

Liver Transplantation

National Digestive Diseases Information Clearinghouse



U.S. Department
of Health and
Human Services

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What is liver transplantation?

Liver transplantation is surgery to remove a diseased or injured liver and replace it with a healthy whole liver or a segment of a liver from another person, called a donor. A successful liver transplant is a life-saving treatment for people with liver failure, a condition in which the liver no longer works as it should.

What does the liver do?

The body's largest internal organ, the liver has many important functions including

- preventing infections
- removing bacteria and toxins from the blood
- controlling immune responses
- processing nutrients, medications, and hormones
- making proteins that help the blood clot
- producing bile, which helps the body absorb fats—including cholesterol—and fat-soluble vitamins
- storing vitamins, minerals, fats, and sugars for use by the body

A healthy liver is necessary for survival. A healthy liver can regenerate most of its own cells when they become damaged.

Who needs a liver transplant?

People with either acute or chronic liver failure may need a liver transplant to survive.

- Acute liver failure (ALF) happens suddenly. Drug-induced liver injury (DILI) is the leading cause of ALF in the United States. The most common cause of DILI is an overdose of acetaminophen (Tylenol).
- Chronic liver failure, also called end-stage liver disease, progresses over months, years, or decades. Most often, chronic liver failure is the result of cirrhosis, a condition in which scar tissue replaces healthy liver tissue until the liver cannot function adequately.

In U.S. adults, the most common reason for needing a liver transplant is cirrhosis caused by chronic hepatitis C, followed by cirrhosis caused by long-term alcohol abuse. Many other liver diseases also cause cirrhosis, including

- other forms of chronic hepatitis, including chronic hepatitis B and autoimmune hepatitis
- diseases that affect the bile ducts—tubes that carry bile from the liver to the gallbladder and small intestine—including biliary atresia, Alagille syndrome, primary biliary cirrhosis, and primary sclerosing cholangitis

- hemochromatosis, a genetic condition in which iron builds up in the liver
- Wilson disease, a genetic condition in which copper builds up in the liver
- nonalcoholic steatohepatitis, or NASH, a disease caused by fat and inflammation in the liver

In children, biliary atresia is the most common cause of liver failure and the need for a liver transplant. Biliary atresia is a disease in newborns in which the bile ducts are absent, damaged, or blocked. As a result, toxic bile builds up in the liver, resulting in cirrhosis.

Other reasons for liver transplantation include cancers originating in the liver such as hepatocellular carcinoma, hepatoblastoma, and cholangiocarcinoma.

What are the signs and symptoms of liver failure?

The signs and symptoms of liver failure may include

- jaundice, a condition that causes yellowing of the skin and the whites of the eyes
- fatigue
- weakness
- loss of appetite
- nausea
- weight loss
- muscle loss
- itching
- bruising or bleeding easily because blood does not clot
- bleeding in the stomach
- vomiting blood

- passing black stools
- ascites, the buildup of fluid in the abdomen
- forgetfulness or confusion

What is the process for getting a liver transplant?

The process for getting a liver transplant begins with a referral by a doctor to a transplant center. People seeking a liver transplant are carefully evaluated by a team at the transplant center to determine whether they are suitable candidates for transplantation. The evaluation includes a complete medical history, physical examination, blood and urine tests, x rays and other imaging tests, and tests to check the function of the heart, lungs, and kidneys. The transplant team usually includes liver transplant surgeons; liver specialists, called hepatologists; nurses; transplant coordinators; social workers; a psychiatrist; and other specialists. A financial counselor may help with making arrangements to pay for the transplant.

The evaluation of a transplant candidate typically includes assessment of

- the status of the person's liver disease
- other diseases and conditions the person has
- the likelihood the person will survive the transplant operation
- the person's ability to follow instructions and the complex medical regimen required after a transplant
- the person's mental and emotional health
- the person's support system

A liver transplant selection committee reviews the results of the evaluation, determines whether the person meets the transplant center's criteria for a transplant, and decides whether to register the person on the national waiting list for a transplant.

