# Cigna Medical Coverage Policy

**Effective Date** ..... **5/15/2014**
**Next Review Date** ..... **5/15/2015**
**Coverage Policy Number** ..... **0355**

**Subject** **Liver Transplantation**

**Table of Contents**

Coverage Policy ..... 1
General Background ..... 2
Coding/Billing Information ..... 8
References ..... 9

**Hyperlink to Related Coverage Policies**

Transarterial Chemoembolization
Transplantation Donor Charges

***INSTRUCTIONS FOR USE***
*The following Coverage Policy applies to health benefit plans administered by Cigna companies. Coverage Policies are intended to provide guidance in interpreting certain **standard** Cigna benefit plans. Please note, the terms of a customer's particular benefit plan document [Group Service Agreement, Evidence of Coverage, Certificate of Coverage, Summary Plan Description (SPD) or similar plan document] may differ significantly from the standard benefit plans upon which these Coverage Policies are based. For example, a customer's benefit plan document may contain a specific exclusion related to a topic addressed in a Coverage Policy. In the event of a conflict, a customer's benefit plan document **always supersedes** the information in the Coverage Policies. In the absence of a controlling federal or state coverage mandate, benefits are ultimately determined by the terms of the applicable benefit plan document. Coverage determinations in each specific instance require consideration of 1) the terms of the applicable benefit plan document in effect on the date of service; 2) any applicable laws/regulations; 3) any relevant collateral source materials including Coverage Policies and; 4) the specific facts of the particular situation. Coverage Policies relate exclusively to the administration of health benefit plans. Coverage Policies are not recommendations for treatment and should never be used as treatment guidelines. In certain markets, delegated vendor guidelines may be used to support medical necessity and other coverage determinations. Proprietary information of Cigna. Copyright ©2014 Cigna*

## Coverage Policy

**Cigna covers liver transplantation as medically necessary for individuals with ANY of the following indications:**

- end-stage liver failure
- hepatocellular carcinoma (i.e., single lesion ≤ 5 cm, up to three separate lesions, none larger than 3 cm, no evidence of gross vascular invasion and no regional nodal metastasis)
- hepatoblastoma which is confined to the liver (children)
- metabolic disease with intact hepatic synthetic function (e.g., type I hyperoxaluria, familial homozygous hypercholesterolemia, familial amyloidosis)
- unresectable hilar cholangiocarcinoma when the individual has received a Model for End-Stage Liver Disease (MELD) score exception by a United Network for Organ Sharing (UNOS) Regional Review Board for all of the following considerations:
  - a UNOS approved treatment protocol
  - mass ≤3cm on imaging studies
  - absence of metastasis
  - completion of neoadjuvant therapy
  - subsequent operative staging
- neuroendocrine/gastroenteropancreatic (GEP) tumors with ALL of the following:
  - unresectable liver metastasis
  - prior complete resection of the primary GEP
  - absence of extrahepatic metastasis
  - failure to respond to medical and/or interventional treatment

- severe hypoglycemia, poorly controlled hyperglycemia, cardiac distress, respiratory distress or other symptoms directly attributable to aberrant GEP tumor production of life-threatening hormones such as insulin, catecholamines, or histamine

**Cigna covers liver retransplantation as medically necessary for individuals considered to have a significant chance of success and who still meet eligibility criteria for primary transplantation for ANY of the following indications:**

- primary graft failure
- hepatic artery thrombosis
- severe rejection
- recurrence of the disease which prompted the initial liver transplantation

**Cigna does not cover liver transplantation for individuals with ANY of the following contraindications to transplant surgery because it is considered not medically necessary (this list may not be all-inclusive):**

- ongoing alcohol abuse
- active extrahepatic malignancy that is expected to significantly limit future survival
- persistent, recurrent or unsuccessfully treated major or systemic infections
- systemic illness or comorbidities that would be expected to substantially negatively impact the successful completion and/or outcome of transplant surgery
- a pattern of demonstrated noncompliance which would place a transplanted organ at serious risk of failure
- human immunodeficiency virus (HIV) disease unless ALL of the following are noted:
  - cluster determinant (CD)4 count >100 cells/$mm^3$
  - HIV-1 ribonucleic acid (RNA) undetectable
  - stable antiretroviral therapy for more than three months
  - absence of serious complications associated with HIV disease (e.g., opportunistic infection, including aspergillus, tuberculosis, coccidioidomycosis; or resistant fungal infections; or Kaposi's sarcoma or other neoplasm)
- known intrahepatic or central cholangiocarcinoma
- donor with:
  - ongoing alcohol abuse
  - active malignancy, with the exception of non-melanotic skin cancer
  - persistent, recurrent or unsuccessfully treated infections, including hepatitis A, B or C or HIV
  - active systemic illness or serious comorbidities that would be expected to substantially negatively impact the successful completion and/or outcome of transplant surgery
  - active systemic illness that is likely to negatively affect survival

