the skin to allow for smooth movement of the transducer over the skin and to eliminate air between the skin and the transducer for the best sound conduction. Another type of ultrasound is Doppler ultrasound, sometimes called a duplex study, used to show the speed and direction of blood flow within the abdomen. Unlike a standard ultrasound, some sound waves during the Doppler exam are audible.

Ultrasound should be safely used during pregnancy or in the presence of allergies to contrast dye, because no radiation or contrast dyes are used. Other related procedures that may be performed to evaluate the abdomen include abdominal X-rays, computed tomography (CT scan) of the abdomen, and abdominal angiogram.

**Need an abdominal ultrasound: Why?**

Abdominal ultrasound may be used to assess the size and location of abdominal organs and structures. It can also be used to check the abdomen for conditions such as:

- Cysts
- Tumors
- Collection of pus (abscesses)
- Obstructions
- Fluid collection
- Blockages (clots) in blood vessels
- Infection.

The size of the abdominal aorta can be measured by ultrasound in order to detect an aortic aneurysm. Stones in the gallbladder, kidneys, and ureters may be detected by ultrasound. Abdominal ultrasound may be performed to assist in placement of needles used to biopsy abdominal tissue or to drain fluid from a cyst or abscess. Abdominal ultrasound may also be used to assess the blood flow of various structures within the abdomen. There may
be other reasons for your doctor to recommend an abdominal ultrasound.

**Risks of abdominal Ultrasound**

There is no radiation used and generally no discomfort from the application of the ultrasound transducer to the skin. There may be risks depending on your specific medical condition. Be sure to discuss any concerns with your doctor prior to the procedure. Certain factors or conditions may interfere with the results of the test. These include:

- Severe obesity
- Barium within the intestines from a recent barium procedure
- Intestinal gas.

**Preparation for an abdominal ultrasound?**

EAT/DRINK: For an A.M. appointment, fat free dinner the evening before. Nothing to eat or drink from midnight until after the examination. For a P.M. appointment, clear liquid breakfast (no milk) before 9 A.M. Nothing to eat or drink after breakfast.

MEDICATIONS: You may take your medications with a small amount of water. Based on your medical condition, your doctor may request other specific preparation.

**How to Perform abdominal ultrasound?**

An abdominal ultrasound may be done as an outpatient or as part of your stay in a hospital. Although each facility may have different protocols in place, generally an ultrasound procedure follows this process:

- You will be asked to remove any clothing, jewelry, or other objects that may interfere with the scan.
- If asked to remove clothing, you will be given a gown to wear.
- You will lie on an examination table on your back or side, depending on the specific area of the abdomen to be examined.
• Ultrasound gel is placed on the area of the body that will undergo the ultrasound examination.

• Using a transducer, a device that sends out the ultrasound waves, the ultrasound wave will be sent through the patient's body.

• The sound will be reflected off structures inside the body, and the ultrasound machine will analyze the information from the sound waves.

• The ultrasound machine will create an image of these structures on a monitor. These images will be stored digitally.

There are no confirmed adverse biological effects on patients or instrument operators caused by exposures to ultrasound at the intensity levels used in diagnostic ultrasound. While the abdominal ultrasound procedure itself causes no pain, having to lie still for the length of the procedure may cause slight discomfort, and the clear gel will feel cool and wet. The technologist will use all possible comfort measures and complete the procedure as quickly as possible to minimize any discomfort.

ABDOMINAL X-RAY

X-rays use beams of energy that pass through body tissues onto a special film and make a picture. They show pictures of your internal tissues, bones, and organs. Bone and metal show up as white on X-rays. X-rays of the belly may be done to check the area for causes of abdominal pain. It can also be done to find an object that has been swallowed or to look for a blockage or a hole in the intestine.

Abdominal X-rays may be taken in the following positions:

• Standing up
• Lying flat with the exposure made from above
• Lying flat with the exposure made from the side of the patient
• The left side-lying position may be used for people who can't stand up
When two or more of these views are taken, the set of films may be called an obstruction series. This series of X-rays is done to try to locate a site of an intestinal or abdominal blockage.

**Need an abdominal X-ray**

Abdominal X-rays may be used to diagnose causes of abdominal or belly pain. These can include things such as masses, holes in the intestine, or blockage. Abdominal X-rays may be done before other tests that look at the GI tract or urinary tract. These include an abdominal CT scan and renal or kidney tests. Basic information regarding the size, shape, and position of abdominal organs can be seen with abdominal X-rays. Stones in the gallbladder, kidneys, or ureters may be seen. Calcification of the aorta may also be seen with an abdominal X-ray. There may be other reasons for your health care provider to recommend an abdominal X-ray.

**Risks of an abdominal X-ray**

You may want to ask your health care provider about the amount of radiation used during the procedure. Also ask about the risks related to your particular situation. If you are pregnant or think you may be pregnant, you should tell your health care provider. Being exposed to radiation during pregnancy may lead to birth defects.

There may be other risks depending on your specific medical problem. Be sure to discuss any concerns with your health care provider prior to the procedure. Recent barium X-rays of the abdomen or belly may affect the accuracy of an abdominal X-ray.

**Getting ready for an abdominal X-ray: How?**

- Your health care provider will explain the procedure to you and give you a chance to ask any questions about the procedure.
- Generally, no prior preparation, such as not eating or sedation or drugs to make you sleepy, is required.
- Tell your health care provider and the radiologic technologist if you are pregnant or think you may be pregnant.
Tell your health care provider and radiologic technologist if you have taken a medication that contains bismuth, such as Pepto-Bismol, in the past four days. Medicines that have bismuth may get in the way of the testing procedures.

Based on your medical problem, your health care provider may ask for other specific preparation.

Process of an abdominal X-ray

Abdominal X-rays may be done on an outpatient basis or as part of your hospital stay. Tests and procedures may vary depending on your condition. Generally, abdominal X-rays follow this process:

- You will be asked to remove any clothing, jewelry, or other objects that might get in the way during the procedure.
- If you are asked to remove clothing, you will be given a gown to wear.
- You will be positioned in a way that carefully places the part of the abdomen or belly to be X-rayed between the X-ray machine and the film. You may be asked to stand up, lie flat on a table, or lie on your side on a table, depending on the X-ray view your health care provider has asked for. You may have X-rays taken from more than one position.
- Body parts not being imaged may be covered with a lead apron or shield to limit exposure to the X-rays.
- Once you are positioned, you will be asked to hold still for a few moments while the X-ray is taken. You may be asked to hold your breath at various times during the X-ray. It is very important to stay completely still while the X-ray is taken. Any movement may alter the image and may even require another X-ray to be done.
- The X-ray beam is then focused on the area to be examined.
- The radiologic technologist steps behind a protective window while the image is taken.

While the X-ray procedure itself causes no pain, the manipulation of the body part being examined may cause some discomfort or pain, particularly if you've recently had surgery or
been injured. The radiologic technologist will use all possible comfort measures and complete the procedure as quickly as possible to minimize any discomfort or pain.

What happens after an abdominal X-ray?

Generally there is no special type of care after abdominal X-rays. Your health care provider may give you other instructions, depending on your situation.

BPD/DS WEIGHT-LOSS SURGERY

If you are very-very obese and have tried without success to get your weight under control, your doctor may recommend a weight-loss surgery (bariatric surgery) known as biliopancreatic diversion with duodenal switch (BPD/DS). The surgery has been shown to help reduce obesity and related illnesses, including heart disease, high blood pressure, and especially type 2 diabetes.

BPD/DS is a complex weight-loss surgery that makes it hard to ingest and absorb enough calories, vitamins, and minerals. You’ll be at high risk of developing nutritional deficiencies afterward, including some that can be life-threatening if untreated. When deciding whether to have the surgery, these complications and other surgical risks should be carefully considered along with the benefits.

BPD/DS weight-loss Surgery

Doctors may recommend the BPD/DS to people who are severely obese, usually with a body mass index (BMI) of 50 or greater or a BMI of 40 or greater with serious type 2 diabetes. These health problems include:

- Type 2 diabetes
- Sleep apnea
- Heart disease
- High blood pressure
- High cholesterol
- Nonalcoholic fatty liver disease.
BPD/DS is a complex procedure that tackles weight loss in 3 different ways. First, the surgery takes out a large portion of the stomach to stop you from overeating. With less stomach to fill, you will feel full more quickly and eat less food and fewer calories.

The second part of the procedure reroutes food away from the upper part of the small intestine, which is the natural path of digestion. This cuts back on how many calories and nutrients your body is able to absorb. The third part of the BPD/DS procedure changes the normal way that bile and digestive juices break down food. This cuts back on how many calories you absorb, causing still more weight loss.

**Open vs. laparoscopic BPD/DS**

BPD/DS is done as either laparoscopic or traditional open surgery. In an open surgery, the doctor makes a cut in your belly area long enough to reach the stomach and intestines. Laparoscopic BPD/DS requires 5 to 7 much smaller cuts – typically only about a half-inch to an inch long. And it uses tiny tools with a lighted camera to perform the surgery. Laparoscopic surgery can help you recover more quickly and may reduce the risk for complications such as hernias. People who are quite obese may not be good candidates for laparoscopic BPD/DS. Laparoscopic surgery may also not be appropriate for people who have already had some type of stomach surgery or those with serious medical problems.

**Advantages of the procedure**

The BPD/DS can cause drastic, significant weight loss, because it restricts how much food you can eat and reduces how many calories you can absorb.

**Risks of the procedure**

BPD/DS reduces the absorption of essential vitamins and minerals and can result in serious, long-term complications. People who have BPD/DS may develop anemia, osteoporosis, or kidney stones. Besides, people who have undergone BPD/DS are at high risk for calcium and iron deficiencies, as well as deficiencies in
vitamins A, D, E, and K, the so-called fat soluble vitamins. Although rare, a thiamine deficiency resulting in a condition called beriberi can occur after BPD/DS surgery. Beriberi can permanently damage the nervous system if untreated. Up to 18% of people with a BPD/DS surgery also develop some element of protein-energy malnutrition.

When severe, this condition is known as kwashiorkor, a severe and potentially life-threatening form of malnutrition. If you have BPD/DS surgery, you will need to take vitamin and mineral supplements and have regular blood testing for the rest of your life in order to prevent severe vitamin deficiencies and related complications. Even if you take the supplements as prescribed, you still may develop nutritional problems and require treatment.

Like any surgery, the BPD/DS procedure carries certain risks:

- Internal bleeding
- Infection
- Potentially fatal blood clots in your legs that can move to the lungs or heart
- Hernias
- Death

After the procedure

The American Society for Metabolic and Bariatric Surgery (ASMBS) recommends that doctors prescribe these daily supplements after BPD/DS weight-loss surgery to help prevent nutritional deficiencies:

- Vitamin A, starting 2 to 4 weeks after surgery
- Vitamin D, starting 2 to 4 weeks after surgery
- Vitamin K, starting 2 to 4 weeks after surgery
- Multivitamin with 200% of the daily values, starting the first day after discharge from the hospital
- Minimum of 18 mg to 27 mg of iron, and up to 50 mg to 100 mg a day for menstruating women or adolescents at risk for anemia, starting the first day after discharge
• Calcium supplements, usually taken as 3 doses to 4 doses of 500 mg to 600 mg doses, starting on the first day after your discharge or within the first month after surgery. Note: Don’t take these at the same time as iron supplements; wait a couple of hours.
• Vitamin B₁₂ supplements containing 350 mcg to 500 mcg; some people will need to give themselves B₁₂ injections
• Optional B-complex vitamin
• Up to 3 servings of calcium-rich dairy beverages

The ASMBS also recommends that you eat small but nutritious meals that are high in protein, along with fruits, vegetables, whole grains, and omega-3 fatty acids. You should avoid meals high in sugar. It’s important to understand that following a healthy lifestyle is critical to maintaining weight loss after surgery. This includes eating a healthy diet and getting plenty of regular exercise. And it requires a lifelong commitment. For these reasons, BPD/DS surgery should not be considered a quick fix to lose weight.

CECOSTOMY

Procedure Overview

Cecostomy is a surgical procedure that is used to clear the bowels of fecal matter. It’s typically used for children with fecal incontinence related to severe disorders. Fecal incontinence is the inability to control your bowels, which can involve symptoms ranging from severe constipation to having a bowel movement at an unexpected or embarrassing time.

Children with fecal incontinence often have severe constipation. In some cases, liquid fecal matter bypasses the solid fecal matter and leaks out, which can cause embarrassment and frustration for the child.

Cecostomy differs very little from the traditional enema that is used to relieve constipation. An enema is given directly through the rectum to promote the release of fecal matter. But a cecostomy is known as an “antegrade enema.”
In the cecostomy, a tube (catheter) is used for the procedure. This catheter is inserted into the cecum, which is the first portion of the bowel, or large intestines. The cecum is located in the lower right abdomen. Liquid medication is injected into the cecum through this tube, which helps coax the fecal matter out of the body through the rectum.

**Reasons behind Procedure**

A cecostomy may be needed for very severe constipation that is not responding to laxatives or other methods of relieving the bowels. If constipation is causing severe pain or other potential bodily harm, then your child’s doctor might recommend a cecostomy. Conditions that can lead to severe fecal incontinence that might require a cecostomy include:

- An imperforate anus (the anus isn't allowing material to pass properly)
- Spinal abnormalities, such as spina bifida
- A combination of the two above conditions
- Other muscular conditions

Generally, fecal incontinence has to be very severe and unresponsive to other treatments to require a cecostomy. Most children with fecal incontinence will respond to other methods of treatment that are not quite as invasive.

**Risks of the procedure**

A cecostomy is generally well-tolerated. Still, the procedure does have some risks involved. These comprise:

- Catheter dislodgement
- An infection in the abdomen, known as peritonitis, caused by misplacing the catheter
- Mechanical failure of the catheter
- Growth of tissue at the catheter site
- Bleeding and irritation at the catheter site
- Skin infections and other infections around the insertion point for the catheter
Before the procedure

- Before the cecostomy tube can be inserted, a “bowel prep” may be completed to cleanse the colon.
- The bowel preparation includes following a clear-fluid diet for two days before the procedure.
- The night before the procedure, your child will likely need to drink an oral solution provided by the doctor. This is a laxative that is used to clean out the bowels.
- On the day of the procedure, an abdominal X-ray will be used to ensure that the bowel is free of stool.

During the procedure

The cecostomy tube insertion procedure is one that needs a brief hospital stay, usually around one or two days. This is a general guideline of how the procedure will go:

- Doctors will usually use IV sedation (relaxed while awake for the procedure) or a general anesthesia (asleep for the procedure) for cecostomy tube insertion.
- Doctors usually inflate the colon with air until the cecum is distended.
- The doctor inserts surgical tools through the skin and into the cecum and attaches the bowel to the abdominal wall with stitches, sutures, or fasteners.
- The doctor inserts a special hollow needle into the cecum.
- A catheter, or narrow tube, is threaded through this needle and into the cecum.

This procedure can also be done laparoscopically. This technique involves placing a laparoscope into the belly button.

The process outlined above is what is required to insert the cecostomy tube. The process of a cecostomy itself will then be done occasionally to relieve the bowels based on individual needs.

After the procedure

Once the cecostomy tube has been inserted, your child will generally stay in the hospital until the next day for observation and to minimize the risks of complications. Your child may need
to return to the doctor for a “contrast study.” To more sure that the catheter is placed properly. For this test, contrast dye is injected through the catheter and into the cecum. Then an X-ray is used to examine this dye and ensure that it travels into the cecum. Your child may also need to return for replacement of the original catheter tube. The insertion of the cecostomy tube is just the first step in relieving fecal incontinence through the process of cecostomy. After about a week, you will give your child an antegrade enema through the cecostomy tube at home, with guidance from your child’s doctor.