The national waiting list is maintained by the United Network for Organ Sharing (UNOS), which administers the U.S. Organ Procurement and Transplantation Network (OPTN) under contract with the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services.

Not everyone sent to the transplant center is advised to have a transplant, and not every person who starts an evaluation is placed on the transplant list. While undergoing evaluation, and while waiting for a transplant, patients should take care of their health.

Even if the liver transplant selection committee approves a candidate for a transplant, he or she may choose not to proceed with it. To ensure the person can make an informed decision about having a transplant, the transplant team provides information about the

- selection process for transplantation
- operation and recovery
- long-term demands of living with a liver transplant

Scoring Systems

When people are registered on the waiting list, they are assigned a score that indicates how urgently they need a transplant. The two scoring systems are the Model for End-stage Liver Disease (MELD) scoring system, used for people age 12 and older, and the Pediatric End-stage Liver Disease (PELD) scoring system, used for children younger than 12.

MELD and PELD scores are calculated by computer using the results of blood tests. MELD scores range from 6 to 40. PELD scores can range from negative numbers to 99. These scores are used to estimate the likelihood of dying within the next 90 days without a transplant. A higher score indicates a more urgent need for a liver transplant. While patients are on the national list wait for a transplant, their MELD or PELD score may go up if their condition worsens or go down if their condition improves.

The MELD score is calculated using the results of three blood tests:

- bilirubin, which tests the amount of bile pigment in the blood
- creatinine, which tests kidney function
- international normalized ratio (INR), which tests the blood's ability to clot

The MELD score calculation also considers whether a patient who has poor kidney function is on dialysis.

The PELD score is calculated based on

- the results of blood tests for bilirubin, INR, and albumin, the major protein in the blood
- the child's degree of growth failure
- the child's age at time of registration

The MELD and PELD scoring systems have been in place since early 2002 and have helped reduce the size of the waiting list and the amount of time a person has to wait to receive a transplant. The MELD and PELD scoring systems continue to be studied to see whether adding other factors in the calculations can increase the ability to predict the risk of death without a transplant. The UNOS uses MELD and PELD scores in allocating livers for transplantation to patients on the national waiting list. More information about the MELD and PELD scoring systems is available from the UNOS at www.unos.org/resources/meldPeldCalculator.asp and [www.unos.org/SharedContentDocuments/MELD_PELD\(1\).pdf](http://www.unos.org/SharedContentDocuments/MELD_PELD(1).pdf).

Status 1 Patients

Critically ill patients with acute liver failure who are likely to die within a week are categorized as status 1 patients and are given highest priority for liver transplantation.

What might prevent a person from having a liver transplant?

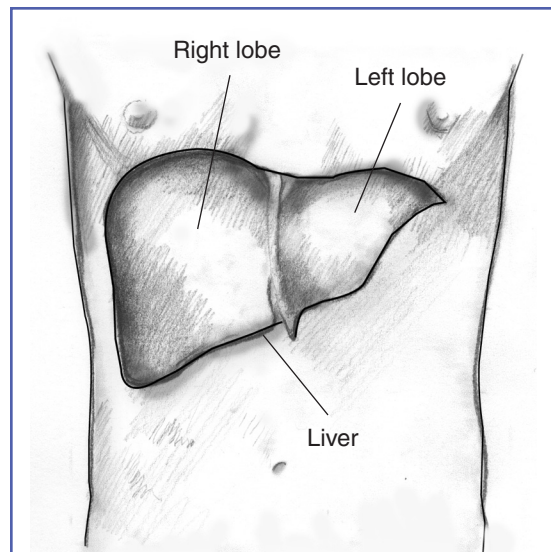
Each transplant center has its own guidelines regarding eligibility for liver transplantation. A center might determine that a person with acute or chronic liver failure is not a candidate for a liver transplant if the person has

- cancer outside the liver
- infection throughout the body
- advanced heart or lung disease
- an alcohol or drug abuse problem
- AIDS
- the inability to follow a treatment regimen
- a lack of psychosocial support

In addition, the transplant candidate may decide not to go forward with a transplant.

