WHAT IS CYSTIC FIBROSIS?

Cystic fibrosis (CF) is a genetic disorder that can cause severe damage to the lungs, digestive system, and other organs in the body. CF affects the cells that produce mucus, sweat, and digestive juices. These secreted fluids are normally thin and slippery and act as lubricants. In people with CF, a mutated gene causes the secretions to become thick and sticky. Instead of lubricating, the secretions build up in tubes, ducts, and passageways of bodily organs, especially in the lungs and pancreas. Patients experience difficulty breathing, chest and lung infections, lung damage, nutritional deficits, and slow growth rates.

Cystic fibrosis is passed from parent to child through genes. Human DNA contains 46 chromosomes (23 from each parent.) The genes on these chromosomes direct cells to produce the proteins that control the body’s functions. CF is caused by damaging mutations of the cystic fibrosis transmembrane conductance regulator (CFTR) gene. If a person only has one copy of the CFTR gene with a damaging mutation, then they are a carrier for CF but will not develop any symptoms. Cystic fibrosis disease occurs when a person has damaging mutations on each copy of their CFTR gene, one mutation inherited from each parent. If two parents each have one damaging CFTR mutation and have a baby, then their child has a 25% chance of getting CF.

LABORATORY TESTS RELATED TO CYSTIC FIBROSIS

*Cystic fibrosis can affect people of all genders. In this material, the terms “male” and “man” are used to refer to people assigned male at birth. The terms “female” and “woman” are used to refer to people assigned female at birth.

UNDER THE MICROSCOPE

Most patients with CF develop chronic bacterial infections within their airways. This picture shows Mucoid Pseudomonas bacteria, which are elongated rod-shaped organisms. If not controlled, these bacteria can cause tissue damage and dangerous chronic lung infections.

ASK YOUR DOCTOR

• What is the course of action based on my lab results?
• What are my treatment options?
• What are signs and symptoms I should look out for?
• Why do you recommend this particular treatment option?
• What lab tests and which results indicate successful treatments?
• What are the markers we are monitoring? What are the levels we are looking for? What happens if the markers are outside of the reference range?
• Are their additional tests that could be used to understand my disease and prognosis better?
COMMON SIGNS AND SYMPTOMS OF CYSTIC FIBROSIS

Symptoms of CF are variable, and some may begin at birth. For example, a baby with CF may be unable to pass their first bowel movement (meconium) because of an intestinal blockage called meconium ileus. Externally, this buildup of mucus and stool causes the baby’s belly to be firm and distended. Other signs of CF in babies include coughing and shortness of breath, frequent lung infections, having a lot of mucus in the lungs, stomach pain, abnormal bowel movements, and dry or salty-tasting skin.

Cystic Fibrosis can cause growth delays, and kids with CF tend to be smaller than their peers. Teens and adults with CF often have chronic lung issues including shortness of breath and frequent coughing. People with CF may develop small growths in their noses, called nasal polyps. These small growths, which look like translucent bags of fluid, block the nasal passages and make patients feel congested.

The abnormally sticky mucus that CF creates can cause long-term damage to mucus-producing organs, including the lungs, liver, kidneys, and pancreas. This damage can cause lung disease, liver disease, kidney stone disease, and diabetes, among other complications.

Though CF does not usually affect fertility hormones like progesterone, estrogen, and testosterone, it can cause fertility issues for people of all genders. Most men with CF do not have a vas deferens, a channel that carries sperm from the testes to the urethra. They are infertile because their semen does not contain any sperm. Women with CF can have thicker than normal cervical mucus, which can prevent sperm from entering the uterus and fertilizing an egg. Many women with CF need medical intervention to get pregnant.

LAB TESTS RELATED TO DIAGNOSING CYSTIC FIBROSIS

*Reference ranges are set by individual laboratories for their specific populations so reference ranges might differ slightly.

IMMUNOREACTIVE TRYPsinogen (IRT): This is the most common of the blood tests performed on all newborns to screen for CF. A small blood sample is collected by pricking the baby’s heel, and it is tested for trypsinogen, a chemical produced by the pancreas. Infants with CF may have elevated levels of trypsinogen. An abnormal IRT result indicates that the baby may have CF and additional confirmatory testing is necessary.

SWEAT CHLORIDE TEST: This test measures the amount of chloride in sweat. CF prevents chloride molecules from moving in and out of cells, so people with CF will have more chloride in their sweat than normal. In a sweat chloride test, a chemical called pilocarpine is applied to the skin, and then the skin is stimulated with electricity to encourage sweat production. The sweat is collected for 30 minutes and sent to the lab to be tested. An abnormal sweat chloride test result is considered positive. Sweat chloride test result within normal limits suggests that CF is unlikely. A borderline sweat chloride test result will need to be clarified with genetic analysis. The sweat chloride test is the primary test for the diagnosis of CF.

LABORATORY TESTS RELATED TO MONITORING CYSTIC FIBROSIS COMPLICATIONS

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LIVER FUNCTION TESTS: This series of blood tests monitor how well the liver is working by measuring specific enzymes and proteins in a single blood sample. The liver creates enzymes, which are chemicals that help the body break down protein. Liver function tests (also called a liver panel) usually measure the following:

- Albumin, a protein made in the liver
- The total amount of protein in the blood
- Bilirubin, a waste product made by the liver
- Prothrombin time (PT) which is how long it takes blood to clot.
- Alkaline phosphatase (ALP), a liver enzyme
- Alanine aminotransferase (ALT), a liver enzyme
- Aspartate aminotransferase (AST), a liver enzyme
- Gamma-glutamyl transferase (GGT), a liver enzyme
- Lactate dehydrogenase (LDH), an enzyme found in most of the body’s cells that is released in response to damage or disease.