This process will involve inserting liquid into the cecostomy tube, which will pass into the cecum to encourage a bowel movement. The frequency of the antegrade enemas through the cecostomy tube that you’ll require to do will vary based on your child’s needs. Your child’s doctor will give you with guidance in this area. Tell your child’s doctor about any of the following:

- A noticeable skin infection at the catheter site
- Bleeding or swelling at the site
- Pus leaking from the site
- The catheter becomes dislodged or moves
- Abdominal pain
- Fever

For hygiene and to avoid the risk of complications, your child will likely need to have the catheter removed and replaced occasionally.

**CHOLECYSTECTOMY**

A cholecystectomy is surgery to remove your gallbladder. The gallbladder is a small organ under your liver. It is on the upper right side of your belly or abdomen. The gallbladder stores a digestive juice called bile which is made in the liver.

There are 2 types of surgery to remove the gallbladder:

- Open (traditional) method. In this method, 1 cut (incision) about 4 to 6 inches long is made in the upper right-hand
side of your belly. The surgeon finds the gallbladder and takes it out through the incision.

- Laparoscopic method. This method uses 3 to 4 very small incisions. It uses a long, thin tube called a laparoscope. The tube has a tiny video camera and surgical tools. The tube, camera and tools are put in through the incisions. The surgeon does the surgery while looking at a TV monitor. The gallbladder is removed through 1 of the incisions.

A laparoscopic cholecystectomy is less invasive. That means it uses very small incisions in your belly. There is less bleeding. The recovery time is usually shorter than an open surgery. In some cases the laparoscope may show that your gallbladder is very diseased. Or it may show other problems. Then the surgeon may have to use an open surgery method to remove your gallbladder safely.

**Need of a Cholecystectomy**

A cholecystectomy may be done if your gallbladder:

- Has lumps of solid material (gallstones)
- Is red or swollen (inflamed), or infected (cholecystitis)
- Is cancerous

Gallbladder problems may cause pain which:

- Is usually on the right side of your upper belly
- May be constant or may get worse after a heavy meal
- May sometimes feel more like fullness than pain
- May be felt in your back and in the tip of your right shoulder blade

Other symptoms may include nausea, vomiting, fever, and chills. The symptoms of gallbladder problems may look like other health problems. Always see your health care provider to be sure. Your health care provider may have other reasons to recommend a cholecystectomy.

**Risks of a Cholecystectomy**

Some possible complications of a cholecystectomy may include:

- Bleeding
• Infection
• Injury to the tube (the bile duct) that carries bile from the gallbladder to the small intestine
• Liver injury
• Scars and a numb feeling at the incision site
• A bulging of organ or tissue (a hernia) at the incision site

During a laparoscopic procedure, surgical tools are put into your belly. This may hurt your intestines or blood vessels. You may have other risks that are unique to you. Be sure to discuss any concerns with your health care provider before the procedure.

How do I get ready for a cholecystectomy?
• Your health care provider will explain the procedure to you. Ask him or her any questions you have.
• You may be asked to sign a consent form that gives permission for the procedure. Read the form carefully and ask questions if anything is not clear.
• Your provider will ask questions about your past health. He or she may also give you a physical exam. This is to make sure you are in good health before the procedure. You may also need blood tests and other diagnostic tests.
• You must not eat or drink for 8 hours before the procedure. This often means no food or drink after midnight.
• Tell your provider if you are pregnant or think you may be pregnant.
• Tell your provider if you are sensitive to or allergic to any medicines, latex, tape, and anesthesia medicines (local and general).
• Tell your provider about all the medicines you take. This includes both over-the-counter and prescription medicines. It also includes vitamins, herbs, and other supplements.
• Tell your provider if you have a history of bleeding disorders. Let your provider know if you are taking any blood-thinning medicines, aspirin, ibuprofen, or other medicines that affect blood clotting. You may need to stop taking these medicines before the procedure.
If this is an outpatient procedure, you will need to have someone drive you home afterward. You won’t be able to drive because of the medicine given to relax you before and during the procedure.

Follow any other instructions your provider gives you to get ready.

**Process of Cholecystectomy**

You may have a cholecystectomy as an outpatient or as part of your stay in a hospital. The way the surgery is done may vary depending on your condition and your health care provider’s practices. A cholecystectomy is generally done while you are given medicines to put you into a deep sleep (under general anesthesia).

Generally, a cholecystectomy follows this process:

- You will be asked to take off any jewelry or other objects that might interfere during surgery.
- You will be asked to remove clothing and be given a gown to wear.
- An intravenous (IV) line will be put in your arm or hand.
- You will be placed on your back on the operating table. The anesthesia will be started.
- A tube will be put down your throat to help you breathe. The anesthesiologist will check your heart rate, blood pressure, breathing, and blood oxygen level during the surgery.
- If there is a lot of hair at the surgical site, it may be clipped off.
- The skin over the surgical site will be cleaned with a sterile (antiseptic) solution.

**Open method cholecystectomy**

- An incision will be made. The incision may slant under your ribs on the right side of your abdomen. Or it may be made in the upper part of your abdomen.
- Your gallbladder is removed.
- In some cases, 1 or more drains may be put into the incision. This allows drainage of fluids or pus.
Laparoscopic method cholecystectomy

- About 3 or 4 small incisions will be made in your abdomen. Carbon dioxide gas will be put into your abdomen so that it swells up. This lets the gallbladder and nearby organs be easily seen.
- The laparoscope will be put into an incision. Surgical tools will be put through the other incisions to remove your gallbladder.
- When the surgery is done, the laparoscope and tools are removed. The carbon dioxide gas is let out through the incisions.

Procedure completion, both methods

- The gallbladder will be sent to a lab for testing
- The incisions will be closed with stitches or surgical staples
- A sterile bandage or dressing or adhesive strips will be used to cover the wounds

After a Cholecystectomy

**In the Hospital**

After the procedure, you will be taken to the recovery room to be watched. Your recovery process will depend on the type of surgery and the type of anesthesia you had. Once your blood pressure, pulse, and breathing are stable and you are awake and alert, you will be taken to your hospital room. A laparoscopic cholecystectomy may be done on an outpatient basis. In this case, you may be discharged home from the recovery room.

You will get pain medicine as required. A nurse may give it to you. Or you may give it to yourself through a device connected to your IV (intravenous) line. You may have a thin plastic tube that goes through your nose into your stomach. This is to remove air that you swallow. The tube will be taken out when your bowels are working normally. You won’t be able to eat or drink until the tube is removed.

You may have 1 or more drains in the incision if an open procedure was done. The drains will be removed in a day or so.
You might be discharged with the drain still in and covered with a dressing. Follow your provider’s instructions for taking care of it. You will be asked to get out of bed a few hours after a laparoscopic procedure or by the next day after an open procedure.

Depending on your situation, you may be given liquids to drink a few hours after surgery. You will slowly be able to eat more solid foods as tolerated. Arrangements will be made for a follow-up visit with your provider. This is usually 2 to 3 weeks after surgery.

At home

Once you are home, it’s important to keep the incision clean and dry. Your provider will give you specific bathing instructions. If stitches or surgical staples are used, they will be removed during a follow-up office visit. If adhesive strips are used, they should be kept dry and usually will fall off within a few days. The incision and your abdominal muscles may ache, especially after long periods of standing. If you had a laparoscopic surgery, you may feel pain from any carbon dioxide gas still in your belly. This pain may last for a few days. It should feel a bit better each day.

Take a pain reliever as recommended by your provider. Aspirin or other pain medicines may raise your risk of bleeding. Be sure to take only medicines your health care provider has approved. Walking and limited movement are generally fine. But you should avoid strenuous activity. Your provider will tell you when you can return to work and go back to normal activities.

Call your provider if you have any of the following:
- Fever or chills
- Redness, swelling, bleeding, or other drainage from the incision site
- More pain around the incision site
- Yellowing of your skin or the whites of your eyes (jaundice)
- Belly or abdominal pain, cramping, or swelling
- No bowel movement or gas for 3 days
- Pain behind your breastbone
GASTRIC BANDING SURGERY FOR TEENS

Gastric banding is a form of weight-loss (bariatric) surgery. It is used to treat people with severe obesity who have trouble losing weight through diet or exercise alone.

Procedure Overview

Gastric banding involves putting a small, bracelet-like band around the area near the top of the stomach. The band is put close to where the esophagus leads into the stomach. The band makes that part of the stomach much smaller. It is about the size of a golf ball. This small size decreases the amount of food the person can eat. A doctor can control the size of the opening by inflating or deflating a balloon that is inside the band.

Weight-loss surgery and Teens

Some studies suggest that weight-loss surgery for extremely obese teens may improve both their weight and their health. By losing a lot of weight, your teen may avoid health problems linked to obesity. These include type 2 diabetes, sleep apnea, high blood pressure, and heart disease. After the operation, your teen may also escape the bullying, teasing, and social problems that some overweight teens experience. But experts are unsure about the long-term consequences of gastric banding for a teen’s developing body. Weight-loss surgery may weaken teens’ bones, for example. A recent study found that teens who had weight-loss surgery lost an average of 7.4% of their bone mass. Because the teen years mark the peak of bone development, the researchers urge that teens be carefully monitored after the surgery.

Risks and possible Complications

Like all operations, weight-loss surgery also involves some risk. This includes hernia, infection, internal bleeding, blood clots, and death. Your teen will also have to make permanent changes in his or her lifestyle. This means eating only small amounts of food and taking daily vitamin and mineral supplements. These are things that impulsive teenagers may not want to do. When
your teen eats, the small pouch at the top of the stomach will fill up quickly. As a result, your teen will feel full after eating a small amount of food. The pouch then empties slowly into the bottom part of the stomach.

Once the gastric band is in place, eating more than the pouch can handle can lead to vomiting and other problems. Your teenager may also have problems if the gastric band erodes or slips out of place.

For these reasons, doctors will generally advise the surgery only if a teen has tried to lose weight for at least 6 months without success and has other health problems such as type 2 diabetes. Because data on long-term studies are not yet in, the New England Journal of Medicine recommends that such surgeries for teens be used only for those who are “morbidly obese.”

This means teens who have a body mass index (BMI) of at least 40 and have other health conditions, or those who have a BMI of 50 or more.

Other criteria your child should meet:

- Your teen should have reached physical maturity.
- Your teen should be mentally and emotionally mature.
- Your teen should have a supportive family.
- Your teen should not have an untreated eating disorder or mental illness.
- The weight-loss surgery should be done only in a bariatric center with enough medical staff.

**Before the Procedure**

- A gastric banding procedure is a major life change that your teen requires to take seriously. Your teen will likely be asked to take classes that explain what is involved with the procedure. He or she will learn what life will be like after the procedure, especially diet.
- Your teen will also need to have ultrasounds, blood tests, and other tests to make sure that he or she is healthy enough for surgery.
• Your teen may need to see a mental health counselor to make sure he or she is mentally ready for the surgery.
• Your teen will also need a complete physical exam.
• The doctor may ask your teen to stop taking certain medicines during the week leading up to the surgery.
• Be sure your teen does not eat or drink anything starting at midnight the night before the surgery.

Based upon your teen’s health condition, the doctor may ask for other specific preparations.

**During the Procedure**

A gastric banding surgery generally needs a hospital stay of about 24 hours. Your teen may be asked to check in the day before or the morning of the procedure. Procedures may vary, depending on your teen’s specific condition and the doctor’s practices. Generally, a gastric banding surgery follows this process:

• Your teen will get general anesthesia before the surgery. Your teen will be completely asleep during the procedure.
• The surgeon will make 1 to 5 small cuts in the belly (abdomen).
• Through these small cuts, the surgeon will place instruments needed to do the surgery. These comprise a small camera that lets the surgeon see what he or she is doing during the surgery.
• Using these tools and camera, the surgeon will put a small, flexible band around the top part of the stomach. This divides the stomach into a small pouch at the top and a larger lower part.
• The procedure may take 30 to 60 minutes, depending on how complicated it is.

**After the Procedure**

After gastric banding surgery, it’s normal for your teen to feel some pain and discomfort. This is generally treated with general pain relievers. Your teen’s healthcare team may also try to get him or her up and walking. This will help your teen recover faster.
On the day after surgery, your teen will perhaps have an X-ray to make sure that the gastric band is working properly. He or she may be asked to swallow a liquid that can be seen on the X-ray.

Eating will be much different after the surgery. The counseling done before the surgery is meant to help get your teen ready for this.

GASTRIC BYPASS (MALABSORPTIVE) SURGERY PROCEDURE

Gastric bypass surgery, a type of bariatric surgery (weight loss surgery), is a procedure that alters the process of digestion. Bariatric surgery is the only option today that effectively treats morbid obesity in people for whom more conservative measures such as diet, exercise, and medication have not been effective.

Bariatric surgery works in one of three ways:
- Restriction, or limiting the amount of food intake by reducing the size of the stomach
- Malabsorption, or limiting the absorption of foods in the intestinal tract by “bypassing” a portion of the small intestine to varying degrees
- Combination of both restriction and malabsorption

At present, in the U.S., five types of bariatric surgical procedures are generally used to obtain continued weight loss. The purely restrictive bariatric surgeries are called gastric banding or gastric stapling. The biliopancreatic diversion with or without duodenal switch (BPD-DS) is mainly a malabsorptive bariatric surgery. Gastric bypass surgery is a combination of both restriction and malabsorption. Types of bariatric surgical procedures that involve gastric bypass to some degree include:

**Roux-en-Y Gastric Bypass (RYGBP)**

Roux-en-Y gastric bypass is the generally performed bariatric procedure. It works by combining both restrictive and malabsorptive elements. The restrictive element can be achieved
by stapling the stomach into two sections. The top section becomes a small pouch that serves as the “new” stomach. The small size of this newly formed stomach is so reduced that it “restricts” or limits the amount of food intake.

It also provides a feeling of fullness and satisfaction with smaller portions of food. The lower section of the stomach no longer receives, stores, and mixes food but remains functional by continuing to secrete digestive juices.

The malabsorptive element in gastric bypass is achieved by surgically dividing the small intestine in a certain area. Once divided, the lower part of the intestine (jejunum) is pulled up to directly connect to the small pouch or “new” stomach. The other end of this divided intestine is surgically sewn back at a specific point further down the small intestine. The shape of the intestine now somewhat resembles a “Y.”

As a result, when food is eaten, it enters the “new” stomach, then travels into the jejunum, first “bypassing” the upper part of the intestine. The effect of bypassing the upper portion of the intestine decreases the amount of calories and nutrients that are absorbed into the body. This surgery can result in two-thirds of excess weight loss within two years. Because of the malabsorption, this increases the risk of nutritional deficiencies. Therefore, after surgery, it will be significant to follow the physician’s guidelines for nutritional supplementation.

The Roux-en-Y gastric bypass may be performed with a laparoscope rather than through an open incision in some patients. This procedure uses several small incisions and three or more laparoscopes, small thin tubes with video cameras attached, to visualize the inside of the abdomen during the operation.

The surgeon performs the surgery while looking at a TV monitor. People with a Body Mass Index (BMI) of 60 or more or those who have already had some type of abdominal surgery are generally not considered for this technique. A laparoscopic method allows the physician to make a series of much smaller incisions.
Laparoscopic gastric bypass usually reduces the length of hospital stay, the amount of scarring, and results in quicker recovery than an open procedure.

**Biliopancreatic Diversion (BPD)**

A biliopancreatic diversion is mainly malabsorptive, and is a more complicated procedure than the Roux-en-Y gastric bypass. In this procedure a part of the lower stomach is removed. The part of stomach that is left is connected directly to the last part of the small intestine (jejunum). As food is digested, it completely bypasses a larger section of the small intestine than in the Roux-en-Y gastric bypass. This surgery may result in a greater degree of malabsorption than the Roux-en-Y, resulting in greater nutritional deficiencies. It is not as commonly performed.

