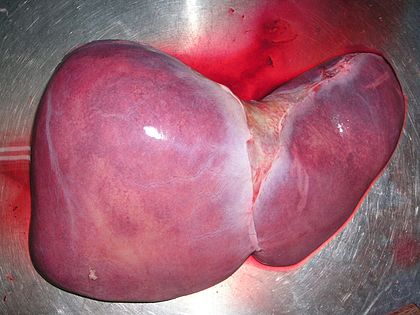
Liver transplant:

Liver transplantation or hepatic transplantation is the replacement of a diseased liver with some or all of a healthy liver from another person (allograft). The most commonly used technique is phototropic transplantation, in which the native liver is removed and replaced by the donor organ in the same anatomic location as the original liver. Liver transplantation is a viable treatment option for end-stage liver disease and acute liver failure. Typically three surgeons and two anesthesiologists are involved, with up to four supporting nurses. The surgical procedure is very demanding and ranges from 4 to 18 hours depending on outcome. Numerous anastomoses and sutures, and many disconnections and reconnections of abdominal and liver tissue, must be made for the transplant to succeed, requiring an eligible recipient and a well-calibrated live or cadaveric donor match.



History

The first human liver transplant was performed in 1963 by a surgical team led by Dr. Thomas Starzl of Denver, Colorado, United States.[1] Dr. Starzl performed several additional transplants over the next few years before the first short-term success was achieved in 1967 with the first one-year survival post transplantation. Despite the development of viable surgical techniques, liver transplantation remained experimental through the 1970s, with one year patient survival in the vicinity of 25%. The introduction of ciclosporin by Sir Roy Calne, Professor of Surgery Cambridge, markedly improved patient outcomes, and the 1980s saw recognition of liver transplantation as a standard clinical treatment for both adult and pediatric patients with appropriate indications. Liver transplantation is now performed at over one hundred centers in the US, as well as numerous centres in Europe and elsewhere. One-year patient survival is 80–85%, and outcomes continue to improve, although liver transplantation remains a formidable procedure with frequent complications. The supply of liver allografts from non-living donors is far short of the number of potential recipients, a reality that has spurred the development of living donor liver transplantation. The first altruistic living liver donation in Britain was performed in December 2012 in St James University Hospital Leeds. First transplant in Pakistan was performed in 2011 (This transplant is momentous as it was done with help from doctors from India).

Indications

Liver transplantation is potentially applicable to any acute or chronic condition resulting in irreversible liver dysfunction, provided that the recipient does not have other conditions that will preclude a successful transplant. Uncontrolled metastatic cancer outside liver, active drug or alcohol abuse and active septic infections are absolute contraindications. While HIV infection was once considered an absolute contraindication, this has been changing recently. Advanced age and serious heart, lung, or other disease may also prevent transplantation (relative contraindications). Most liver transplants are performed for chronic liver diseases that lead to irreversible scarring of the liver, or cirrhosis of the liver. Some centers use the Milan criteria to select patients with liver cancers for liver transplantation.

Techniques

Before transplantation, liver-support therapy might be indicated (bridging-to-transplantation). Artificial liver support like liver dialysis or bioartificial liver support concepts are currently under preclinical and clinical evaluation. Virtually all liver transplants are done in an orthotopic fashion, that is, the native liver is removed and the new liver is placed in the same anatomic location.[1] The transplant operation can be conceptualized as consisting of the hepatectomy (liver removal) phase, the anhepatic (no liver) phase, and the postimplantation phase. The operation is done through a large incision in the upper abdomen. The hepatectomy involves division of all ligamentous attachments to the liver, as well as the common bile duct, hepatic artery, hepatic vein and portal vein. Usually, the retrohepatic portion of the inferior vena cava is removed along with the liver, although an alternative technique preserves the recipient's vena cava ("piggyback" technique).

The donor's blood in the liver will be replaced by an ice-cold organ storage solution, such as UW (Viaspan) or HTK until the allograft liver is implanted. Implantation involves anastomoses (connections) of the inferior vena cava, portal vein, and hepatic artery. After blood flow is restored to the new liver, the biliary (bile duct) anastomosis is constructed, either to the recipient's own bile duct or to the small intestine. The surgery usually takes between five and six hours, but may be longer or shorter due to the difficulty of the operation and the experience of the surgeon.