Where do donated livers come from?

Most donated livers come from deceased donors—donors who have recently died. Adults usually receive the entire liver from a deceased donor, although a segment of the liver can be transplanted when the donor liver is too large. Because few donor livers come from children, pediatric recipients more often receive a portion of a liver from an adult donor. Occasionally, an adult liver is split into two portions and given to two different recipients. For example, the smaller left lobe may be given to a child and the larger right lobe given to an adult.



The liver

A small number of liver transplants are performed using living donors. Most living donors are relatives of the recipient. In living donor transplantation, a segment of the donor's healthy liver is surgically removed and transplanted into the recipient. Because a healthy liver can regenerate, the donor's liver soon grows back to normal size after the surgery, while the segment of the liver that was transplanted into the recipient also grows to normal size.

The entire left lobe or a portion of the left lobe of the liver from a living adult donor is usually sufficient for transplantation in a child. For adult recipients, the larger right lobe of the liver may be needed. However, the removal of the right lobe of the liver from a living donor is a challenging and complex surgery with significant risks to the donor, including death.

According to the OPTN, about 16,000 people in the United States were on the waiting list for a liver transplant in 2008, and 6,318 liver transplants were performed.¹ Because not enough donated livers are available, many people on the waiting list must wait a long time to receive a liver, and up to one out of 10 die while on the waiting list. More donors are needed to meet the demand. Information about organ donation is available from the UNOS at www.unos.org and from the HRSA at www.organdonor.gov.

¹The Organ Procurement and Transplantation Network website. <http://optn.transplant.hrsa.gov>. Accessed October 28, 2009.

How are liver donors and potential recipients matched?

Livers for transplantation are identified and allocated through policies developed by the OPTN. The UNOS maintains a centralized computer network that links all organ procurement organizations and transplant centers in the United States. Livers are allocated to specific recipients based on the status 1 and MELD and PELD scoring systems, which give priority to people with the most urgent need for a new liver. Donors and recipients are matched on the basis of having compatible blood types and ideally should be similar in size.

When a donor liver becomes available, information about the donor is entered into the UNOS computer system. The computer creates a ranked list of potential recipients with compatible blood type and size for the donor liver. The UNOS then offers the liver to the transplant team at the center with the patient at the top of the list. The transplant team has the right to decline the liver for that patient. The team might be forced to decline the donated liver if, for example,

- the patient's condition has improved
- the patient's condition has deteriorated
- the transplant team's assessment is that the donor liver is unlikely to function properly in the recipient

If a donor liver is declined, the UNOS immediately offers the donated liver to the next patient on the list.

What happens during liver transplant surgery?

When a suitable liver from a deceased donor is matched to a person who is ready to receive it, the surgery is scheduled as quickly as possible. The recipient completes presurgical testing and is prepared for surgery while the donor liver is obtained, transported to the hospital, and carefully checked to ensure it is suitable for transplantation.

Liver transplant surgery is complex and can take up to 12 hours. The patient receiving the liver requires general anesthesia given through a breathing tube inserted into the windpipe, intravenous lines to provide medicine and fluids, and a catheter to drain urine.

An incision is made in the upper abdomen, and the surgical team detaches the diseased or injured liver from blood vessels and the common bile duct, clamps the vessels and duct, and removes the liver. The team then attaches the recipient's blood vessels and common bile duct to those in the donor liver. The donor liver is typically placed in the same location where the diseased or injured liver was. Tubes are sometimes placed around the transplanted liver to allow blood and fluids to drain out of the abdomen. A tube may be used to temporarily drain bile from the new liver into an external pouch so the bile can be measured to determine whether the liver is producing bile as it should. In cases where the recipient's common bile duct cannot be connected to the donor's bile duct, the donor bile duct is drained into a loop of small intestine.

After surgery, the patient goes to an anesthesia recovery area and then to an intensive care unit. After the patient is stabilized, the breathing tube used for anesthesia is removed and the patient moves out of intensive care and into a regular hospital room. Patients usually stay in the hospital from 1 to 2 weeks after a liver transplant.