A variation of the biliopancreatic diversion is a procedure called the duodenal switch (BPD-DS). This adaptation retains the part of the stomach that includes the valve that controls the release of food into the small intestine. This helps to prevent the “dumping syndrome” which can result in vomiting or diarrhea. A small part of the upper intestine (duodenum) is also retained.

**Need of Gastric bypass Surgery**

Bariatric surgery is performed because it is currently the best treatment option for producing lasting weight loss in obese patients for whom nonsurgical methods of weight loss have not been effective.

Potential candidates for bariatric surgery comprise:

- People with a body mass index (BMI) greater than 40
- Men who are 100 pounds over their ideal body weight or women who are 80 pounds over their ideal body weight
- People with a BMI of 35 or more who have another condition such as obesity-related type 2 diabetes, sleep apnea, or heart disease

Because the surgery can have serious side effects, the long-term health benefits must be considered and found greater than
the risk. Inspite of the fact that some surgical techniques can be done laparoscopically with reduced risk, all bariatric surgery is considered to be major surgery.

Although not all risks with each procedure are very known, bariatric surgery does help many people to reduce or eliminate some health-related obesity problems. It may help to:

- Lower blood sugar
- Lower blood pressure
- Reduce or eliminate sleep apnea
- Decrease the workload of the heart
- Lower cholesterol levels

Surgery for weight loss is not a universal remedy, but these procedures can be highly effective in people who are motivated after surgery to follow their physician’s guidelines for nutrition and exercise and to take nutritional supplements. There may be other reasons for your physician to recommend a gastric bypass procedure.

**Risks of gastric bypass Surgery**

As with any surgical procedure, complications may occur. Some possible complications include, but are not limited to, the following:

- Infection
- Blood clots
- Pneumonia
- Bleeding ulcer
- Development of gallstones
- Gastrointestinal hemorrhage

With the Roux-en-Y gastric bypass procedure, and especially the biliopancreatic diversion procedure, malabsorptive symptoms may be more serious with an increased risk of anemia and loss of fat-soluble vitamins (vitamins A, D, E, and K). Adequate amounts of iron, calcium, and vitamin B₁₂ may not be absorbed. This can cause metabolic bone disease and osteoporosis.
Stomal stenosis occurs when there is a stricture (tightening) of the opening between the stomach and intestine after a Roux-en-Y procedure. When this occurs, vomiting after eating and sometimes after drinking may occur. Stomal stenosis can be treated easily but should be treated immediately.

“Dumping syndrome” is also very likely to occur with these procedures because the food in the stomach moves to the intestines quickly. Symptoms include nausea, sweating, fainting, light-headedness, tachycardia, palpitations, desire to lie down, loss of concentration, weakness, and/or diarrhea. Almost 85 percent of patients who have gastric bypass surgery will experience this syndrome after the procedure.

There is a risk that additional surgery may be necessary because of complications, comprising gallstones. One of the most serious complications of gastric bypass is a stomach leak that can cause peritonitis to develop. Peritonitis is an inflammation of the peritoneum, the smooth membrane that lines the cavity of the abdomen. There may be other risks depending upon your specific medical condition. Be sure to discuss any concerns with your physician prior to the procedure.

Getting ready for gastric bypass surgery: how?

- Your physician will explain the procedure to you and offer you the opportunity to ask any questions that you might have about the procedure.
- You will be asked to sign a consent form that gives your physician permission to perform the procedure. Read the form carefully and ask questions if something is unclear.
- In addition to a complete medical history, your physician may perform a complete physical examination to ensure you are in good health before undergoing the procedure. You may undergo blood tests or other diagnostic tests.
- You will be asked to fast for eight hours before the procedure, generally after midnight.
- If you are pregnant or suspect that you are pregnant, you should notify your physician.
• Notify your physician if you are sensitive to or are allergic to any medications, latex, iodine, tape, or anesthetic agents (local and general).
• Notify your physician of all medications (prescription and over-the-counter) and herbal supplements that you are taking.
• Notify your physician if you have a history of bleeding disorders or if you are taking any anticoagulant (blood-thinning) medications, aspirin, ibuprofen, naprosyn, or other medications that affect blood clotting. It may be necessary for you to stop some of these medications prior to the procedure.
• You may be asked to begin exercising and alter your diet several weeks before surgery.
• If you are a woman of child-bearing age, you may receive birth control counseling so that you do not become pregnant in your first year after surgery due to the risk to the fetus from rapid weight loss.
• You may receive a sedative prior to the procedure to help you relax.
• Based upon your medical condition, your physician may request other specific preparation.

Process of gastric bypass surgery: Gastric bypass surgery requires a stay in the hospital. Procedures may vary depending on which type of procedure is performed and your physician’s practices. Gastric bypass is generally performed while you are asleep under general anesthesia.

Generally, gastric bypass surgery follows this process:
• You will be asked to remove clothing and will be given a gown to wear.
• An intravenous (IV) line will be started in your arm or hand.
• You will be positioned lying on your back on the operating table.
• A urinary catheter may be inserted into your bladder.
• If there is excessive hair at the surgical site, it may be clipped off.
• The anesthesiologist will continuously monitor your heart rate, blood pressure, breathing, and blood oxygen level during the surgery.
• The skin over the surgical site will be cleansed with an antiseptic solution.
• For an open procedure, the physician will make a single large incision in the abdominal area. For a laparoscopic procedure, a series of small incisions will be made on the abdomen. Carbon dioxide gas will be introduced into the abdomen to inflate the abdominal cavity so that the stomach and other structures can easily be visualized with the laparoscope.
• For an open procedure, the abdominal muscles will be separated and the abdominal cavity will be opened. For a laparoscopic procedure, the physician will insert the laparoscope and other small instruments.
• For a Roux-en-Y gastric bypass, the physician will staple the stomach across the top to create a new small pouch for a stomach. The rest of the stomach will be separated from the new pouch and closed off by the staples; however, the remaining stomach will continue to produce digestive juices that will be used in digestion. A portion of the small intestine will be shaped like a “Y” and connected to the pouch.
• For a biliopancreatic diversion, a large part of the lower stomach will be removed. The small part of stomach that is left is then connected directly to the last part of the small intestine. For a duodenal switch procedure, the physician will retain more of the stomach, including the valve that controls the release of food into the small intestine. A small part of the duodenum will also be kept.
• A drain may be placed in the incision site to remove fluid.
• The incision will be closed with sutures or surgical staples.
• A sterile bandage/dressing will be applied.
Gastric bypass Surgery after the Procedure

In the Hospital

After the procedure, you will be taken to the recovery room for observation. Once your blood pressure, pulse, and breathing are stable and you are alert, you will be taken to your hospital room. Weight loss surgery generally needs an in-hospital stay of several days. You may receive pain medication as needed, either by a nurse or by administering it yourself through a device connected to your intravenous line.

You are encouraged to move around as tolerated while you are in bed, and then to get out of bed and walk around as your strength improves. This is very important, as it helps to prevent blood clots from forming.

At first you will receive fluids through an IV. After a day or two you will be given liquids, such as broth or clear juice, to drink. As you are able to tolerate liquids, you will be given thicker liquids, such as pudding, milk, or cream soup, followed by foods that you do not have to chew, such as hot cereal or pureed foods. Your physician will instruct you about how long to eat pureed foods after surgery. By one month after your procedure, you may be eating solid foods. You will be instructed about taking nutritional supplements to replace the nutrients lost due to the reconstruction of the digestive tract.

Before you are discharged from the hospital, arrangements will be made for a follow-up visit with your physician.

At home

Once you are home, it will be significant to keep the surgical area clean and dry. Your physician will give you specific bathing instructions. The sutures or surgical staples will be removed during a follow-up visit. The incision and abdominal muscles may ache, particularly with deep breathing, coughing, and exertion. Take a pain reliever for soreness as recommended by your physician. Aspirin or certain other pain medications may increase the chance
of bleeding. Be sure to take only recommended medications. You should continue the breathing exercises used in the hospital. You should gradually increase your physical activity as tolerated. It may take several weeks to return to your previous levels of stamina.

You may be instructed to avoid lifting heavy items for several months in order to prevent strain on your abdominal muscles and surgical incision. Weight loss surgery can be emotionally difficult because you will be adjusting to new dietary habits and a body in the process of change. You may feel especially tired during the first month following surgery. Exercise and attending a support group may be helpful at this time.

Notify your physician to report any of the following:

- Fever and/or chills
- Redness, swelling, or bleeding or other drainage from the incision site
- Increased pain around the incision site

Following gastric bypass surgery, your physician may give you additional or alternate instructions, depending on your particular situation.
INTRODUCTION

Liver disease (also known as hepatic disease) is a type of damage to or disease of the liver.

ASSOCIATED MEDICAL CONDITIONS

Types

There are more than a hundred kinds of liver disease, these are some of the most common:

- Fascioliasis, a parasitic infection of liver caused by a Liver fluke of the *Fasciola* genus, mostly the *Fasciola hepatica*.
- Hepatitis, inflammation of the liver, is caused by various viruses (viral hepatitis) also by some liver toxins (e.g. alcoholic hepatitis), autoimmunity (autoimmune hepatitis) or hereditary conditions.
- Alcoholic liver disease is a hepatic manifestation of alcohol overconsumption, including fatty liver disease, alcoholic hepatitis, and cirrhosis. Analogous terms such as “drug-induced” or “toxic” liver disease are also used to refer to disorders caused by various drugs.
• Fatty liver disease (hepatic steatosis) is a reversible condition where large vacuoles of triglyceride fat accumulate in liver cells. Non-alcoholic fatty liver disease is a spectrum of disease associated with obesity and metabolic syndrome.

• Hereditary diseases that cause damage to the liver include hemochromatosis, involving accumulation of iron in the body, and Wilson’s disease. Liver damage is also a clinical feature of alpha 1-antitrypsin deficiency and glycogen storage disease type II.

• In transthyretin-related hereditary amyloidosis, the liver produces a mutated transthyretin protein which has severe neurodegenerative and/or cardiopathic effects. Liver transplantation can give a curative treatment option.

• Gilbert's syndrome, a genetic disorder of bilirubin metabolism found in a small percent of the population, can cause mild jaundice.

• Cirrhosis is the formation of fibrous tissue (fibrosis) in the place of liver cells that have died due to a variety of causes, including viral hepatitis, alcohol overconsumption, and other forms of liver toxicity. Cirrhosis causes chronic liver failure.

• Primary liver cancer most commonly manifests as hepatocellular carcinoma and/or cholangiocarcinoma; rarer forms include angiosarcoma and hemangiosarcoma of the liver. (Many liver malignancies are secondary lesions that have metastasized from primary cancers in the gastrointestinal tract and other organs, such as the kidneys, lungs.)

• Primary biliary cirrhosis is a serious autoimmune disease of the bile capillaries.

• Primary sclerosing cholangitis is a serious chronic inflammatory disease of the bile duct, which is believed to be autoimmune in origin.

• Budd–Chiari syndrome is the clinical picture caused by occlusion of the hepatic vein.
Liver disease can occur through several mechanisms. A common form of liver disease is viral infection. Viral hepatitides such as Hepatitis B virus and Hepatitis C virus can be vertically transmitted during birth via contact with infected blood. According to a 2012 NICE publication, “about 85% of hepatitis B infections in newborns become chronic”. In occult cases, Hepatitis B virus is present by HBVDNA, but testing for HBsAg is negative. High consumption of alcohol can lead to several forms of liver disease including alcoholic hepatitis, alcoholic fatty liver disease, cirrhosis, and liver cancer. In the earlier stages of alcoholic liver disease, fat builds up in the liver’s cells due to increased creation of triglycerides and fatty acids and a decreased ability to break down fatty acids. Progression of the disease can lead to liver inflammation from the excess fat in the liver. Scarring in the liver often occurs as the body attempts to heal and extensive scarring can lead to the development
of cirrhosis in more advanced stages of the disease. Approximately 3-10% of individuals with cirrhosis develop a form of liver cancer known as hepatocellular carcinoma.

**Diagnosis**

A number of liver function tests (LFTs) are available to test the proper function of the liver. These test for the presence of enzymes in blood that are normally most abundant in liver tissue, metabolites or products. serum proteins, serum albumin, serum globulin, alanine transaminase, aspartate transaminase, prothrombin time, partial thromboplastin time.

**Treatment**

Anti-viral medications are available to treat infections such as hepatitis B. Other conditions may be managed by slowing down disease progression, for example:

- By using steroid-based drugs in autoimmune hepatitis.
- Regularly removing a quantity of blood from a vein (venesection) in the iron overload condition, hemochromatosis.
- Wilson’s disease, a condition where copper builds up in the body, can be managed with drugs which bind copper allowing it to be passed from your body in urine.
- In cholestatic liver disease, (where the flow of bile is affected due to cystic fibrosis) a medication called ursodeoxycholic acid (URSO, also referred to as UDCA) may be given.

**ALCOHOLIC LIVER DISEASE**

Alcoholic liver disease is a term that encompasses the liver manifestations of alcoholoverconsumption, including fatty liver, alcoholic hepatitis, and chronic hepatitis with liver fibrosis or cirrhosis.

It is the major cause of liver disease in Western countries. Although steatosis (fatty liver) will develop in any individual who consumes a large quantity of alcoholic beverages over a long period of time, this process is transient and reversible. Of all
chronic heavy drinkers, only 15–20% develop hepatitis or cirrhosis, which can occur concomitantly or in succession. The mechanism behind this is not completely understood. 80% of alcohol passes through the liver to be detoxified. Chronic consumption of alcohol results in the secretion of pro-inflammatory cytokines (TNF-alpha, Interleukin 6 [IL6] and Interleukin 8 [IL8]), oxidative stress, lipid peroxidation, and acetaldehyde toxicity. These factors cause inflammation, apoptosis and eventually fibrosis of liver cells. Why this occurs in only a few individuals is still unclear. Additionally, the liver has tremendous capacity to regenerate and even when 75% of hepatocytes are dead, it continues to function as normal.

**Risk factors**

The risk factors presently known are:

- **Quantity of alcohol taken:** Consumption of 60–80g per day (about 75–100 mL/day) for 20 years or more in men, or 20g/day (about 25 mL/day) for women significantly increases the risk of hepatitis and fibrosis by 7 to 47%.
- **Pattern of drinking:** Drinking outside of meal times increases up to 3 times the risk of alcoholic liver disease.
- **Gender:** Women are twice as susceptible to alcohol-related liver disease, and may develop alcoholic liver disease with shorter durations and doses of chronic consumption. The lesser amount of alcohol dehydrogenase secreted in the gut, higher proportion of body fat in women, and changes in fat absorption due to the menstrual cycle may explain this phenomenon.
- **Hepatitis C infection:** A concomitant hepatitis C infection significantly accelerates the process of liver injury.
- **Genetic factors:** Genetic factors predispose both to alcoholism and to alcoholic liver disease. Both monozygotic twins are more likely to be alcoholics and to develop liver cirrhosis than both dizygotic twins. Polymorphisms in the enzymes involved in the metabolism of alcohol, such as ADH, ALDH, CYP4502E1, mitochondrial dysfunction, and cytokine polymorphism may partly explain this genetic
component. However, no specific polymorphisms have currently been firmly linked to alcoholic liver disease.

- Iron overload (Hemochromatosis)
- Diet: Malnutrition, particularly vitamin A and E deficiencies, can worsen alcohol-induced liver damage by preventing regeneration of hepatocytes. This is particularly a concern as alcoholics are usually malnourished because of a poor diet, anorexia, and encephalopathy.