The large majority of liver transplants use the entire liver from a non-living donor for the transplant, particularly for adult recipients. A major advance in pediatric liver transplantation was the development of reduced size liver transplantation, in which a portion of an adult liver is used for an infant or small child. Further developments in this area included split liver transplantation, in which one liver is used for transplants for two recipients, and living donor liver transplantation, in which a portion of a healthy person's liver is removed and used as the allograft. Living donor liver transplantation for pediatric recipients involves removal of approximately 20% of the liver (Couinaud segments 2 and 3).

Further advance in liver transplant involves only resection of the lobe of the liver involved in tumors and the tumor-free lobe remains within the recipient. This speeds up the recovery and the patient stay in the hospital quickly shortens to within 5–7 days.

Many major medical centers are now using radiofrequency ablation of the liver tumor as a bridge while awaiting for liver transplantation. This technique has not been used universally and further investigation is warranted.

Graft rejection

After a liver transplantation, there are three types of graft rejection that may occur. They include hyperacute rejection, acute rejection and chronic rejection. Hyperacute rejection is caused by preformed anti-donor antibodies. It is characterized by the binding of these antibodies to antigens on vascular endothelial cells. Complement activation is involved and the effect is usually profound. Hyperacute rejection happens within minutes to hours after the transplant procedure. Unlike hyperacute rejection, which is B cell mediated, acute rejection is mediated by T cells. It involves direct cytotoxicity and cytokine mediated pathways. Acute rejection is the most common and the primary target of immunosuppressive agents. Acute rejection is usually seen within days or weeks of the transplant. Chronic rejection is the presence of any sign and symptom of rejection after 1 year. The cause of chronic rejection is still unknown but an acute rejection is a strong predictor of chronic rejections. Liver rejection may happen anytime after the transplant. Lab findings of a liver rejection include abnormal AST, ALT, GGT and liver function values such as prothrombin time, ammonia level, bilirubin level, albumin concentration, and blood glucose. Physical findings include encephalopathy, jaundice, bruising and bleeding tendency. Other nonspecific presentation are malaise, anorexia, muscle ache, low fever, slight increase in white blood count and graft-site tenderness.

Results

Prognosis is quite good, but those with certain illnesses may differ.[4] There is no exact model to predict survival rates; those with transplant have a 58% chance of surviving 15 years.[5] Failure of the new liver occurs in 10% to 15% of all cases. These percentages are contributed to by many complications. Early graft failure is probably due to preexisting disease of the donated organ. Others include technical flaws during surgery such as revascularization that may lead to a nonfunctioning graft.

Who Needs a Liver transplant?

Liver transplantation surgically replaces a failing or diseased liver with one that is normal and healthy. At this time, transplantation is the only cure for liver insufficiency or liver failure because no device or machine reliably performs all of the functions of the liver. People who require liver transplants typically have one of the following conditions.

Acute Liver Failure

Acute liver failure, also known as fulminant hepatic failure, occurs when a previously healthy liver suffers massive injury resulting in clinical signs and symptoms of liver insufficiency. Any number of things can lead to acute liver failure but the most common causes are acetaminophen (Tylenol®) overdose, viral infections (known or yet unknown virus), ingestion of a toxin such as poisonous mushrooms, or an idiosyncratic drug reaction.

The hallmark of this condition is the development of confusion (encephalopathy) within eight weeks after the onset of yellowing of the skin (jaundice). Confusion occurs because toxins typically metabolized by the liver accumulate. Unlike patients with chronic liver disease, who can survive weeks to months to years while awaiting liver transplantation, patients with acute liver failure may die within days if not transplanted. These patients are listed at highest priority (Status I), placing them at the top of local, regional and national waiting lists for a donor liver.

Chronic liver failure

The liver has a remarkable ability to repair itself in response to injury. Nevertheless, repeated injury and repair, typically over many years and even decades, scars the liver permanently. The end stage of scarring is termed cirrhosis and corresponds to the point where the liver can no longer repair itself. Once a person has cirrhosis, he or she may begin to show signs of inadequate liver function. This is termed "decompensated liver disease." Although medications can decrease the symptoms caused by the liver failure, liver transplantation represents the only permanent cure.