---

## General Background

Liver transplantation is a complex operation requiring vascular reconstruction of the hepatic artery, the portal vein, and the hepatic venous system. Surgical techniques, which continue to evolve, include the orthotopic approach, involving replacement of the recipient liver with the donor liver, and the heterotopic approach in which the recipient liver is left in place and the donor liver is transplanted to an ectopic site. The whole liver, a reduced liver, or a liver segment may be transplanted depending on whether the donor is cadaveric (deceased) or living.

Living-donor liver transplantation was introduced as an alternative to deceased donor transplantation in response to the shortage of available cadaveric donor organs and is used for both adults and children. The graft from a living donor is more commonly from a relative of the recipient. The success of this type of transplantation is based on the ability of the liver to regenerate in both the donor and the recipient. The graft must be of adequate size in order to function in the recipient (Emond, 2001).The risks and benefits of using a living-donor graft must be considered as there are surgical risks to both the recipient and the donor. Benefits to the recipient include a reduced chance of mortality related to waiting for a cadaveric-donor organ, a reduced likelihood of primary non-function of the graft, and a potential decrease in the chance of graft rejection and the need for immunosuppression (OPTN, 2014).

A major factor in patient survival following transplantation is the degree of hepatic decompensation and associated debility at the time of transplantation. Using the Model for End Stage Liver Disease (MELD) scoring model for an individual who is ≥12 years, and the Pediatric End-Stage Liver Disease (PELD) scoring model for a child <12 years, a donor organ is allocated to a transplant candidate designated as having the greatest risk of death. Exceptions to this policy, which result in the assignment of additional MELD/PELD points and therefore a higher priority for allocation of donor organs, can be requested of a United Network for Organ Sharing (UNOS) regional review board by the transplanting physician and/or facility for individuals with certain diagnoses, such as unresectable hilar cholangiocarcinoma (CCA).

Outcomes of liver transplantation have improved due to effective immunosuppression, improved surgical preservation techniques, and better strategies to treat postoperative complications. Both patient and graft survival rates are calculated to determine overall survival. Based on primary liver transplants performed between 1997 and 2004, one- and five-year patient survival rates for cadaveric (deceased) donor recipients were 87.7% and 74.3%, respectively, with one- and five-year graft survival rates of 83.3% and 67.3%, respectively (OPTN, 1997-2004).

**Indications for Liver Transplantation**
Although liver transplantation has not been studied in randomized controlled clinical trials it is considered the standard of care for selected individuals with liver failure not amenable to alternative medical or surgical care. In the absence of absolute contraindications, liver transplantation is considered a standard treatment option for selected individuals with acute and chronic end-stage liver failure. Important indications remain disease severity reflective of hepatocellular failure, complications of portal hypertension, or the combination of portosystemic shunting and diminished hepatocellular function, as occurs in hepatic encephalopathy (Martin, 2010). These conditions include, but are not limited to, the following: (Lee, 2011; Manns, 2011; Bruix, 2010, Chapman, 2010; O'Shea, 2010; UNOS, 2010; O'Leary, 2008; Ahmed, 2007; Keefe, 2007; Feldman, 2006; van Vilsteren, 2006; Murray, 2005; Markman, 2003; McDiarmid, 2001; Steinman, 2001; Carithers, 2000):

- cholestatic disease
- chronic hepatitis
- alcoholic liver disease
- cirrhosis of unknown causes
- unresectable hepatocellular carcinoma (HCC) confined to the liver (i.e., single lesion ≤ 5 cm, up to three separate lesions none larger that 3 cm, no evidence of gross vascular invasion and no regional nodal metastasis)
- hepatic vein occlusion
- polycystic liver disease
- hepatoblastoma which is confined to the liver
- unresectable hilar cholangiocarcinoma when the individual has received a Model for End-Stage Liver Disease (MELD) score exception by a United Network for Organ Sharing (UNOS) Regional Review Board for all of the following considerations:
    - a UNOS approved treatment protocol
    - mass ≤3cm on imaging studies
    - absence of metastasis
    - completion of neoadjuvant therapy
    - subsequent operative staging
- neuroendocrine/gastroenteropancreatic (GEP) tumors with ALL of the following:
    - unresectable liver metastasis
    - prior complete resection of the primary GEP
    - absence of extrahepatic metastasis
    - failure to respond to medical and/or interventional treatment
    - severe hypoglycemia, poorly controlled hyperglycemia, cardiac distress, respiratory distress or other
      symptoms directly attributable to aberrant GEP tumor production of life-threatening hormones such as insulin, catecholamines, or histamine
- liver failure secondary to mushroom poisoning, hepatic vein thrombosis, and acetaminophen-induced acute liver failure.