Pathophysiology

Pathogenesis of alcohol induced liver injury

**Fatty change**

Fatty change, or steatosis is the accumulation of fatty acids in liver cells. These can be seen as fatty globules under the microscope.
Alcoholism causes development of large fatty globules (macrovesicular steatosis) throughout the liver and can begin to occur after a few days of heavy drinking. Alcohol is metabolized by alcohol dehydrogenase (ADH) into acetaldehyde, then further metabolized by aldehyde dehydrogenase (ALDH) into acetic acid, which is finally oxidized into carbon dioxide (CO₂) and water (H₂O). This process generates NADH, and increases the NADH/NAD⁺ ratio. A higher NADH concentration induces fatty acid synthesis while a decreased NAD level results in decreased fatty acid oxidation. Subsequently, the higher levels of fatty acids signal the liver cells to compound it to glycerol to form triglycerides. These triglycerides accumulate, resulting in fatty liver.

**Alcoholic hepatitis**

Alcoholic hepatitis is characterized by the inflammation of hepatocytes. Between 10% and 35% of heavy drinkers develop alcoholic hepatitis (NIAAA, 1993). While development of hepatitis is not directly related to the dose of alcohol, some people seem more prone to this reaction than others. This is called alcoholic steato necrosis and the inflammation appears to predispose to liver fibrosis. Inflammatory cytokines (TNF-alpha, IL6 and IL8) are thought to be essential in the initiation and perpetuation of liver injury by inducing apoptosis and necrosis. One possible mechanism for the increased activity of TNF-α is the increased intestinal permeability due to liver disease. This facilitates the absorption of the gut-produced endotoxin into the portal circulation. The Kupffer cells of the liver then phagocytose endotoxin, stimulating the release of TNF-α. TNF-α then triggers apoptotic pathways through the activation of caspases, resulting in cell death.

**Cirrhosis**

Cirrhosis is a late stage of serious liver disease marked by inflammation (swelling), fibrosis (cellular hardening) and damaged membranes preventing detoxification of chemicals in the body, ending in scarring and necrosis (cell death). Between 10% to 20% of heavy drinkers will develop cirrhosis of the liver (NIAAA,
Acetaldehyde may be responsible for alcohol-induced fibrosis by stimulating collagen deposition by hepatic stellate cells. The production of oxidants derived from NADPH oxidase and/or cytochrome P-450 2E1 and the formation of acetaldehyde-protein adducts damage the cell membrane. Symptoms include jaundice (yellowing), liver enlargement, and pain and tenderness from the structural changes in damaged liver architecture. Without total abstinence from alcohol use, cirrhosis will eventually lead to liver failure. Late complications of cirrhosis or liver failure include portal hypertension (high blood pressure in the portal vein due to the increased flow resistance through the damaged liver), coagulation disorders (due to impaired production of coagulation factors), ascites (heavy abdominal swelling due to buildup of fluids in the tissues) and other complications, including hepatic encephalopathy and the hepatorenal syndrome. Cirrhosis can also result from other causes than alcohol abuse, such as viral hepatitis and heavy exposure to toxins other than alcohol. The late stages of cirrhosis may look similar medically, regardless of cause. This phenomenon is termed the “final common pathway” for the disease. Fatty change and alcoholic hepatitis with abstinence can be reversible. The later stages of fibrosis and cirrhosis tend to be irreversible, but can usually be contained with abstinence for long periods of time.

Diagnosis

In the early stages, patients with ALD exhibit subtle and often no abnormal physical findings. It is usually not until development of advanced liver disease that stigmata of chronic liver disease become apparent. Early ALD is usually discovered during routine health examinations when liver enzyme levels are found to be elevated. These usually reflect alcoholic hepatic steatosis. Microvesicular and macrovesicular steatosis with inflammation are seen in liver biopsy specimens. These histologic features of ALD are indistinguishable from those of nonalcoholic fatty liver disease. Steatosis usually resolves after discontinuation of alcohol use. Continuation of alcohol use will result in a higher
risk of progression of liver disease and cirrhosis. In patients with acute alcoholic hepatitis, clinical manifestations include fever, jaundice, hepatomegaly, and possible hepatic decompensation with hepatic encephalopathy, variceal bleeding, and ascites accumulation. Tender hepatomegaly may be present, but abdominal pain is unusual. Occasionally, the patient may be asymptomatic.

**Laboratory findings**

In people with alcoholic hepatitis, the serum aspartate aminotransferase (AST) to alanine aminotransferase (ALT) ratio is greater than 2:1. AST and ALT levels are almost always less than 500. The elevated AST to ALT ratio is due to deficiency of pyridoxal-6-phosphate, which is required in the ALT enzyme synthetic pathway. Furthermore, alcohol metabolite-induced injury of hepatic mitochondria results in AST isoenzyme release.

Other laboratory findings include red blood cell macrocytosis (mean corpuscular volume > 100) and elevations of serum α-glutamyl transferase, alkaline phosphatase, and bilirubin levels. Folate level is reduced in alcoholic patients due to decreased intestinal absorption, increased bone marrow requirement for folate in the presence of alcohol, and increased urinary loss. The magnitude of leukocytosis reflects severity of liver injury.

Histologic features include Mallory bodies, giant mitochondria, hepatocyte necrosis, and neutrophil infiltration at the perivenular area. Mallory bodies, which are also present in other liver diseases, are condensations of cytokeratin components in the hepatocyte cytoplasm and do not contribute to liver injury. Up to 70% of patients with moderate to severe alcoholic hepatitis already have cirrhosis identifiable on biopsy examination at the time of diagnosis.

**Treatment**

Not drinking further alcohol is the most important part of treatment. People with chronic HCV infection should abstain from any alcohol intake, due to the risk for rapid acceleration of liver disease.
Medications

A 2006 Cochrane review did not find evidence sufficient for the use of androgenic anabolic steroids. Corticosteroids are sometimes; however, recommended when severe liver inflammation is present.

The effects of anti-tumor necrosis factor medication such as infliximab and etanercept are unclear and possibly harmful. Evidence is unclear for pentoxifylline. Propylthiouracil may result in harm.

Evidence does not support supplemental nutrition in liver disease.

Transplantation

Although in rare cases liver cirrhosis is reversible, the disease process remains mostly irreversible. Liver transplantation remains the only definitive therapy. Today, survival after liver transplantation is similar for people with ALD and nonALD. The requirements for transplant listing are the same as those for other types of liver disease, except for a 6-month sobriety prerequisite along with psychiatric evaluation and rehabilitation assistance (i.e., Alcoholics Anonymous). Specific requirements vary among the transplant centers. Relapse to alcohol use after transplant listing results in delisting. Re-listing is possible in many institutions, but only after 3–6 months of sobriety. There are limited data on transplant survival in patients transplanted for acute alcoholic hepatitis, but it is believed to be similar to that in nonacute ALD, non-ALD, and alcoholic hepatitis with MDF less than 32.

Antioxidants

Alcohol-induced liver damage occurs via generation of oxidants. Thus alternative health care practitioners often recommend natural antioxidant supplements like milk thistle. Currently, there exists no substantive clinical evidence to suggest that milk thistle or other antioxidant supplements are efficacious beyond placebo in treating liver disease caused by chronic alcohol
consumption. One review claimed benefit for S-adenosyl methionine in disease models. There however is insufficient human evidence.

**Prognosis**

The prognosis for people with ALD depends on the liver histology as well as cofactors, such as concomitant chronic viral hepatitis. Among patients with alcoholic hepatitis, progression to liver cirrhosis occurs at 10–20% per year, and 70% will eventually develop cirrhosis. Despite cessation of alcohol use, only 10% will have normalization of histology and serum liver enzyme levels. As previously noted, the MDF has been used to predict short-term mortality (i.e., MDF e’ 32 associated with spontaneous survival of 50–65% without corticosteroid therapy, and MDF < 32 associated with spontaneous survival of 90%). The Model for End-Stage Liver Disease (MELD) score has also been found to have similar predictive accuracy in 30-day (MELD > 11) and 90-day (MELD > 21) mortality. Liver cirrhosis develops in 6–14% of those who consume more than 60–80 g of alcohol daily for men and more than 20 g daily for women. Even in those who drink more than 120 g daily, only 13.5% will suffer serious alcohol-related liver injury. Nevertheless, alcohol-related mortality was the third leading cause of death in 2003 in the United States. Worldwide mortality is estimated to be 150,000 per year.

**FATTY LIVER**

Fatty liver, also known as fatty liver disease (FLD), is a reversible condition wherein large vacuoles of triglyceride fat accumulate in liver cells via the process of steatosis (i.e., abnormal retention of lipids within a cell). Despite having multiple causes, fatty liver can be considered a single disease that occurs worldwide in those with excessive alcohol intake and the obese (with or without effects of insulin resistance). The condition is also associated with other diseases that influence fat metabolism. When this process of fat metabolism is disrupted, the fat can accumulate in the liver
in excessive amounts, thus resulting in a fatty liver. It is difficult
to distinguish alcoholic FLD from nonalcoholic FLD, and both
show microvesicular and macrovesicular fatty changes at different
stages.

Accumulation of fat may also be accompanied by a progressive
inflammation of the liver (hepatitis), called steatohepatitis. By
considering the contribution by alcohol, fatty liver may be termed
alcoholic steatosis or nonalcoholic fatty liver disease (NAFLD),
and the more severe forms as alcoholic steatohepatitis (part of
alcoholic liver disease) and non-alcoholic steatohepatitis (NASH).

Causes

Fatty liver (FL) is commonly associated with alcohol or
metabolic syndrome (diabetes, hypertension, obesity, and
dyslipidemia), but can also be due to any one of many causes:

Metabolic

Abetalipoproteinemia, glycogen storage diseases, Weber-
Christian disease, acute fatty liver of pregnancy, lipodystrophy

Nutritional

Malnutrition, total parenteral nutrition, severe weight loss,
refeeding syndrome, jejunoileal bypass, gastric bypass, jejunal
diverticulosis with bacterial overgrowth

Drugs and toxins

Amiodarone, methotrexate, diltiazem, expired tetracycline,
highly active antiretroviral therapy, glucocorticoids, tamoxifen,
environmental hepatotoxins (e.g., phosphorus, mushroom
poisoning)

Alcoholic

Alcoholism is one of the major cause of fatty liver due to
production of toxic metabolites like aldehydes during metabolism
of alcohol in the liver. This phenomenon most commonly occurs
with chronic alcoholism.
Other

inflammatory bowel disease, HIV, hepatitis C (especially genotype 3), and alpha 1-antitrypsin deficiency

Pathology

![Micrograph of periportal hepatic steatosis, as may be seen due to steroid use, trichrome stain](image)

Fatty change represents the intracytoplasmatic accumulation of triglycerides (neutral fats). At the beginning, the hepatocytes present small fat vacuoles (liposomes) around the nucleus (microvesicular fatty change). In this stage, liver cells are filled with multiple fat droplets that do not displace the centrally located nucleus. In the late stages, the size of the vacuoles increases, pushing the nucleus to the periphery of the cell, giving characteristic signet ring appearance (macrovesicular fatty change). These vesicles are well-delineated and optically “empty” because fats dissolve during tissue processing. Large vacuoles may coalesce and produce fatty cysts, which are irreversible lesions. Macrovesicular steatosis is the most common form and is typically associated with alcohol, diabetes, obesity, and corticosteroids. Acute fatty liver of pregnancy and Reye’s syndrome are examples of severe liver disease caused by microvesicular fatty change. The diagnosis of steatosis is made when fat in the liver exceeds 5–10% by weight.

Defects in fatty acid metabolism are responsible for pathogenesis of FLD, which may be due to imbalance in energy consumption and its combustion, resulting in lipid storage, or can be a consequence of peripheral resistance to insulin, whereby the transport of fatty acids from adipose tissue to the liver is increased.
Impairment or inhibition of receptor molecules (PPAR-δ, PPAR-α and SREBP1) that control the enzymes responsible for the oxidation and synthesis of fatty acids appears to contribute to fat accumulation. In addition, alcoholism is known to damage mitochondria and other cellular structures, further impairing cellular energy mechanism. On the other hand, nonalcoholic FLD may begin as excess of unmetabolised energy in liver cells. Hepatic steatosis is considered reversible and to some extent nonprogressive if the underlying cause is reduced or removed.

Severe fatty liver is sometimes accompanied by inflammation, a situation referred to as steatohepatitis. Progression to alcoholic steatohepatitis (ASH) or Non-alcoholic steatohepatitis (NASH) depends on the persistence or severity of the inciting cause. Pathological lesions in both conditions are similar. However, the extent of inflammatory response varies widely and does not always correlate with degree of fat accumulation. Steatosis (retention of lipid) and onset of steatohepatitis may represent successive stages in FLD progression.

Liver disease with extensive inflammation and a high degree of steatosis often progresses to more severe forms of the disease. Hepatocyte ballooning and necrosis of varying degrees are often present at this stage. Liver cell death and inflammatory responses lead to the activation of stellate cells, which play a pivotal role in hepatic fibrosis. The extent of fibrosis varies widely. Perisinusoidal fibrosis is most common, especially in adults, and predominates in zone 3 around the terminal hepatic veins.

The progression to cirrhosis may be influenced by the amount of fat and degree of steatohepatitis and by a variety of other sensitizing factors. In alcoholic FLD, the transition to cirrhosis related to continued alcohol consumption is well-documented, but the process involved in nonalcoholic FLD is less clear.

**Diagnosis**

Most individuals are asymptomatic and are usually discovered incidentally because of abnormal liver function tests or
hepatomegaly noted in unrelated medical conditions. Elevated liver biochemistry is found in 50% of patients with simple steatosis. The serum alanine transaminase level usually is greater than the aspartate transaminase level in the nonalcoholic variant and the opposite in alcoholic FLD (AST:ALT more than 2:1).

Liver steatosis (fatty liver disease) as seen on CT

Ultrasound showing diffuse increased echogenicity of the liver.

Imaging studies are often obtained during the evaluation process. Ultrasonography reveals a “bright” liver with increased echogenicity. Medical imaging can aid in diagnosis of fatty liver; fatty livers have lower density than spleens on computed tomography (CT), and fat appears bright in T1-weighted magnetic resonance images (MRIs). No medical imagery, however, is able to distinguish simple steatosis from advanced NASH. Histological
diagnosis by liver biopsy is sought when assessment of severity is indicated.

**Treatment**

The treatment of fatty liver depends on its cause, and, in general, treating the underlying cause will reverse the process of steatosis if implemented at an early stage. Two known causes of fatty liver disease are an excess consumption of alcohol and a prolonged diet containing foods with a high proportion of calories coming from lipids. For the patients with non-alcoholic fatty liver disease with pure steatosis and no evidence of inflammation, a gradual weight loss is often the only recommendation. In more serious cases, medications that decrease insulin resistance, hyperlipidemia, and those that induce weight loss have been shown to improve liver function.

For advanced patients with non-alcoholic steatohepatitis (NASH), there are no currently available therapies.

Up to 10% of people with cirrhotic alcoholic FLD will develop hepatocellular carcinoma. The overall incidence of liver cancer in nonalcoholic FLD has not yet been quantified, but the association is well-established.

**Epidemiology**

The prevalence of FLD in the general population ranges from 10% to 24% in various countries. However, the condition is observed in up to 75% of obese people, 35% of whom progressing to NAFLD, despite no evidence of excessive alcohol consumption. FLD is the most common cause of abnormal liver function tests in the United States. "Fatty livers occur in 33% of European-Americans, 45% of Hispanic-Americans, and 24% of African-Americans."