Signs and Symptoms of Decompensated Liver Disease

Gastrointestinal bleeding: As the liver becomes increasingly scarred, the resistance to portal blood flow increases leading to increased pressure in the portal venous system. This portal hypertension necessitates alternative routes for blood to return to the heart. Small veins throughout the abdomen, but outside of the liver, then become enlarged and thin-walled due to the abnormally high amount of blood flowing through them under increased pressure. These fragile veins, called varices, often line portions of the gastrointestinal tract, especially the esophagus and the stomach, and are prone to rupture and bleeding. When bleeding occurs into the intestinal tract, it can be life-threatening.

Fluid retention: One function of the liver is to synthesize many of the proteins circulating in the bloodstream, including albumin. Albumin and other proteins in the blood stream retain fluid in the vascular space by exerting what is known as an oncotic (or osmotic) pressure. In liver failure, low albumin levels force fluid out of the bloodstream, which cannot be re-absorbed. Fluid therefore accumulates in tissues and body cavities, most commonly, in the abdominal cavity, which is termed "ascites." Fluid can also accumulate in the legs (peripheral or pedal edema), or in the chest cavity (hydrothorax). Fluid retention is treated first by strict limitation of dietary salt intake, second with medications (diuretics) that force increased salt and water loss through the kidneys and, lastly, by intermittent drainage through insertion of a needle into the abdominal or chest cavity.

Encephalopathy: Failure of the liver to clear ammonia and other toxins from the blood allows these substances to accumulate. These toxins result in cognitive dysfunction that ranges from disturbed sleep-wake cycle patterns to mild confusion to coma.

Jaundice: One of the main functions of the liver is to eliminate the degradation products of hemoglobin, the molecule that carries oxygen in our blood. Bilirubin is one of those degradation products processed and excreted by the liver. In liver failure, bilirubin is not cleared from the body and bilirubin levels increase in the blood. The skin and all tissues of the body will then assume a yellow color.

**Causes of Liver Injury**

**Viral Hepatitis**

* Hepatitis B: Hepatitis B infection accounts for 5% of all liver transplants performed in the United States but accounts for a larger proportion of liver transplants in other parts of the world, especially Asia and Australia / New Zealand.
* Hepatitis C: This is the most common indication for liver transplantation in the United States, affecting nearly 50% of all liver transplant recipients.

**Alcoholic Liver Disease**

Liver failure due to alcohol abuse is the second most common indication for liver transplantation in the United States. Most centers require at least a six-month period of abstinence, often within a recognized substance abuse program such as Alcoholics Anonymous, as a condition of listing for transplantation.

**Metabolic Liver Disease**

Non-alcoholic steatohepatitis (NASH): Deposition of fat within liver cells may result in inflammation that injures and scars the liver. Risk factors for the development of fatty liver and NASH include obesity and metabolic conditions such as diabetes and hyperlipidemia (increased cholesterol). The percentage of patients being transplanted for this condition has increased 35 fold from 2000 to 2005.

**Autoimmune Liver Disease**

* Autoimmune hepatitis (destruction of the liver by the patient's own immune system)
* Cholestatic Liver Diseases
* Primary Biliary Cirrhosis (PBC) (destruction of small bile ducts within the liver)
* Primary Sclerosing Cholangitis (PSC) (destruction of bile ducts inside and outside the liver). Seventy percent of patients with PSC also suffer from ulcerative colitis, an autoimmune disorder of the colon.
* Neonatal sclerosing cholangitis (infection and scarring of the bile ducts in the liver of an infant)
* Biliary atresia (absence of bile ducts outside the liver)
* Caroli's disease (abnormality of the bile ducts within the liver)
* TPN-induced cholestasis. Patients who receive intravenous nutrition, termed total parenteral nutrition (TPN) sometimes develop bile stasis (slowing or stopping of normal bile flow) that can, over time, lead to liver injury and failure.

**Genetic Liver Disease**

* Hemachromatosis: excess iron deposition in the liver
* Wilson's disease: abnormal copper metabolism
* Alpha-1 anti-trypsin deficiency: lack of a gene product that limits the activity of trypsin, an enzyme that digests protein. Over time this leads to progressive destruction of the liver and lung.
* Glycogen storage disease (type I, III, IV): an inherited metabolic disorder
* Tyrosinemia: a disorder of tyrosine metabolism

## Living donor transplantation

[](https://en.wikipedia.org/wiki/File:LDLT_volume_measure.jpg)

Volume rendering image created with [computed tomography](https://en.wikipedia.org/wiki/Computed_tomography), which can be used to evaluate the volume of the liver of a potential donor.