If any of these measurements are outside of the normal range, it can suggest liver disease.
Fecal Pancreatic Elastase: This is a stool test that monitors how well the pancreas is working. Elastase is an enzyme created in the pancreas that breaks down fats, proteins, and carbohydrates. For this test, a sample of stool is collected at home by the patient or their parent and sent to the lab. The lab measures how much elastase is present in the sample. If there is little or no elastase, the enzyme is not working as it should. This can be a sign of pancreatic insufficiency.

Lipase Test: This is a test to evaluate the pancreas by measuring the level of lipase in the blood. Lipase is a protein created by the pancreas to help digest fats. Increased blood lipase levels can be used to help diagnose pancreatitis in CF patients.

Amylase Test: This is a test to evaluate the pancreas by measuring the level of amylase in the blood. Amylase is a protein created by the pancreas and salivary glands to help break down carbohydrates. Increased amylase in one’s blood can be used to help diagnose pancreatitis, but lipase is preferred for this purpose.

Respiratory Culture: This test checks for infections in the lungs and airways. It identifies what bacteria or fungi are present so doctors can treat them quickly and effectively. Samples that can be used for this type of test include mucus coughed up from the lungs (sputum), a throat swab, or tissue from the airways taken during a surgical procedure. The sample is sent to the lab and placed in a special container that helps bacteria and fungi grow. After 1-2 days, a medical laboratory scientist will look at the growth in the culture under a microscope and perform testing to identify what type of bacteria or fungi is present (if any).

Oral Glucose Tolerance Test (OGTT): This blood test measures how well the body removes glucose (a type of sugar) from the bloodstream. CF causes mucus to build up in the pancreas, the organ that helps break down fats and sugars. The pancreas produces insulin, a chemical that helps process glucose into energy. People with CF may have trouble making insulin and can develop CF-related diabetes (CFRD) or impaired glucose tolerance (IGT). The OGTT compares the level of glucose in a patient’s blood before and after drinking a special glucose liquid. 2-hour OGTT plasma glucose levels above 200 mg/dl can mean that the patient has developed CFRD.

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Essential Fatty Acid Status: This blood test helps screen for nutritional deficiencies in CF patients. Essential fatty acids are necessary building blocks, and they cannot be made by the body. Low levels of essential fatty acids can signal that the body is not absorbing enough fat.

Urinalysis: This urine test monitors how well the kidneys are functioning. It checks the appearance, contents, and concentration of urine. Doctors use urinalysis to screen patients with CF for kidney stones.

Additional Tests to Monitor Cystic Fibrosis

Pulmonary Function Test: These are tests that measure the ability of the lungs to exchange oxygen and carbon dioxide. There are two types of pulmonary function tests:

- Spirometry: A provider will use a device called a spirometer to measure how well a patient’s lungs are working. The patient’s nose is pinched shut with a soft clip, and they are asked to inhale fully and then exhale as quickly and forcefully as they can into the mouthpiece of the spirometer. The results show how much lung capacity a patient has. If the value is lower than normal, it may mean the patient has lung damage.
- Diffusion Capacity Test: In this test of lung function, the patient breathes in air through a mouthpiece. The air contains a very small amount of carbon monoxide and a tracer gas like methane or helium. They will hold their breath for a count of ten and then rapidly breathe it out. The exhaled air is collected and studied to see how much of the tracer gas was absorbed. Values outside of the normal range (80–120% of its predicted value for men and 76–120% of its predicted value for women) may indicate that the lungs are not exchanging gasses properly.

Dual Energy X-Ray Absorptiometry (DXA or DEXA): This test measures the strength of bones by using low-dose x-rays. People with CF can develop CF-related bone disease which increases the risk of fractures. DXA scans help monitor bone density and can identify weak bones before they fracture. Levels below -1.0 are abnormal and mean that the patient is at higher risk of fractures.

X-Rays: Doctors can use chest and sinus x-rays to look for airway blockages and chronic sinusitus, which is a long-lasting infection in the nasal cavities and sinuses that can cause difficulty breathing.

Computerized Tomography (CT) Scans: These scans give doctors a high-resolution look at a patient’s lungs or sinuses. They can use a scan to look for clogged airways in the lungs and to examine the sinuses for mucus buildup and nasal polyps. CT Scans can often catch structural damage to the lungs before it will show up in other tests.
Leland was diagnosed with Cystic Fibrosis when he was 4 years old. His entire life has been structured around his CF monitoring through testing, treatment, and minimizing potential complications. Because of his diagnosis, Leland lives at a much greater risk of getting a lung infection by being exposed to germs during his everyday life. As a kid, his parents wanted him to live like every other kid, but they had to take precautions to limit the amount of contact between him and other kids.

Even with careful precautions, Leland still developed lung damage from CF. When he was 28, Leland received a double lung transplant to replace his damaged lungs. The transplant was successful, and Leland is doing well. He continues to receive follow-up care and testing multiple times a year to monitor his health post-transplant and check the effects of his treatment medications.

To learn more about other lab tests, go to www.ascp.org/patients.