**LIVER FUNCTION TESTS**

Liver function tests (LFTs or LF) are groups of blood tests that give information about the state of a patient’s liver. These tests include prothrombin time (PT/INR), aPTT, albumin, bilirubin
Liver Disease: Mechanism, Risk Factors, Function Tests

Liver transaminases (AST or SGOT and ALT or SGPT) are useful biomarkers of liver injury in a patient with some degree of intact liver function. Most liver diseases cause only mild symptoms initially, but these diseases must be detected early. Hepatic (liver) involvement in some diseases can be of crucial importance. This testing is performed on a patient’s blood sample. Some tests are associated with functionality (e.g., albumin), some with cellular integrity (e.g., transaminase), and some with conditions linked to the biliary tract (gamma-glutamyl transferase and alkaline phosphatase). Several biochemical tests are useful in the evaluation and management of patients with hepatic dysfunction. These tests can be used to detect the presence of liver disease, distinguish among different types of liver disorders, gauge the extent of known liver damage, and follow the response to treatment. Some or all of these measurements are also carried out (usually about twice a year for routine cases) on those individuals taking certain medications, such as anticonvulsants, to ensure the medications are not damaging the person’s liver.

Standard liver Panel

Although example reference ranges are given, these will vary depending on age, gender, ethnicity, method of analysis, and units of measurement. Individual results should always be interpreted using the reference range provided by the laboratory that performed the test.

Albumin

Albumin is a protein made specifically by the liver, and can be measured cheaply and easily. It is the main constituent of total protein (the remaining from globulins). Albumin levels are decreased in chronic liver disease, such as cirrhosis. It is also decreased in nephrotic syndrome, where it is lost through the urine. The consequence of low albumin can be edema since the intravascular oncotic pressure becomes lower than the extravascular space. An alternative to albumin measurement is
prealbumin, which is better at detecting acute changes (half-life of albumin and prealbumin is about 2 weeks and about 2 days, respectively).

**Aspartate transaminase**

AST, also called serum glutamic oxaloacetic transaminase or aspartate aminotransferase, is similar to ALT in that it is another enzyme associated with liver parenchymal cells. It is raised in acute liver damage, but is also present in red blood cells, and cardiac and skeletal muscle, so is not specific to the liver. The ratio of AST to ALT is mostly useful in differentiating between causes of liver damage. Elevated AST levels are not specific for liver damage, and AST has also been used as a cardiac marker. When the AST is higher than ALT, a muscle source of these enzymes should be considered. For example, muscle inflammation due to dermatomyositis may cause AST>ALT. This is a good reminder that AST and ALT are not good measures of liver function because they do not reliably reflect the synthetic ability of the liver and they may come from tissues other than liver (such as muscle).

**Transaminases**

AST/ALT elevations instead of ALP elevations favor liver cell necrosis as a mechanism over cholestasis. When AST and ALT are both over 1000 IU/L, the differential can include acetaminophen toxicity, shock, or fulminant liver failure. When AST and ALT are greater than three times normal but not greater than 1000 IU/L, the differential can include alcohol toxicity, viral hepatitis, drug-induced level, liver cancer, sepsis, Wilson’s disease, post-transplant rejection of liver, autoimmune hepatitis, and steatohepatitis (nonalcoholic). AST/ALT levels elevated minorly may be due to rhabdomyolysis, among many possibilities.

**Alkaline phosphatase**

Alkaline phosphatase (ALP) is an enzyme in the cells lining the biliary ducts of the liver. ALP levels in plasma rise with large bile duct obstruction, intrahepatic cholestasis, or infiltrative diseases
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ALP is also present in bone and placental tissue, so it is higher in growing children (as their bones are being remodelled) and elderly patients with Paget’s disease. In the third trimester of pregnancy, ALP is about two to three times higher.

Biliary tract disease produces relatively greater increases in ALP than increases in ALT, AST, or LD. ALP is associated with the plasma membrane of hepatocytes adjacent to the biliary canaliculus. Obstruction or inflammation of the biliary tract results in an increased concentration of the ALP in the circulation. Similar to ALT and AST, ALP is not specific for biliary tract disease. ALP is released by osteoblasts, the ileum, and the placenta. ALP is elevated: 1) in children 2- to 3-fold over adults because the child’s skeleton is growing, 2) with bone disease involving osteoblasts (e.g., metastatic cancer or following a fracture), 3) in hyperparathyroidism where parathyroid hormone stimulates osteoblasts through a series of steps that enhances bone resorption (e.g., parathyroid adenoma, hyperplasia, or secondary hyperparathyroidism from vitamin D deficiency or renal disease), 4) in cases of ileal disease, and 5) during the third trimester of pregnancy because the placental isoenzyme is elevated.

Total bilirubin

Measurement of total bilirubin includes both unconjugated and conjugated bilirubin. Unconjugated bilirubin is a breakdown product of heme (a part of hemoglobin in red blood cells). It is very hydrophobic and is mainly transported bound to albumin circulating in the blood. Addition of high-concentration hydrophobic drugs (certain antibiotics, diuretics) and high free fatty acids can cause elevated unconjugated bilirubin. Heme can also come from myoglobin, found mostly in muscle, cytochromes, found mostly in mitochondria, catalase, peroxidase, and nitric oxide synthase. The liver is responsible for clearing the blood of unconjugated bilirubin, and about 30% of it is taken up by a normal liver on each pass of the blood through the liver by the following mechanism: bilirubin is taken up into hepatocytes,
‘conjugated’ (modified to make it water-soluble) by UDP-glucuronyl-transferase, and secreted into the bile by CMOAT (MRP2), which is excreted into the intestine. In the intestine, conjugated bilirubin may be metabolized by colonic bacteria, eliminated, or reabsorbed. Metabolism of bilirubin into urobinigen followed by reabsorption of urobinigen accounts for the yellow color of urine, as urine contains a downstream product of urobinigen. Further metabolism of urobinigen into stercobilin while in the bowels accounts for the brown color of stool. Thus, having white or clay-colored stool is an indicator for a blockage in bilirubin processing and thus potential liver dysfunction or cholestasis.

Increased total bilirubin (TBIL) causes jaundice, and can indicate a number of problems:

- 1. Prehepatic: Increased bilirubin production can be due to a number of causes, including hemolytic anemias and internal hemorrhage.
- 2. Hepatic: Problems with the liver are reflected as deficiencies in bilirubin metabolism (e.g., reduced hepatocyte uptake, impaired conjugation of bilirubin, and reduced hepatocyte secretion of bilirubin). Some examples would be cirrhosis and viral hepatitis.
- 3. Posthepatic: Obstruction of the bile ducts is reflected as deficiencies in bilirubin excretion. (Obstruction can be located either within the liver or in the bile duct).

**Direct bilirubin**

The diagnosis is narrowed down further by evaluating the levels of direct bilirubin.

- If direct (conjugated) bilirubin is normal, then the problem is an excess of unconjugated bilirubin (indirect bilirubin), and the location of the problem is upstream of bilirubin conjugation in the liver. Hemolysis, or internal hemorrhage can be suspected.
- If direct bilirubin is elevated, then the liver is conjugating bilirubin normally, but is not able to excrete it. Bile duct
obstruction by gallstones, hepatitis, cirrhosis or cancer should be suspected.

**Congenital bilirubin disorders**

About 5% of the population has Gilbert’s syndrome, a mutation (or variation) in the UDP-glucuronyl-transferase promotor that manifests itself as jaundice when the individual is stressed (i.e. starves). Autosomal recessive knockouts of UDP-glucuronyl-transferase can lead to Crigler-Najjar syndrome and elevations of unconjugated bilirubin. Defects in CMOAT (MRP2) results in Dubin-Johnson syndrome and elevations of conjugated bilirubin.

**High bilirubin in neonates**

Neonates are especially vulnerable to high bilirubin levels due to an immature blood-brain barrier that predisposes them to kernicterus/bilirubin encephalopathy, which can result in permanent neurological damage. Neonates also have a low amount of functional UDP-glucuronyl-transferase and can have elevated unconjugated bilirubin, since conjugation is limited. So, newborns are often treated with blue light (420-470 nm) to turn the hydrophobic, albumin-binding unconjugated bilirubin into a form that is more hydrophilic and able to be secreted in urine, sparing the neonate’s brain.

**Gamma glutamyl transpeptidase**

Although reasonably specific to the liver and a more sensitive marker for cholestatic damage than ALP, gamma glutamyl transpeptidase (GGT) may be elevated with even minor, subclinical levels of liver dysfunction. It can also be helpful in identifying the cause of an isolated elevation in ALP (GGT is raised in chronic alcohol toxicity).

The proximal convoluted tubule of the kidney, the liver, the pancreas, and the intestine are sources of GGT, in decreasing order of tissue concentration. Within the cell, GGT is located in microsomes and along the biliary tract plasma membrane, GGT is more commonly measured than 5’-NT because GGT testing is
widely available on a variety of laboratory instruments. GGT is typically not elevated with bone disease. Combined elevations of ALP and GGT are compatible with biliary tract disease. However, if the ALP is elevated to a far greater extent than the GGT (or the GGT is normal), ALP sources other than the biliary tract, such as bone, must be investigated. GGT elevations occur in response to alcohol use and anticonvulsants, as GGT is induced by such agents.

**INR**

Prothrombin time (PT) and its derived measures of prothrombin ratio (PR) and international normalized ratio (INR) are measures of the extrinsic pathway of coagulation. This test is also called “ProTime INR” and “INR PT”. They are used to determine the clotting tendency of blood, in the measure of warfarin dosage, liver damage, and vitamin K status.

**Other tests**

Other tests commonly requested alongside LFTs include

**5′ Nucleotidase**

5′ Nucleotidase (5′NTD) is another test specific for cholestasis or damage to the intra- or extrahepatic biliary system, and in some laboratories, is used as a substitute for GGT for ascertaining whether an elevated ALP is of biliary or extrabiliary origin.

**Coagulation test**

The liver is responsible for the production of coagulation factors. INR measures the speed of a particular pathway of coagulation, comparing it to normal. Increased levels of INR means blood is taking more time than usual to clot. The INR increases only if the liver is so damaged that synthesis of vitamin K-dependent coagulation factors has been impaired; it is not a sensitive measure of liver function.

It is very important to normalize the INR before operating on people with liver problems (usually by transfusion with blood plasma containing the deficient factors), as they could bleed excessively.
Serum glucose

The serum glucose test, abbreviated as “BG” or “Glu”, measures the liver’s ability to produce glucose (gluconeogenesis); it is usually the last function to be lost in the setting of fulminant liver failure.

Lactate dehydrogenase

Lactate dehydrogenase (LDH) is found in many body tissues, including the liver. Elevated levels of LDH may indicate liver damage. LDH isotype-1 (or cardiac) is used for estimating damage to cardiac tissue, although troponin and creatine kinase tests are more preferred.

CHRONIC LIVER DISEASE

Chronic liver disease in the clinical context is a disease process of the liver that involves a process of progressive destruction and regeneration of the liver parenchyma leading to fibrosis and cirrhosis. Chronic liver disease refers to disease of the liver which lasts over a period of six months. It consists of a wide range of liver pathologies which include inflammation (chronic hepatitis), liver cirrhosis, and hepatocellular carcinoma. The entire spectrum need not be experienced.

Causes

The list of conditions associated with chronic liver disease is extensive and can be categorized in the following way:

Viral causes

- Hepatitis B
- Hepatitis C

Cytomegalovirus (CMV), Epstein Barr virus (EBV), and yellow fever viruses cause acute hepatitis.

Toxic and drugs

- Alcoholic liver disease
- Rarely drug induced liver disease from methotrexate, amiodarone, nitrofurantoin and others
Paracetamol (acetaminophen) causes acute liver damage.

**Metabolic**
- Non-alcoholic fatty liver disease
- Haemochromatosis
- Wilson’s Disease

**Autoimmune**
- Autoimmune hepatitis
- Primary biliary cholangitis (primary biliary cirrhosis)
- Primary sclerosing cholangitis

**Other**
- Right heart failure

**Complications of chronic liver disease**
1. Portal hypertension
   - Ascites
   - Hypersplenism (with or without splenomegaly)
   - Lower oesophageal varices and rectal varices
2. Synthetic dysfunction
   - Hypoalbuminaemia
   - Coagulopathy
3. Hepatopulmonary syndrome
4. Hepatorenal syndrome
   - Encephalopathy
   - Hepatocellular carcinoma

**Physical signs**

Signs of chronic liver disease detectable on clinical examination can be divided into those that are associated with the diagnosis of chronic liver disease, associated with decompensation and associated with the aetiology.

**Signs associated with diagnosis of chronic liver disease**
- Clubbing
- Palmar erythema
• Spider nevi (angiomata)
• Gynaecomastia
• Feminising hair distribution
• Testicular atrophy
• Small irregular shrunken liver
• Anaemia
• Caput medusae

**Signs associated with decompensation**

• Drowsiness (encephalopathy)
• Hyperventilation (encephalopathy)
• Metabolic flap/asterixis (encephalopathy)
• Jaundice (excretory dysfunction)
• Ascites (portal hypertension and hypoalbuminaemia)
• Leukonychia (hypoalbuminaemia)
• Peripheral oedema (hypoalbuminaemia)
• Bruising (coagulopathy)
• Acid-base imbalance, most commonly respiratory alkalosis

**Signs associated with the aetiology**

• Dupuytren’s contracture (alcohol)
• Parotid enlargement (alcohol)
• Peripheral neuropathy (alcohol and some drugs)
• Cerebellar signs (alcohol and Wilson’s disease)
• Liver enlargement (alcohol, NAFLD, haemochromatosis)
• Kayser-Fleisher rings (Wilson’s disease)
• Increased pigmentation of the skin (haemochromatosis)
• Signs of right heart failure

Note that other diseases can involve the liver and cause hepatomegaly but would not be considered part of the spectrum of chronic liver disease. Some examples of this would include chronic cancers with liver metastases, infiltrative haematological disorders such as chronic lymphoproliferative conditions, chronic myeloid leukaemias, myelofibrosis and metabolic abnormalities such as Gaucher’s disease and glycogen storage diseases.
Recognition

Chronic liver disease takes several years to develop and the condition may not be recognised unless there is clinical awareness of subtle signs and investigation of abnormal liver function tests.

Testing for chronic liver disease involves blood tests, imaging including ultrasound and a biopsy of the liver. The liver biopsy is a simple procedure done with a fine thin needle under local anaesthesia. The tissue sample is sent to a laboratory where it is examined underneath a microscope.

Risk factors for various liver diseases

These differ according to the type of chronic liver disease.

- Excessive alcohol use
- Obesity
- Metabolic syndrome including raised blood lipids
- Health care professionals who are exposed to body fluids and infected blood
- Sharing infected needle and syringes
- Having unprotected sex and multiple sex partners
- Working with toxic chemicals without wearing safety clothes
- Certain prescription medications

Treatment

The treatment of chronic liver disease depends on the cause. Specific conditions may be treated with medications including corticosteroids, interferon, antivirals, bile acids or other drugs. Supportive therapy for complications of cirrhosis include diuretics, albumin, vitamin K, blood products, antibiotics and nutritional therapy. Other patients may require surgery or a transplant. Transplant is required when the liver fails and there is no other alternative.

Alternative medicine

Some herbal remedies have been advocated for chronic liver
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disease but the evidence is not conclusive. Some common herbs are known to be harmful to the liver, including black cohosh, ma huang, chaparral, comfrey, germander, greater celandine, kava, mistletoe, pennyroyal, skull cap and valerian.

LIVER FAILURE

Liver failure occurs when large parts of the liver become damaged beyond repair and the liver is no longer able to function.

Liver failure is a life-threatening condition that demands urgent medical care. Most often, liver failure occurs gradually and over many years. However, a more rare condition known as acute liver failure occurs rapidly (in as little as 48 hours) and can be difficult to detect initially.

What Causes Liver Failure?