**Living donor liver transplantation** (LDLT) has emerged in recent decades as a critical [surgical](https://en.wikipedia.org/wiki/Surgery) option for patients with end stage liver disease, such as [cirrhosis](https://en.wikipedia.org/wiki/Cirrhosis) and/or [hepatocellular carcinoma](https://en.wikipedia.org/wiki/Hepatocellular_carcinoma) often attributable to one or more of the following: long-term [alcohol abuse](https://en.wikipedia.org/wiki/Alcoholism), long-term untreated [hepatitis C](https://en.wikipedia.org/wiki/Hepatitis_C) infection, long-term untreated [hepatitis B](https://en.wikipedia.org/wiki/Hepatitis_B) infection. The concept of LDLT is based on (1) the remarkable regenerative capacities of the human liver and (2) the widespread shortage of [cadaveric](https://en.wikipedia.org/wiki/Cadaver) livers for patients awaiting [transplant](https://en.wikipedia.org/wiki/Organ_transplant). In LDLT, a piece of healthy liver is surgically removed from a living person and transplanted into a recipient, immediately after the recipient’s diseased liver has been entirely removed.

Historically, LDLT began with terminal pediatric patients, whose parents were motivated to risk donating a portion of their compatible healthy livers to replace their children's failing ones. The first report of successful LDLT was by Dr. [Christoph Broelsch](https://en.wikipedia.org/wiki/Christoph_Broelsch) at the [University of Chicago Medical Center](https://en.wikipedia.org/wiki/University_of_Chicago_Medical_Center) in November 1989, when two-year-old Alyssa Smith received a portion of her mother's liver.[[6]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-6) Surgeons eventually realized that adult-to-adult LDLT was also possible, and now the practice is common in a few reputable medical institutes. It is considered more technically demanding than even standard, cadaveric donor liver transplantation, and also poses the ethical problems underlying the indication of a major surgical operation ([hemihepatectomy](https://en.wikipedia.org/w/index.php?title=Hemihepatectomy&action=edit&redlink=1" \o "Hemihepatectomy (page does not exist)) or related procedure) on a healthy human being. In various case series, the risk of complications in the donor is around 10%, and very occasionally a second operation is needed. Common problems are [biliary fistula](https://en.wikipedia.org/wiki/Biliary_fistula), [gastric stasis](https://en.wikipedia.org/w/index.php?title=Gastric_stasis&action=edit&redlink=1) and [infections](https://en.wikipedia.org/wiki/Infection); they are more common after removal of the right lobe of the liver. Death after LDLT has been reported at 0% (Japan), 0.3% (USA) and <1% (Europe), with risks likely to decrease further as surgeons gain more experience in this procedure.[[7]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-FOOTNOTEUmeshitaFujiwaraKiyosawaMakuuchi2003-7) Since the law was changed to permit altruistic non-directed living organ donations in the UK in 2006, the first altruistic living liver donation took place in Britain in December 2012.[[8]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-8)

In a typical adult recipient LDLT, 55 to 70% of the liver (the right lobe) is removed from a healthy living donor. The donor's liver will regenerate approaching 100% function within 4–6 weeks, and will almost reach full volumetric size with recapitulation of the normal structure soon thereafter. It may be possible to remove up to 70% of the liver from a healthy living donor without harm in most cases. The transplanted portion will reach full function and the appropriate size in the recipient as well, although it will take longer than for the donor.[[9]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-9)

Living donors are faced with risks and/or complications after the surgery. Blood clots and biliary problems have the possibility of arising in the donor post-op, but these issues are remedied fairly easily. Although death is a risk that a living donor must be willing to accept prior to the surgery, the mortality rate of living donors in the United States is low. The LDLT donor's immune system does diminish as a result of the liver regenerating, so certain foods which would normally cause an upset stomach could cause serious illness.