Living donor transplants involve two surgeries performed in the same hospital. In one operating room, a surgical team removes the transplant recipient's diseased or injured liver. In another operating room, another surgical team removes a segment of the donor's healthy liver. Then the segment of donor liver is transplanted into the recipient. Otherwise, the surgery and recovery for the recipient is similar to that for a recipient of a liver from a deceased donor. The living donor typically remains hospitalized for about 1 week after surgery.

What are the complications of liver transplantation?

Possible complications of liver transplant surgery include

- bleeding
- damage to the bile ducts
- blood clots in the liver's blood vessels
- infection
- rejection of the new liver by the body's immune system
- side effects from the immunosuppressive medications liver transplant recipients must take to prevent rejection

In addition, liver diseases can recur in transplanted livers. The transplanted liver can be damaged if, for example, a person who had cirrhosis caused by long-term alcohol abuse resumes drinking after the transplant. Recurrence of certain liver diseases such as hepatitis C can also damage the transplanted liver. Recurrence of hepatitis B in the transplanted liver can now be prevented. Finally, autoimmune diseases, such as autoimmune hepatitis, primary biliary cirrhosis, and primary sclerosing cholangitis, may also recur.

If a person's transplanted liver fails as a result of rejection or recurrent disease, the doctors on the transplant team must decide whether another transplant is possible.

What is liver transplant rejection and how is it treated?

Rejection occurs when a person's immune system recognizes the transplanted liver as "foreign" and tries to destroy it. Rejection commonly occurs a week or two after a transplant, although rejection can occur at any time that immunosuppressive medications fail to control the patient's immune reaction. Rejection does not always cause noticeable symptoms. Elevated liver enzyme levels in the blood may be the first sign that rejection is occurring. Other signs and symptoms of rejection may include fatigue, loss of appetite, nausea, abdominal tenderness or pain, fever, jaundice, dark-colored urine, or light-colored stools.

A liver biopsy is usually needed to verify that rejection is occurring in the transplanted liver and exclude other causes of symptoms or abnormal liver enzyme levels. A biopsy involves using a needle to remove a small piece of liver tissue to be examined with a microscope.

Immunosuppressive medications are used to decrease the activity of the recipient's immune response to prevent and treat rejection. Transplant recipients must take immunosuppressive medications for the rest of their life to prevent rejection.

Immunosuppressive medications commonly given after a transplant include

- intravenous methylprednisolone (Depo-Medrol, Solu-Medrol), which is given during and immediately after surgery, and prednisone (Deltasone, Sterapred), once oral medications can be given
- tacrolimus (Prograf) or cyclosporine (Neoral, Sandimmune)
- sirolimus (Rapamune), which cannot be used for several months after a liver transplant because it can cause blood clots in the major artery providing blood to the transplanted liver and prevents the surgical wounds from healing; however, sirolimus is safe once the artery and wounds have completely healed
- mycophenolate mofetil (CellCept), mycophenolic acid (Myfortic), and azathioprine (Azasan, Imuran), which may be given along with cyclosporine or tacrolimus

In general, a transplant recipient needs to take more medications during the first several months after a transplant, and later

some medications may be eliminated or doses may be lowered to minimize side effects. One year after transplantation, many patients require only tacrolimus, cyclosporine, or sirolimus.

Immunosuppressive medications can have significant side effects. By suppressing the immune system, the medications can make patients more susceptible to infections. Other possible side effects include

- weight gain—prednisone
- diabetes—tacrolimus, cyclosporine
- high blood pressure—prednisone, tacrolimus, cyclosporine, sirolimus
- high blood cholesterol or triglycerides—cyclosporine, sirolimus
- osteoporosis—prednisone
- kidney damage—tacrolimus, cyclosporine, sirolimus

Long-term use of immunosuppressive medications can also increase a person's risk of developing cancers of the skin and other sites. Yearly monitoring is required to detect any cancers at an early, treatable stage.