The most common causes of chronic liver failure (where the liver fails over months to years) include:

- Hepatitis B
- Hepatitis C

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- Long-term alcohol consumption
- Cirrhosis
- Hemochromatosis (an inherited disorder that causes the body to absorb and store too much iron)
- Malnutrition

The causes of acute liver failure, when the liver fails rapidly, however, are often different. These include:
- Acetaminophen (Tylenol) overdose
- Viruses including hepatitis A, B, and C (especially in children)
- Reactions to certain prescription and herbal medications
- Ingestion of poisonous wild mushrooms

**Symptoms of Liver Failure**

The initial symptoms of liver failure are often ones that can be due to any number of conditions. Because of this, liver failure may be initially difficult to diagnose. Early symptoms include:
- Nausea
- Loss of appetite
- Fatigue
- Diarrhea

However, as liver failure progresses, the symptoms become more serious, requiring urgent care. These symptoms include:
- Jaundice
- Bleeding easily
- Swollen abdomen
- Mental disorientation or confusion (known as hepatic encephalopathy)
- Sleepiness
- Coma

**Treatment to Liver Failure**

If detected early enough, acute liver failure caused by an overdose of acetaminophen can sometimes be treated and its effects
reversed. Likewise, if a virus causes liver failure, supportive care can be given at a hospital to treat the symptoms until the virus runs its course. In these cases, the liver will sometimes recover on its own.

For liver failure that is the result of long-term deterioration, the initial treatment goal may be to save whatever part of the liver is still functioning. If this is not possible, then a liver transplant is required. Fortunately, liver transplant is a common procedure that is often successful.

LIVER’S CIRRHOSIS

The liver weighs about 3 pounds and is the largest solid organ in the body. It performs many important functions, such as:

- Manufacturing blood proteins that aid in clotting, oxygen transport, and immune system function
- Storing excess nutrients and returning some of the nutrients to the bloodstream
- Manufacturing bile, a substance needed to help digest food
- Helping the body store sugar (glucose) in the form of glycogen
- Ridding the body of harmful substances in the bloodstream, including drugs and alcohol
- Breaking down saturated fat and producing cholesterol

Cirrhosis is a slowly progressing disease in which healthy liver tissue is replaced with scar tissue, eventually preventing the liver from functioning properly. The scar tissue blocks the flow of blood through the liver and slows the processing of nutrients, hormones, drugs, and naturally produced toxins. It also slows the production of proteins and other substances made by the liver.

According to the National Institutes of Health, cirrhosis is the 12th leading cause of death by disease.

Causes of Cirrhosis of the Liver

Hepatitis C, fatty liver, and alcohol abuse are the most common
causes of cirrhosis of the liver in the U.S., but anything that damages the liver can cause cirrhosis, including:

- Fatty liver associated with obesity and diabetes
- Chronic viral infections of the liver (hepatitis types B, C, and D; Hepatitis D is extremely rare)
- Blockage of the bile duct, which carries bile formed in the liver to the intestines, where it helps in the digestion of fats; in babies, this can be caused by biliary atresia in which bile ducts are absent or damaged, causing bile to back up in the liver. In adults, bile ducts may become inflamed, blocked, or scarred, due to another liver disease called primary biliary cirrhosis.
- Repeated bouts of heart failure with fluid backing up into the liver
- Certain inherited diseases such as:
  - Cystic fibrosis
  - Glycogen storage diseases, in which the body is unable to process glycogen, a form of sugar that is converted to glucose and serves as a source of energy for the body
  - Alpha 1 antitrypsin deficiency, an absence of a specific enzyme in the liver
  - Diseases caused by abnormal liver function, such as hemochromatosis, a condition in which excessive iron is absorbed and deposited into the liver and other organs, and Wilson's disease, caused by the abnormal storage of copper in the liver

Although less likely, other causes of cirrhosis include reactions to prescription drugs, prolonged exposure to environmental toxins, or parasitic infections.

**LIVER SCAN**

A liver scan is a specialized radiology procedure used to examine the liver to identify certain conditions or to assess the function of the liver. A liver scan may also be used to follow the progress of treatment of certain conditions. This procedure may
also be referred to as a liver-spleen scan because the spleen often is examined as well due to its proximity and close functional relationship to the liver. A liver scan is a type of nuclear medicine procedure. This means that a tiny amount of a radioactive substance is used during the procedure to assist in the examination of the liver. The radioactive substance, called a radiopharmaceutical or radioactive tracer, is formed by the addition of a radioactive atom (radionuclide) to a molecule absorbed by normal liver tissue. The remainder of the radioactive substance is absorbed by the spleen and bone marrow.

The radionuclide used in liver scans is generally a form of technetium. Once absorbed into the liver tissue, the radionuclide emits a type of radiation, called gamma radiation. The gamma radiation is detected by a scanner, which processes the information into a picture of the liver. By measuring the behavior of the radionuclide in the body during a nuclear scan, the doctor can assess and diagnose various conditions, such as tumors, abscesses, hematomas, organ enlargement, or cysts.

A nuclear scan may also be used to assess organ function and blood circulation. The areas where the radionuclide collects in greater amounts are called “hot spots.” The areas that do not absorb the radionuclide and appear less bright on the scan image are referred to as “cold spots.”

Other concerned procedures that may be used to diagnose problems of the liver include abdominal X-rays, abdominal ultrasound, computed tomography (CT scan) of the abdomen or liver, or a liver biopsy.

**Anatomy of the liver**

The liver is the largest organ in the body. This dark reddish brown organ is located in the upper right side of the abdomen, beneath the diaphragm, and on top of the stomach, right kidney, and intestines.

The wedge-shaped liver is made up of 2 main lobes. Each lobe is made up of thousands of lobules. These lobules are connected
to small ducts that connect with larger ducts to ultimately form the hepatic duct. The hepatic duct moves the bile (fluid that helps break down fats and gets rid of wastes in the body) that is made by the liver cells to the gallbladder and duodenum (the first part of the small intestine).

The liver carries out many important functions, such as:

- Making bile. Bile is a fluid that helps break down fats and gets rid of wastes in the body
- Changing food into energy
- Clearing the blood of drugs and other poisonous substances
- Producing certain proteins for blood plasma
- Regulating blood clotting

The spleen, an egg-shaped organ that lies between the stomach and the diaphragm on the left side of the body, helps to keep the blood healthy. The spleen plays a role in the production of lymphocytes (white blood cells that fight infection and disease), destruction of red blood cells, and filtration and storage of blood.

The biliary system is made up of the organs and ducts (bile ducts, gallbladder, and associated structures) that make and transport bile.

**Reasons behind liver Scan**

A liver scan may be done to check for diseases such as liver cancer, hepatitis, or cirrhosis. Lesions such as tumors, abscesses, or cysts of the liver or spleen may be seen on a liver scan. A liver scan may be done to assess the condition of the liver and/or spleen after trauma to the abdomen or when there is unexplained pain in the right upper quadrant of the abdomen. Enlargement of the liver or spleen may be seen on a liver scan.

A liver scan may also be used to assess response to therapy for liver disease and/or to monitor the course of liver disease. Portal hypertension (elevated blood pressure within the liver’s circulation) may be detected with a liver scan when more of the radionuclide is absorbed by the spleen rather than the liver.
There may be other reasons for your doctor to recommend a liver scan.

**Risks of a liver Scan**

The amount of the radionuclide injected into your vein for the procedure is small enough that there is no need for precautions against radioactive exposure. The injection of the radionuclide may cause some slight discomfort. Allergic reactions to the radionuclide are rare, but may occur.

For some patients, having to lie still on the scanning table for the length of the procedure may cause some discomfort or pain. Patients who are allergic to or sensitive to medications, contrast dyes, or latex should notify their doctor.

If you are pregnant or suspect that you may be pregnant, you should notify your health care provider due to the risk of injury to the fetus from a liver scan. If you are lactating, or breastfeeding, you should notify your health care provider due to the risk of contaminating breast milk with the radionuclide. There may be other risks depending on your specific medical condition. Be sure to discuss any concerns with your doctor prior to the procedure. Certain factors or conditions may interfere with the accuracy of a liver scan. These factors include, but are not limited to, the following:

- Presence of a radionuclide in the body from a previous nuclear medicine procedure within a certain period of time
- Barium remaining in the gastrointestinal (GI) tract from a recent barium procedure

**Preparation for a liver Scan**

PRECAUTIONS: If you are pregnant or think you might be pregnant, please check with your doctor before scheduling the exam. We will discuss other options with you and your doctor.

BREASTFEEDING: If you are breastfeeding, you should notify your health care provider due to the risk of contaminating breast milk with the tracer.
CLOTHING: You may be asked to change into a patient gown. A gown will be provided for you. Lockers are provided to secure your personal belongings. Please remove all piercings and leave all jewelry and valuables at home.

EAT/DRINK: Generally, no prior preparation, such as fasting or sedation, is required prior to a liver scan.

ALLERGIES: Notify the radiologist or technologist if you are allergic to or sensitive to medications, contrast dyes or iodine. The injection of the radiotracer may cause some slight discomfort. Allergic reactions to the radiotracer are rare, but may occur.
- Based on your medical condition, your doctor may request other specific preparation.

Process of liver Scan

A liver scan may be performed on an outpatient basis or as part of your stay in a hospital. Procedures may vary depending on your condition and your doctor’s practices. Generally, a liver scan follows this process:
- You will be asked to remove any clothing, jewelry, or other objects that may interfere with the procedure.
- You will be asked to remove clothing and will be given a gown to wear.
- An intravenous (IV) line will be started in the hand or arm for injection of the radionuclide.
- The radionuclide will be injected into your vein. The radionuclide will be allowed to concentrate in the liver tissue for approximately 30 minutes.
- You will be asked to lie still on a scanning table, as any movement may affect the quality of the scan.
- The scanner will be placed over the right upper quadrant of the abdomen in order to detect the gamma rays emitted by the radionuclide in the liver tissue.
- You may be repositioned during the scan in order to obtain views of all the surfaces of the liver.
- When the scan has been completed, the IV line will be removed.
While the liver scan itself causes no pain, having to lie still for the length of the procedure might cause some discomfort or pain, particularly in the case of a recent injury or invasive procedure such as surgery. The technologist will use all possible comfort measures and complete the procedure as quickly as possible to minimize any discomfort or pain.

**What happens after a liver scan?**

You should move slowly when getting up from the scanner table to avoid any dizziness or lightheadedness from lying flat for the length of the procedure. You may be instructed to drink plenty of fluids and empty your bladder frequently for about 24 hours after the procedure to help flush the remaining radionuclide from your body.

The IV site will be checked for any signs of redness or swelling. If you notice any pain, redness, and/or swelling at the IV site after you return home following your procedure, you should notify your doctor as this may indicate an infection or other type of reaction. You may resume your usual diet and activities, unless your doctor advises you differently. Your doctor may give you additional or alternate instructions after the procedure, depending on your particular situation.

**LIVER TRANSPLANT**

A liver transplant is surgery to replace a diseased liver with a healthy liver from another person. A whole liver may be transplanted, or just part of one. In most cases the healthy liver will come from an organ donor who has just died. Sometimes a healthy living person will donate part of their liver. A living donor may be a family member. Or it may be someone who is not related to you but whose blood type is a good match.

People who donate part of their liver can have healthy lives with the liver that is left.

The liver is the only organ in the body that can replace lost or injured tissue (regenerate). The donor’s liver will soon grow
back to normal size after surgery. The part that you receive as a new liver will also grow to normal size in a few weeks.

**Need of a Liver Transplant**

You can’t live without a working liver. If your liver stops working properly, you may need a transplant. A liver transplant may be recommended if you have end-stage liver disease (chronic liver failure). This is a serious, life-threatening liver disease. It can be caused by several liver conditions.

Cirrhosis is a common cause of end-stage liver disease. It is a chronic liver disease. It happens when healthy liver tissue is replaced with scar tissue. This stops the liver from working properly.

Other diseases that may lead to end-stage liver disease include:
- Acute hepatic necrosis. This is when tissue in the liver dies.
- Biliary atresia. A rare disease of the liver and bile ducts that occurs in newborns.
- Metabolic diseases. Disorders that change the chemical activity in cells affected by the liver.
- Primary liver cancers. These are cancerous tumors that start in the liver.
- Autoimmune hepatitis. A redness or swelling (inflammation) of the liver. It happens when your body’s disease-fighting system (immune system) attacks your liver.

**Process of Transplant Evaluation**

If your provider thinks you may be a good candidate for a liver transplant, he or she will refer you to a transplant center for evaluation. Transplant centers are located in certain hospitals throughout the U.S.

You will have a variety of tests done by the transplant center team. They will decide whether to place your name on a national transplant waiting list. The transplant center team will include:
- A transplant surgeon
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- A transplant provider specializing in treating the liver (a hepatologist)
- Transplant nurses
- A social worker
- A psychiatrist or psychologist
- Other team members such as a dietitian, a chaplain, or an anesthesiologist

The transplant evaluation process includes:

- Psychological and social evaluation. Many different issues are assessed. They include stress, financial concerns, and whether you will have support from family or friends after your surgery.
- Blood tests. These tests are done to help find a good donor match and assess your priority on the waiting list. They can also help improve the chances that your body won’t reject the donor liver.
- Diagnostic tests. Tests may be done to check your liver and your general health. These tests may include X-rays, ultrasounds, a liver biopsy, and dental exams. Women may also have a Pap test, gynecology exam, and a mammogram.

The transplant center team will review all of your information. Each transplant center has rules about who can have a liver transplant.

You may not be able to have a transplant if you:
- Have a current or chronic infection that can’t be treated
- Have metastatic cancer. This is cancer that has spread from its main location to 1 or more other parts of the body.
- Have severe heart problems or other health problems
- Have a serious condition besides liver disease that would not get better after a transplant
- Are not able to follow a treatment plan
- Drink too much alcohol

**Getting on the waiting list**

If you are accepted as a transplant candidate, your name will
be placed on a national transplant waiting list. People who most urgently need a new liver are put at the top of the list. Many people have to wait a long time for a new liver.

You will be notified when an organ is available because a donor has died. You will have to go to the hospital right away to get ready for surgery.

If a living person is donating a part of their liver to you, the surgery will be planned in advance. You and your donor will have surgery at the same time. The donor must be in good health and have a blood type that is a good match with yours. The donor will also take a psychological test. This is to be sure he or she is comfortable with this decision.

**Risks of a liver Transplant**

Some complications from liver surgery may include:
- Bleeding
- Infection
- Blocked blood vessels to the new liver
- Leakage of bile or blocked bile ducts
- The new liver not working for a short time right after surgery

Your new liver may also be rejected by your body’s disease-fighting system (immune system). Rejection is the body’s normal reaction to a foreign object or tissue. When a new liver is transplanted into your body, your immune system thinks it is a threat and attacks it.

To help the new liver survive in your body, you must take anti-rejection medicines (immunosuppressive medicines). These medicines weaken your immune system’s response. You must take these medicines for the rest of your life.

**How do I get ready for a liver transplant?**
- Your healthcare provider will explain the procedure to you. Ask him or her any questions you have about the surgery.
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- You may be asked to sign a consent form that gives permission to do the surgery. Read the form carefully and ask questions if anything is not clear.
- For a planned living transplant, you should not eat for 8 hours before the surgery. This often means not having any food or drink after midnight. If your liver is from a donor who has just died, you should not eat or drink once you are told a liver is available.
- You may be given medicine to help you relax (a sedative) before the surgery.

Your healthcare provider may have other instructions for you based on your medical condition.

Process of liver transplant

Liver transplant surgery requires a hospital stay. Procedures may vary depending on your condition and your provider’s practices.