### Liver donor requirements

[](https://en.wikipedia.org/wiki/File:LDLTA.jpg)

[CT scan](https://en.wikipedia.org/wiki/CT_scan) performed for evaluation of a potential donor. The image shows an unusual variation of hepatic artery. The left hepatic artery supplies not only left lobe but also segment 8. The anatomy makes right lobe donation impossible. Even used as left lobe or lateral segment donation, it would be very technically challenging in anastomosing the small arteries.

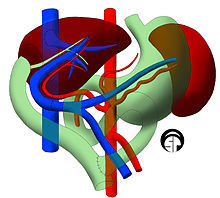
Any member of the family, parent, sibling, child, spouse or a volunteer can donate their liver. The criteria[*[citation needed](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*] for a liver donation include:

* Being in good health
* Having a [blood type](https://en.wikipedia.org/wiki/Blood_type) that matches or is compatible with the recipient's, although some centres now perform blood group incompatible transplants with special immuno suppression protocols
* Having a charitable desire of donation without financial motivation
* Being between 18 and 60 years old
* Being of similar or bigger size than the recipient
* Before one becomes a living donor, the donor must undergo testing to ensure that the individual is physically fit. Sometimes CT scans or MRIs are done to image the liver. In most cases, the work up is done in 2–3 weeks.[[10]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-Who_can_be_a_Donor.3F_-_University_of_Maryland_Medical_Center-10)

### Complications

Living donor surgery is done at a major center. Very few individuals require any [blood transfusions](https://en.wikipedia.org/wiki/Blood_transfusions) during or after surgery. All potential donors should know there is a 0.5 to 1.0 percent chance of death. Other risks of donating a liver include bleeding, infection, painful incision, possibility of [blood clots](https://en.wikipedia.org/wiki/Blood_clots) and a prolonged recovery.[[11]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-Liver_Transplant-11) The vast majority of donors enjoy complete and full recovery within 2–3 months.

### Pediatric transplantation

[](https://en.wikipedia.org/wiki/File:Left_Liver_Transplant.jpg)

In children, due to their smaller [abdominal cavity](https://en.wikipedia.org/wiki/Abdominal_cavity), there is only space for a partial segment of liver, usually the left lobe of the donor's liver. This is also known as a "split" liver transplant. There are four [anastomoses](https://en.wikipedia.org/wiki/Anastomoses) required for a "split" liver transplant: hepaticojejunostomy ([biliary](https://en.wikipedia.org/wiki/Biliary_tract" \o "Biliary tract) drainage connecting to a roux limb of [jejunum](https://en.wikipedia.org/wiki/Jejunum)), [portal venous](https://en.wikipedia.org/wiki/Hepatic_portal_vein) anatomosis, [hepatic arterial](https://en.wikipedia.org/wiki/Hepatic_artery_proper) anastomosis, and [inferior vena cava](https://en.wikipedia.org/wiki/Inferior_vena_cava) anastomosis.

In children, living liver donor transplantations have become very accepted. The accessibility of adult parents who want to donate a piece of the liver for their children/infants has reduced the number of children who would have otherwise died waiting for a transplant. Having a parent as a donor also has made it a lot easier for children - because both patients are in the same hospital and can help boost each other's morale.[[12]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-What_I_need_to_know_about_Liver_Transplantation-12)

### Benefits

There are several advantages of living liver donor transplantation over cadaveric donor transplantation, including:

* Transplant can be done on an elective basis because the donor is readily available
* There are fewer possibilities for complications and death than there would be while waiting for a cadaveric organ donor
* Because of donor shortages, [UNOS](https://en.wikipedia.org/wiki/UNOS) has placed limits on cadaveric organ allocation to foreigners who seek medical help in the USA. With the availability of living donor transplantation, this will now allow foreigners a new opportunity to seek medical care in the USA.

### Screening for donors

Living donor transplantation is a multidisciplinary approach. All living liver donors undergo medical evaluation. Every hospital which performs transplants has dedicated nurses that provide specific information about the procedure and answer questions that families may have. During the evaluation process, confidentiality is assured on the potential donor. Every effort is made to ensure that organ donation is not made by coercion from other family members. The transplant team provides both the donor and family thorough counseling and support which continues until full recovery is made.[[13]](https://en.wikipedia.org/wiki/Liver_transplantation#cite_note-Liver_Donor:_All_you_need_to_know-13)

All donors are assessed medically to ensure that they can undergo the surgery. Blood type of the donor and recipient must be compatible but not always identical. Other things assessed prior to surgery include the anatomy of the donor liver. However, even with mild variations in [blood vessels](https://en.wikipedia.org/wiki/Blood_vessels) and [bile duct](https://en.wikipedia.org/wiki/Bile_duct), surgeons today are able to perform transplantation without problems. The most important criterion for a living liver donor is to be in excellent health.