A number of medications, as well as grapefruit and grapefruit juice, can increase or decrease the levels of tacrolimus, cyclosporine, and sirolimus in the body. To prevent complications caused by the levels of these immunosuppressive medications becoming either too high or too low, people taking these medications should avoid grapefruit and discuss any new medications—prescribed or over-the-counter—with their transplant team.

What is the outlook for people who have a liver transplant?

Most liver transplants are successful. About 80 to 85 percent of transplanted livers are functioning after 1 year.² People who have a liver transplant are usually able to return to normal activities after recovering for several months.

Liver transplant recipients receive intensive medical follow-up during the first year after a transplant. They have regular blood tests to check whether the liver is being damaged by rejection, infections, or problems with blood vessels or bile ducts.

To help achieve a good outcome after a liver transplant, recipients need to

- follow instructions for taking medications
- keep all medical appointments
- avoid people who are ill and let their doctor know when they are ill
- learn to recognize the signs of rejection and infection and report them promptly to their doctor
- maintain a healthy lifestyle by making healthy food choices, exercising, not smoking, and not drinking alcohol

²2008 annual report of the U.S. Organ Procurement and Transplantation Network and the Scientific Registry of Transplant Recipients: transplant data 1997–2007. Health Resources and Services Administration, Healthcare Systems Bureau, Division of Transplantation website. www.ustransplant.org/annual_reports/current. Accessed October 28, 2009.

Points to Remember

- Liver transplantation is surgery to remove a diseased or injured liver and replace it with a healthy whole liver or a segment of a liver from another person, called a donor.
- People with either acute or chronic liver failure may need a liver transplant to survive.
- In adults, chronic liver failure due to cirrhosis caused by hepatitis C is the most common reason for liver transplantation in the United States. The second most common reason is cirrhosis caused by long-term alcohol abuse.
- In children, biliary atresia is the most common cause of liver failure and the need for a liver transplant.
- The process for getting a liver transplant begins with referral to a transplant center, where a transplant team carefully evaluates candidates to determine whether they are suitable candidates for transplantation. The transplant center's liver transplant selection committee decides whether to register a candidate on the national waiting list for a transplant.
- The national waiting list is maintained by the United Network for Organ Sharing (UNOS). The UNOS administers the U.S. Organ Procurement and Transplantation Network (OPTN) under contract with the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services.
- People on the waiting list are assigned a score that indicates how urgently they need a transplant. The two scoring systems are the Model for End-stage Liver Disease (MELD) scoring system, used for people age 12 and older, and

the Pediatric End-stage Liver Disease (PELD) scoring system, used for children younger than 12. A higher score indicates a more urgent need for a liver transplant.

- Critically ill patients with acute liver failure who are likely to die within a week are categorized as status 1 patients and are given highest priority for liver transplantation.
- Most livers for transplantation come from deceased donors. A small number of transplants involve living donors, who donate part of their liver, usually to a family member.
- Liver transplant surgery is complex and can take up to 12 hours. Patients usually stay in the hospital from 1 to 2 weeks after a liver transplant.
- Complications after liver transplant surgery may include bleeding, bile leaks, blood clots in the liver's blood vessels, infection, rejection of the new liver, and side effects from immunosuppressive medications.
- Liver transplant recipients must take immunosuppressive medications for the rest of their life.
- Most liver transplants are successful. People who have a liver transplant are usually able to return to normal activities after recovering for several months.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), through its Liver Disease Research Branch, focuses and accelerates research on liver disease within the Institute and helps coordinate and stimulate liver-related research across the National Institutes of Health and within other federal agencies. The NIDDK aims to improve long-term success and organ availability for liver transplantation as a treatment of acute and chronic liver failure and to provide a means to reliably diagnose, manage, treat, and prevent its major complications.

The NIDDK supports and conducts a wide variety of research related to liver diseases, liver failure, and liver transplantation. Examples of studies funded by the NIDDK include those investigating adult-to-adult living donor liver transplantation, ways to prevent the recurrence of hepatitis C after liver transplantation, and acute liver failure in children.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit www.ClinicalTrials.gov.

For More Information

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Organ Procurement and Transplantation Network

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