Generally, a liver transplant follows this process:
- You will be asked to remove your clothing and given a gown to wear.
- An IV (intravenous) line will be started in your arm or hand. Other tubes (catheters) will be put in your neck and wrist. Or they may be put under your collarbone or in the area between your belly and your thigh (the groin). These are used to check your heart and blood pressure, and to get blood samples.
- You will be placed on your back on the operating table.
- If there is too much hair at the surgical site, it may be clipped off.
- A catheter will be put into your bladder to drain urine.
- After you are sedated, the anesthesiologist will insert a tube into your lungs. This is so that your breathing can be helped with a machine (a ventilator). The anesthesiologist will keep checking your heart rate, blood pressure, breathing, and blood oxygen level during the surgery.
• The skin over the surgical site will be cleaned with a sterile (antiseptic) solution.
• The doctor will make a cut (incision) just under the ribs on both sides of your belly. The incision will extend straight up for a short distance over the breast bone.
• The doctor will carefully separate the diseased liver from the nearby organs and structures.
• The attached arteries and veins will be clamped to stop blood flow into the diseased liver.
• Different surgery methods may be used to remove the diseased liver and implant the donor liver. The method used will depend on your specific case.
• The diseased liver will be removed after it has been cut off from the blood vessels.
• Your surgeon will check the donor liver before implanting it in your body.
• The donor liver will be attached to your blood vessels. Blood flow to your new liver will be started. The surgeon will check for any bleeding where you have stitches.
• The new liver will be attached to your bile ducts.
• The incision will be closed with stitches or surgical staples.
• A drain may be placed in the incision site to reduce swelling.
• A sterile bandage or dressing will be applied.

What happens after a liver Transplant?

In the hospital

After the surgery you may be taken to the recovery room for a few hours before being taken to the intensive care unit (ICU). You will be closely watched in the ICU for several days. You will be hooked up to monitors. They will show your heartbeat, blood pressure, other pressure readings, breathing rate, and your oxygen level. You will need to stay in the hospital for 1 to 2 weeks or longer.

You will most likely have a tube in your throat. This is so you can breathe with the help of a machine (a ventilator) until you can
breathe on your own. You may need the breathing tube for a few hours or a few days, depending on your situation. You may have a thin plastic tube inserted through your nose into your stomach to remove air that you swallow. The tube will be taken out when your bowels start working normally again. You won’t be able to eat or drink until the tube is removed.

Blood samples will be taken often to check your new liver. They will also check that your kidneys, lungs, and circulatory system are all working. You may have IV drips to help your blood pressure and your heart, and to control any problems with bleeding. As your condition gets better, these drips will be slowly decreased and turned off.

Once the breathing and stomach tubes have been removed and you are stable, you may start to drink liquids. You may slowly begin to eat solid foods as directed. Your anti-rejection medicines will be closely watched to be sure you are getting the right dose and the right mix of medicines.

When your provider feels you are ready, you will be moved from the ICU to a private room. You will slowly be able to move about more as you get out of bed and walk around for longer periods of time. You will slowly be able to eat more solid foods. Your transplant team will teach you how to take care of yourself when you go home.

At home

Once you are home, you must keep the surgical area clean and dry. Your provider will give you specific bathing instructions. Any stitches or surgical staples will be removed at a follow-up office visit, if they were not removed before leaving the hospital.

You should not drive until your provider tells you to. You may have other limits on your activity.

Call your healthcare provider if you have any of the following:
- Fever. This may be a sign of rejection or infection.
- Redness, swelling, or bleeding or other drainage from the incision site
• More pain around the incision site. This may be a sign of infection or rejection.
• Vomiting or diarrhea

Your healthcare provider may give you other instructions, depending on your situation.

**How to prevent Rejection**

You must take medicines for the rest of your life to help the transplanted liver survive in your body. These medicines are called anti-rejection medicines (immunosuppressive medicines). They weaken your immune system’s response. Each person may react differently to medicines, and each transplant team has preferences for different medicines.

New anti-rejection medicines are always being made and approved. Your provider will create a medicine treatment plan that is right for you. In most cases you will take a few anti-rejection medicines at first. The doses may change often, depending on how you respond to them.

Because anti-rejection medicines affect the immune system, people who have a transplant are at a higher risk for infections. Some of the infections you will be at greater risk for include:

• Oral yeast infection (thrush)
• Herpes
• Respiratory viruses

For the first few months after your surgery, you should avoid contact with crowds or anyone who has an infection. Each person may have different symptoms of rejection. Some common symptoms of rejection include:

• Fever
• A yellowing of the skin and eyes (jaundice)
• Dark-colored urine
• Itching
• Swollen or sore belly
• Feeling very tired (fatigue)
• Being easily annoyed
• Headache
• Upset stomach

The symptoms of rejection may look like other health problems. Talk with your transplant team about any concerns you have. It is important to see them and speak with them often.
Gastric Motility Disorders

STOMACH’S MOTILITY DISORDERS

One function of the stomach is to grind food into smaller particles and mix it with digestive juices so the food can be absorbed when it reaches the small intestine. The stomach normally empties its contents into the intestine at a controlled rate.

The stomach has three types of contractions:

1. There are rhythmic, 3 per minute, synchronized contractions in the lower part of the stomach, which create waves of food particles and juice which splash against a closed sphincter muscle (the pyloric sphincter) to grind the food into small particles.

2. The upper part of the stomach shows slow relaxations lasting a minute or more that follow each swallow and that allow the food to enter the stomach; at other times the upper part of the stomach shows slow contractions which help to empty the stomach.

3. Between meals, after all the digestible food has left the stomach, there are occasional bursts of very strong, synchronized contractions that are accompanied by opening of the pyloric sphincter muscle. These are sometimes called “housekeeper waves” because their function is to sweep any indigestible particles out of the stomach. Another name for them is the migrating motor complex.
Examples of stomach (gastric) motility disorders include:

- Delayed gastric emptying (gastroparesis)
- Rapid gastric emptying (dumping syndrome)
- Functional dyspepsia.

**Delayed gastric emptying (gastroparesis)**

The symptoms of delayed gastric emptying include nausea and vomiting. Poor emptying of the stomach can occur for several reasons:

1. The outlet of the stomach (the pylorus and duodenum) may be obstructed by an ulcer or tumor, or by something large and indigestible that was swallowed.
2. The pyloric sphincter at the exit of the stomach may not open enough or at the right times to allow food to pass through. This sphincter is controlled by neurological reflexes to ensure that only very tiny particles leave the stomach and also to insure that not too much acid or sugar leaves the stomach at one time, which could irritate or injure the small intestine. These reflexes depend on nerves that sometimes become damaged.
3. The normally rhythmic, 3 per minute contractions of the lower part of the stomach can become disorganized so that the contents of the stomach are not pushed towards the pyloric sphincter. This also usually has a neurological basis; the most common known cause is longstanding diabetes mellitus, but in many patients the cause of delayed gastric emptying is unknown, so the diagnosis given is idiopathic (meaning cause unknown) gastroparesis.

**Cyclic vomiting syndrome (CVS)**

Cyclic vomiting syndrome (CVS) is a disorder with recurrent episodes of severe nausea and vomiting interspersed with symptom free periods. CVS occurs in all ages. Patients may struggle for many years before a correct diagnosis is made.

**Rapid gastric emptying (dumping syndrome)**

Rapid gastric emptying, or dumping syndrome, happens when
the upper end of the small intestine (jejunum) fills too quickly with undigested food from the stomach.

“Early” dumping begins during or right after a meal. “Late” dumping happens 1 to 3 hours after eating. Many people have both type.

Functional dyspepsia

Many patients have pain or discomfort that is felt in the center of the abdomen above the belly button. Some examples of discomfort that is not nonpainful are:

- Fullness
- Early satiety (feeling full soon after starting to eat)
- Bloating
- Nausea

There is no single motility disorder that explains all these symptoms, but about a third of patients with these symptoms have delayed gastric emptying (usually not so severe that it causes frequent vomiting), and about a third show a failure of the relaxation of the upper stomach following a swallow (abnormal gastric accommodation reflex). About half of the patients with these symptoms also have a sensitive or irritable stomach, which causes sensations of discomfort when the stomach is filled with even small volumes.

CHRONIC INTESTINAL PSEUDO-OBSTRUCTION

Chronic intestinal pseudo-obstruction (CIP) is a clinical syndrome caused by ineffective intestinal propulsion and characterized by symptoms and signs of intestinal obstruction in the absence of an occluding lesion of the intestinal lumen. CIP is caused by a group of heterogeneous nerve and muscle disorders and results in obstructive intestinal symptoms in the absence of any mechanical obstruction.

Usually, CIP occurs in patients with severe comorbid clinical conditions or after traumas (even surgical) or in patients with other underlying medical diseases.
A consensus working group defined CIP as a “rare, severe disabling disorder characterized by repetitive episodes or continuous symptoms and signs of bowel obstruction, including radiographic documentation of dilated bowel with air-fluid levels, in the absence of a fixed, lumen-occluding lesion.” However, this definition is really applicable only to the most severe forms of CIP; air-fluid levels may not always be present.

Thus, the criteria for diagnosis should include definite symptoms and signs of obstruction, with documentation of air-fluid levels on plain radiographs of the abdomen or a dilated duodenum, small intestine, or colon on barium radiographs. Even though severe dysmotility may otherwise be present, the term pseudo-obstruction should not be used when these radiographic findings are absent.

Pathophysiology

Coordinated movements of the stomach and intestines are required to digest and propel intestinal contents along the digestive tract. The complex patterns of contraction and relaxation necessary for proper motility of the gastrointestinal (GI) tract are generated in the nerves and muscles within the GI walls.

Every day, at any time, many factors can influence GI motility (eg, physical exercise, emotional distress). The pathogenesis of primary intestinal motility disorders probably is multifactorial, but neither biochemical abnormality nor structural abnormality has been demonstrated commonly, except in some forms of intestinal pseudo-obstruction. More recently, there is evidence that low-grade mucosal inflammation and immune activation (particularly with mast cell involvement) in association with impaired epithelial barrier function and aberrant neuronal sensitivity may play a role in functional gastrointestinal disorders.

Although the overall structural organization is similar throughout the digestive tract, each part has distinct motor activities. The musculature of the digestive tract has either extrinsic innervation (both sympathetic and parasympathetic) or intrinsic
Innervation (Auerbach plexus or myenteric plexus). Intrinsic innervation is fundamental to coordinating GI motor activity. A neural network branching between longitudinal and circular muscle layers of the GI tract constitutes intrinsic innervation. Another nervous intrinsic plexus in the GI tract (Meissner plexus or submucosal plexus) helps to modify mucosal absorption and secretion without influencing motility.

Random, unorganized motor activity with occasional peristaltic and antiperistaltic complexes occurs during feeding, and this allows gastric remixing of foods. After this, another motor activity occurs, which is more regular, and this begins the peristaltic waves (ie, contractions of the circular musculature of the small intestine) that allow progression of undigested food through the intestines.

These events happen because the gastric pacemaker area, which originates electric slow waves with a frequency of 3 cycles per minute, occurs at the junction between the body and the antrum of the stomach. These electric waves, called migrating myoelectric complexes, determine the frequency of muscular contractions in the antral and pyloric areas through electromechanical coupling. Migrating myoelectric complexes regulate gastric emptying and move gastric contents distally. Every 90 minutes, a cluster of migrating myoelectric complexes arises in the stomach and migrates distally beyond the ileum. Vagal function and the release of nitric oxide, vasoactive intestinal polypeptide, motilin, and nutrients of the meal and other enterohormones also affect GI motility.

Knowles and Martin attempted to define a novel classification for intestinal motility disorders, in which these conditions are categorized as well-defined entities, entities with a variable dysfunction-symptom relation, questionable entities, and entities associated with behavioral disorders. Well-defined entities in the Knowles-Martin classification include the following:

- Delayed colonic transit - Slow transit constipation (eg, enteric neuropathy, enteric myopathy, Parkinson disease, endocrine disorders, spinal injury)
Gastric Motility Disorders

- Dilated colon (diffuse or segmental) - Ogilvie syndrome, megacolon
- Absent rectoanal inhibitory reflex - Hirschsprung disease

Entities with a variable dysfunction-symptom relation include the following:
- Abnormally low anal canal pressure fecal incontinence (e.g., diabetes mellitus, spinal injury)

Questionable entities include the following:
- Accelerated transit bile salts
- Short bowel
- Rare endocrine and metabolic disorders

Entities associated with behavioral disorders include the following:
- Impaired pelvic floor relaxation, prolonged storage in the rectosigmoid, outlet delay, anismus
- Avoidance of defecation, functional fecal retention (e.g., poor pelvic floor training, poor diet, fear of pain, learned suppression)

Etiology

Causes of intestinal motility disorders seem to be multifactorial, and only a few have been detected.

Degenerative disorders cause pseudo-obstruction along with other problems; however, in patients with pseudo-obstruction, only changes in the nervous and muscular systems have been observed.

Many drugs that are commonly used (e.g., tricyclic antidepressants, diuretics, laxatives) or have specific indications (e.g., lithium salts, vinca alkaloids, and other chemotherapy agents) may interfere with intestinal motility. Stypsis may be related to drug abuse. Drugs such as benzodiazepines, lithium salts, laxatives, and codeine cause secondary stypsis. The latter can produce narcotic bowel syndrome, which is usually observed in patients who abuse opiates for chronic pain.
Endocrine disorders (eg, myxedema) can also cause pseudo-obstruction.

IBS, the more commonly diagnosed disorder of intestinal motility, has been considered a disease of the colon for decades, but research on GI motility has demonstrated that underlying motility disturbances can occur in the small bowel.

**Irritable bowel syndrome**

The causes of irritable bowel syndrome (IBS) remain unknown. According to some reports, the small intestine and colon of patients with IBS are more sensitive and reactive to mild stimuli than usual. IBS could be related to immature status of muscles and nerves in the intestinal wall of these persons.

**Fecal incontinence**

Aging, dementia, stroke, Parkinson disease, spinal cord injuries, rectal tears during birthing, diabetes, surgical complications, and neuromuscular disorders (eg, myasthenia gravis) may cause fecal incontinence.

Occasionally, fecal incontinence may occur after ingestion of certain foods. Sugars, insoluble fibers, and starches (except rice) are broken down in the intestines, forming a variable amount of gas that must be expelled. Most people who have lactase deficiency cannot digest lactose, a sugar common in several foods (eg, milk, cakes). People who have lactose deficiency may experience uncontrolled liquid diarrhea after lactose ingestion.

**Constipation**

Constipation commonly has several causes, either primary or secondary. The most frequent of these are the following:

- Diet that is very poor in fiber and high in animal fats and refined sugars
- Pregnancy
- Psychological constipation related to lifestyle changes (eg, travel, a new job, or divorce), in which the patient ignores the urge to defecate
Gastric Motility Disorders

• Hypothyroidism
• Electrolyte imbalance, especially if it involves Ca ++ or K +
• Tumors producing mechanical compression on an intestinal tract, either internally or externally
• Nervous system injuries
• Intoxication from lead, mercury, phosphorus, or arsenic
• Constipation also may be secondary to rhagades (anal fissures) and piles.

Genetic factors

In a retrospective study investigating the association between mitochondrial disorders and CIP in 80 patients, Amiot et al determined that 15 patients (19% of the study cohort) had mitochondrial defects, including mutations in the thymidine phosphorylase gene (5 patients), the DNA polymerase-gamma gene (5 patients), and tRNA(leu(UUR)) (2 patients); 3 of the patients had no identifiable genetic defects. Extradigestive symptoms occurred in all 15 patients.

Unlike other CIP patients, patients in whom the condition was associated with a mitochondrial defect tend to require frequent and long-term parenteral nutrition. Because of the frequent occurrence of digestive and neurologic complications, these patients also had a high incidence of premature death.

The authors suggested that mitochondrial defects are an important cause of CIP and recommended that CIP patients be tested for such defects, particularly those with severe CIP who experience associated neurologic symptoms.

Epidemiology

According to some epidemiologic reports, as many as 30 million Americans have intestinal motility disorders. Available data from the medical literature indicate that worldwide, 30-45% of all GI conditions are referable to intestinal motility disorders. When intestinal motility disorders are idiopathic and not related to either malignancies or systemic diseases, morbidity is minimal and
mortality from complications is low (1-1.5%); complications generally occur in patients with intestinal pseudo-obstruction.