## Fact about Liver transplant

1. A liver transplant is a last-resort treatment for a variety of liver-damaging conditions including alcohol abuse, hepatitis, and cancer.
2. Around 6,000 liver transplant surgeries are performed in the United States every year.
3. When you’re chosen to receive a liver transplant will depend on how severe your condition is and how long you’ve been on the national transplant list.

A liver transplant can help save your life when your liver no longer works. Also called a hepatic transplantation, the treatment involves surgical removal of your entire liver. It’s then replaced with a healthy donor liver. This may come from a living or deceased donor.

Having a healthy liver is essential to longevity because your liver is responsible for filtering blood and removing toxins from your body. Liver transplant is a last-resort measure for chronic (long-term) liver diseases and severe acute (sudden-onset) liver diseases.

## Why liver transplants are done

According to the [American Liver Foundation](http://www.liverfoundation.org/patients/organdonor/about/), around 6,000 liver transplant surgeries are performed in the United States every year.

A doctor may recommend a liver transplant for a person with end-stage liver disease. A person with this condition will die without a transplant.

A liver transplant may also be suggested if other traditional treatments for liver disease aren’t enough to keep a person alive. Liver transplants may be offered for chronic liver disease or if liver failure happens very quickly.

Cirrhosis is the most common reason why adults need liver transplants. Cirrhosis replaces healthy liver tissue with scarred tissue. Causes of cirrhosis include:

* alcohol abuse
* chronic hepatitis B or chronic hepatitis C
* nonalcoholic fatty liver disease
* [autoimmune hepatitis](http://www.healthline.com/health/autoimmune-hepatitis)
* biliary atresia, a liver disease in newborns
* metabolic disorders

Your medical team will also consider other factors when determining if you need a liver transplant. These include:

* how severe your condition is
* other medical conditions you have
* a history of [tuberculosis](http://www.healthline.com/health/tuberculosis) and chronic infections like HIV
* your overall physical condition
* your mental well-being
* level of support from your family or friends

Before granting a liver transplant, a doctor will weigh whether it will both extend a person’s life and be successful. A person may not be a likely transplant candidate if they have other chronic conditions that could affect a transplant’s success.

Examples include a person who has cancer that has spread to other body parts or has severe heart problems. As another example, if a person has cirrhosis from alcoholism, their ability to quit drinking is evaluated as part of the transplant planning.

## Possible risks and complications of a liver transplant

The greatest risk of this operation is transplant failure. In such a case, your body rejects the new liver, often for reasons doctors can’t determine. A liver transplant also puts you at a high risk for infection. Other long-term complications can include:

* bleeding
* damage to the bile ducts
* blood clots
* side effects from medications taken to allow your immune system to accept the new liver — including high blood sugar from steroids

## Liver transplant survival statistics

According to the [American Liver Foundation](http://www.liverfoundation.org/patients/organdonor/about/), people who have a liver transplant have an 86 percent chance of living after one year. The three-year survival rate is 78 percent. Sometimes the transplanted liver can fail, or the original disease may return.

It’s important that your doctor monitors your recovery long after the transplant to detect any potential problems. You’ll likely need regular blood tests. According to [John Hopkins](http://www.hopkinsmedicine.org/healthlibrary/test_procedures/gastroenterology/liver_transplantation_procedure_92,p07698/), you’ll also need to take antirejection medications for the rest of your life.

## Healthy liver tips

After a liver transplant, your doctor may recommend lifestyle changes, including regular exercise and a healthy diet. You can incorporate habits like these at any stage to boost your strength and overall health. Being physically healthy may reduce your chances for transplant rejection.

You can also limit risk factors that contribute to liver disease. Among the most common are:

* alcohol abuse
* smoking
* acetaminophen overdose
* obesity and high cholesterol