Persons of any age group may be affected, depending on the specific intestinal motility disorder. For example, IBS occurs more frequently in people aged 20-40 years, whereas intestinal pseudo-obstruction may occur in either newborns or elderly patients. Most patients are female, with a female-to-male ratio of 2.8:1. Primary intestinal motility disorders are most common in white persons and are usually thought to be related to diet.

Prognosis

Primary intestinal motility disorders or disorders that are not secondary to malignancy or debilitating pathology have a good prognosis. According to many reports, the prognosis is excellent for patients with IBS and mild fecal incontinence.

The prognosis is worse for patients with intestinal pseudo-obstruction, which has a high mortality.

MOTILITY DISORDERS

“Motility” is a term used to describe the contraction of the muscles that mix and propel contents in the gastrointestinal (GI) tract. The gastrointestinal tract is divided into four distinct parts that are separated by sphincter muscles; these four regions have distinctly different functions to perform and different patterns of motility (contractions). They are the esophagus (carries food to the stomach), stomach (mixes food with digestive enzymes and grinds it down into a more-or-less liquid form), small intestine (absorbs nutrients), and colon (reabsorbs water and eliminates indigestible food residues). Abnormal motility or abnormal sensitivity in any part of the gastrointestinal tract can cause characteristic symptoms.

Gastroesophageal Reflux Disease (GERD)

The most frequent symptoms of GERD, heartburn and acid regurgitation, are so common that they may not be associated with a disease. Self-diagnosis can lead to mistreatment. Consultation
with a physician is essential to proper diagnosis and treatment of GERD.

Various methods to effectively treat GERD range from lifestyle measures to the use of medication or surgical procedures. It is essential for individuals who suffer persistent heartburn or other chronic and recurrent symptoms of GERD to seek an accurate diagnosis, to work with their physician, and to receive the most effective treatment available.

**Intestinal Pseudo-Obstruction**

Intestinal pseudo-obstruction is a rare condition with symptoms like those caused by a bowel obstruction, or blockage. But when the intestines are examined, no blockage is found. Instead, the symptoms are due to nerve (visceral neuropathy) or muscle (visceral myopathy) problems that affect the movement of food, fluid, and air through the intestines. The intestines, or bowel, include the small intestine and the large intestine, also called the colon.

Intestinal pseudo-obstruction can occur in people of any age, but it occurs more often in children and older adults. Children can have a long-lasting form of the condition called chronic intestinal pseudo-obstruction (CIP). CIP in children is usually present at birth.

In another form of intestinal pseudo-obstruction that mostly affects older adults, the colon becomes enlarged after surgery or illness. This condition is known as acute colonic pseudo-obstruction (ACPO), also called Ogilvie syndrome or acute colonic ileus. ACPO can lead to serious complications and can be life-threatening.

**Causes behind intestinal Pseudo-obstruction**

Normally, nerves and muscles work together to produce wavelike contractions that push food through the intestines. In intestinal pseudo-obstruction, nerve or muscle problems prevent normal contractions. As a result, people with the condition have problems with the movement of food, fluid, and air through the
intestines. When the cause of the nerve or muscle problems leading to intestinal pseudo-obstruction is not known, the condition is called primary or idiopathic intestinal pseudo-obstruction. If the cause is known, the condition is called secondary intestinal pseudo-obstruction. Causes of secondary intestinal pseudo-obstruction include:

- abdominal or pelvic surgery
- diseases that affect muscles and nerves, such as lupus erythematosus, scleroderma, and Parkinson’s disease
- infections
- medications such as opiates and antidepressants that affect muscles and nerves

**Symptoms of intestinal Pseudo-obstruction**

Intestinal pseudo-obstruction symptoms may include cramps, abdominal pain, nausea, vomiting, bloating, and constipation. Occasionally, intestinal pseudo-obstruction may cause diarrhea. Over time, the condition can cause bacterial infections, malnutrition, weight loss, and muscle problems in other parts of the body. Some people develop problems with their esophagus, stomach, or bladder.

**Diagnosis of intestinal pseudo-obstruction**

To diagnose intestinal pseudo-obstruction, the doctor will take a complete medical history, do a physical exam, and take x rays. The doctor will make sure that symptoms are not due to an intestinal blockage and will look for the cause of the condition, such as an underlying illness. Other testing may be needed, such as manometry to measure the patterns of intestinal contractions.

**Treatment of Intestinal pseudo-obstruction treated**

People with intestinal pseudo-obstruction often need nutritional support to prevent malnutrition and weight loss. Enteral nutrition provides liquid food through a feeding tube inserted through the nose into the stomach or placed directly into the stomach or small intestine. Some people need intravenous feeding,
also called parenteral nutrition, which provides liquid food through a tube placed in a vein.

If intestinal pseudo-obstruction is caused by an illness or medication, the doctor will treat the underlying illness or stop the medication.

Treatment may include medications, such as antibiotics to treat bacterial infections, pain medication, and medication to treat intestinal muscle problems. People with ACPO may need procedures to remove gas from the bowel. In severe cases of intestinal pseudo-obstruction, surgery to remove part of the intestine or other intestinal surgery might be necessary.

**Dyssynergic Defecation: Questions and Answers About a Common Cause of Chronic Constipation**

There is no single definition of constipation. A person may experience one or more problems such as infrequent bowel movements, hard and difficult to pass stool, incomplete bowel movements, or straining to have a bowel movement.

A number of factors can cause chronic constipation. Among the most common is a condition called dyssynergic defecation. An estimated one-quarter or more of chronic constipation is caused by this condition.

**What is Dyssynergic Defecation?**

Dyssynergic defecation is a condition in which there is a problem with the way certain nerves and muscles function in the pelvic floor.

The pelvic floor is a group of muscles located at the lower part of the abdomen, between the hip bones, that supports pelvic organs such as the rectum, uterus, and urinary bladder. One of its most important functions is to help make possible our ability to have orderly bowel movements.

Working together, nerves and muscles help maintain continence until we decide to have a bowel movement. The pelvic floor muscles together with anal opening muscles must all relax
in a coordinated way in order to have a normal bowel movement. Failure of this to happen can lead to problems of constipation.

When do Persons Develop Dyssynergic Defecation?

A survey of 100 patients with the condition found that in nearly one-third (31%) the problem began in childhood. About an equal number (29%) appeared to have developed the problem after a particular event, such as pregnancy or an injury. In the remaining 4 out of 10 persons (40%), no cause was identified that may have brought on the condition.

Over half of the individuals that developed the condition in adulthood reported frequent or intermittent passage of hard stools. It may be that too much straining to expel hard stools over time is a factor that may lead to dyssynergic defecation.

People Develop Dyssynergic Defecation: How?

It is not clear what causes dyssynergic defecation. Muscles in the abdomen, rectum, anus, and pelvic floor must all work together in order to facilitate defecation. Most patients with dyssynergic defecation exhibit an inability to coordinate these muscles. Most often this problem of coordination consists either of:

- impaired rectal contraction or tightening rather than relaxing (paradoxical contraction) the anal muscles during defecation, or
Gastric Motility Disorders

- not enough relaxation of the anal muscles.

This lack of coordination (dyssynergia) of the muscles that are involved in defecation is primarily responsible for this condition.

Besides, at least one-half (50–60%) of patients with dyssynergic defecation also show evidence of a decrease in sensation in the rectum. In other words, there is a problem with their ability to perceive the arrival of stool in the rectum.

**Symptoms of Dyssynergic Defecation**

People with dyssynergic defecation have a variety of bowel symptoms. As with many conditions involving the bowel, individuals may hesitate to speak plainly about these symptoms. Some may feel embarrassed to even mention bowel or stool-related matters. Others may simply not know how to describe their symptom experiences, or know what to discuss.

It is significant for individuals to keep in mind that anything out of the ordinary, rather than being a source of embarrassment, is often the very reason for the visit to their doctor.

It is essential to speak plainly to the doctor so he or she can most effectively diagnose and treat the problem. It is not unusual, for example, for a person with long-term constipation to find it necessary to use their finger to move stool out of the anus (doctors call this disimpacting stool with digital maneuvers).

Another common example is for women to use their fingers to press on their vagina to move stool (doctors call this vaginal splinting). In other words, these are medical signs that are meaningful to a physician.

Individuals need to feel at ease talking to their doctor. Patients and doctors both benefit from establishing a relationship of comfort and trust. Open communication is essential. It may be easier to write down the troublesome signs and symptoms before the doctor visit. The use of a symptom questionnaire or stool diary is a helpful way to communicate and identify the exact nature of a bowel problem.
Various of studies have found that the following are common symptoms or signs associated with dyssynergic defecation, with 2 out of 3 or more of individuals reporting:

- Excessive straining
- A feeling of incomplete evacuation
- The passage of hard stools
- A stool frequency of less than 3 bowel movements per week
- The use of digital maneuvers (fingers) to help have a bowel movement

Backache, heartburn, and anorectal surgery have been noted as more likely in patients with pelvic floor dysfunction. However, symptoms alone are usually not enough to predict dyssynergic defecation.

**Functional Diarrhea**

Diarrhea is defined as passing frequent and/or loose or watery stools. Acute diarrhea goes away in a few weeks, and becomes chronic when it lasts longer than 3–4 weeks. If no specific cause is found after a thorough investigation and certain criteria are met, a diagnosis of functional diarrhea may be considered.

**Functional Bowel Disorders**

People with functional bowel disorders do not demonstrate physical or laboratory abnormalities to explain their gastrointestinal (GI) symptoms. One example of a functional bowel disorder is irritable bowel syndrome (IBS), which is estimated to affect approximately 10–15% of all adults.

**Is Functional Diarrhea the Same as Irritable Bowel Syndrome?**

Individuals with functional diarrhea may represent a subgroup of people with IBS. People with IBS often report altered bowel habits, including diarrhea and/or constipation, associated with abdominal pain. Bloating, feeling an urgent need to use a bathroom, straining, or a sense of incomplete evacuation may also occur.
Many of these symptoms occur in persons with functional diarrhea but the absence of abdominal pain distinguishes these people from those with IBS.

**Evaluation of Patients with Functional Diarrhea by Doctors**

The doctor will begin with asking about your medical history, including use of medicines and dietary habits, and performing a careful physical examination. Additional studies such as blood tests and stool analysis may be ordered.

Diagnostic procedures such as colonoscopy or endoscopy may be indicated, allowing the physician to examine the inner surface of the colon and small intestine to exclude other causes of chronic diarrhea, such as infections or inflammation of the colon or small intestinal diseases.

**Importance of Medical and Dietary History**

A diagnosis of functional diarrhea is made only after other possible causes, such as medications and diet induced diarrhea, are excluded. The list of medications which cause diarrhea is extensive and includes certain antibiotics, magnesium containing antacids, blood pressure lowering agents (including beta-blockers, ACE inhibitors), and drugs to control irregular heart beat (quinidine). All medications, whether prescription or over the counter, should be brought to the attention of the physician.

Although some people are sensitive to wheat and other related grains (Celiac disease, gluten enteropathy), true food allergies are rare. However, inability to completely absorb certain food groups can, if they are eaten in sufficient quantities, lead to diarrhea in some people. Milk (lactose) intolerance is one of the more common examples of this.

People with lactose intolerance have low levels of intestinal lactase, the enzyme required to digest the milk sugar, lactose. The unabsorbed sugar then passes to the colon where it is broken down by bacteria to produce abdominal gas (bloating) and diarrhea. Whether a person develops symptoms depends on many factors including the amount of lactose ingested and the levels of lactase
enzyme in the small intestine. Treatment involves reducing or eliminating lactose in the diet or using commercial products that contain the lactase enzyme. Other persons are intolerant of fructose (found in fruit and fruit juices), sorbitol (plums, pears and sugarless gum), and caffeine (coffee, tea, many sodas). Dietary elimination of possible offending agents may resolve symptoms in sensitive persons.

**What Other Factors May Worsen Functional Diarrhea?**

Some people develop diarrhea after undergoing stomach or gallbladder surgery. The exact mechanisms are unclear, but are thought to involve increased transport of food through the GI tract or an increase in bile salts delivered to the colon.

A condition called “runner’s diarrhea” has been described. As the name suggests, these individuals experience diarrhea during long distance marathons. The cause is uncertain but may involve alterations of GI motor activity.

**Cause of Functional Diarrhea**

Although there is no consensus, one proposed mechanism relates to alterations in gastrointestinal motility. Contractions of the smooth muscle of the GI tract regulate movement of food through the small intestine and colon.

People with functional diarrhea may have different motility patterns than do people without diarrhea. However, the causes of the motility dysfunction and changes in intestinal fluid absorption leading to firmer stools or to diarrhea are incompletely understood.

**Treatments Available for Functional Diarrhea**

As the cause of functional diarrhea is unknown, treatment is aimed at symptoms. Dietary modifications include elimination of various substances known to cause diarrhea. In addition to lactose, fructose, sorbitol, and caffeine some persons develop symptoms because they do not completely digest complex carbohydrates (pasta, beans). These too may be reduced in the diet to see if there
is any improvement. Some people with IBS and diarrhea may benefit from an increase in dietary fiber. In contrast, other people benefit from carbohydrate restriction.

For people who do not improve with dietary modifications, antidiarrheal agents such as loperamide (Imodium) or diphenoxylate (Lomotil) are often effective. All work by similar mechanisms. In general, these drugs are used under the supervision of a physician; diphenoxylate requires a doctor’s prescription.

As future research uncovers the mechanisms which underlie functional diarrhea, more specific therapies will be developed. As with many functional disorders, an effective physician-patient relationship should enhance the treatment of this complex problem and promote a better understanding of the dynamics of GI symptoms.


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Preface

Gastroenterology (MeSH heading) is the branch of medicine focused on the digestive system and its disorders. At Gastroenterology Consultants we are dedicated to providing each patient with the individualized attention that you deserve. We provide each patient with state-of-the-art treatment methods that will help relieve the ailments and symptoms that you are experiencing. There are many different diseases and conditions that affect the overall health of the digestive system. The gastrointestinal tract is made up of the stomach and intestine and is often used to refer to all entities involved in the digestive tract from the mouth to anus.

Gastrointestinal diseases implies diseases comprising the gastrointestinal tract, such as the esophagus, stomach, small intestine, large intestine and rectum, and the accessory organs of digestion, the liver, gallbladder, and pancreas. A gastroenterologist needs to have a detailed understanding of the normal physiology of all the above mentioned organs as well as motility through the intestines and gastrointestinal tract in order to maintain a healthy digestion, absorption of nutrients, removal of waste and metabolic processes.

Gastroenterology is the study of the normal function and diseases of the esophagus, stomach, small intestine, colon and rectum, pancreas, gallbladder, bile ducts and liver. It involves a detailed understanding of the normal action (physiology) of the gastrointestinal organs including the movement of material through the stomach and intestine (motility), the digestion and absorption of nutrients into the body, removal of waste from the system, and the function of the liver as a digestive organ. It includes common and important conditions such as colon polyps and cancer, hepatitis,
gastroesophageal reflux (heartburn), peptic ulcer disease, colitis, gallbladder and biliary tract disease, nutritional problems, Irritable Bowel Syndrome (IBS), and pancreatitis. In essence, all normal activity and disease of the digestive organs are part of the study of Gastroenterology.

Gastro-intestinal endoscopy, once largely diagnostic, has evolved such that therapeutic procedures are often performed at the same time. This may prevent the need for major surgery. Safe and effective sedation has been a major factor in the development of therapeutic endoscopy. However, not all patients require sedation for endoscopic procedures. Some patients are quite comfortable with no sedation, or only minimal sedation, depending on the type and duration of the procedure.

It is hoped that the book will serve the purpose of students and scholars on the subject and can be useful to them in allied fields.

—Author