**Metabolic Disease:** Metabolic liver disease encompasses a heterogeneous group of disorders, many of which may be successfully treated with liver transplantation. Metabolic disorders resulting in hepatic decompensation (e.g., hereditary hemochromatosis, Wilson's disease, alpha1-antitrypsin deficiency, non-alcoholic steatohepatitis) or severe extrahepatic organ damage with intact hepatic synthetic function (e.g., type I hyperoxaluria, familial homozygous hypercholesterolemia, hereditary oxalosis, familial amyloidosis) may be indications for liver transplantation in selected individuals. Less common indications include erythropoietic protoporphyria, cystic fibrosis, glycogen storage diseases, and Byler's disease (Bruix, 2010; O'Leary, 2008; Ahmed, 2007; Feldman, 2006; Murray, 2005; Markman, 2003; McDiarmid, 2001; Steinman, 2001; Carithers, 2000).

**Cholangiocarcinoma (CCA):** Cholangiocarcinomas are distinguished by anatomic site and typically classified as intrahepatic (i.e., located within the hepatic parenchyma), or extrahepatic, (i.e., occurring at, or near, the junction of the left or right hepatic ducts, or the common bile duct). The most common type of extrahepatic cholangiocarcinoma is hilar cholangiocarcinoma. Hilar cholangiocarcinoma is an uncommon, but aggressive malignancy. Prognosis is poor; in resectable disease five-year survival is reported to be 20% to 40% (Heimbach, 2008). Several retrospective studies have examined the outcomes of patients undergoing liver transplantation for hilar cholangiocarcinoma (Becker, 2008; Rosen, 2008; Rhea, 2005). Patients received neoadjuvant chemoradiation therapy prior to transplantation. One- and five-year overall survival rates after transplantation were 74%–92% and 38%–71%, respectively. Liver transplantation may be considered an appropriate treatment option for select individuals who have received a MELD/PELD point exception by a UNOS regional review board.

According to the National Comprehensive Cancer Network Guidelines™ (NCCN Guidelines™) (20141) for Hepatobiliary Cancers, liver transplantation is a potentially curative therapeutic option for patients with early HCC. The consensus of the NCCN panel is that initial treatment with either partial hepatectomy or transplantation can be considered for patients with liver function characterized by a Child-Pugh class A score who fit UNOS criteria. In addition, patients must have operable disease on the basis of performance status and co-morbidity." Regarding unresectable disease the Guidelines (2014) note "Liver transplantation is indicated for patients who meet the UNOS criteria." The United Network for Organ Sharing (UNOS) policy (2014): Organ Distribution: Allocation of Livers indicates liver transplantation candidates with cholangiocarcinoma may be eligible for MELD exception points. Patients must satisfy certain criteria to be eligible for MELD exception as follows:

- "Centers must submit a written protocol for patient care to the Organ Procurement and Transplantation Network (OPTN)/United Network for Organ Sharing (UNOS) Liver and Intestinal Organ Transplantation Committee before requesting a Model for End-Stage Liver Disease (MELD) score exception for a candidate with cholangiocarcinoma (CCA). This protocol should include selection criteria, administration of neoadjuvant therapy before transplantation, and operative staging to exclude patients with regional hepatic lymph node metastasis, intrahepatic metastasis, and/or extra-hepatic disease.
- Candidates must satisfy diagnostic criteria for hilar CCA: malignant-appearing stricture on cholangiography and one of the following: carbohydrate antigen 19-9 100 U/mL or biopsy or cytology results demonstrating malignancy, or aneuploidy. The tumor should be considered unresectable on the basis of technical considerations or underlying liver disease.
- If cross-sectional imaging studies (computerized tomography [CT] scan, ultrasound, magnetic resonance imaging [MRI]) demonstrate a mass, the mass should be ≤ 3 cm.
- Intra- and extrahepatic metastases should be excluded by cross-sectional imaging studies of the chest and abdomen at the time of the initial exception and every three months before score increases.
- Regional hepatic lymph node involvement and peritoneal metastasis should be assessed by operative staging after completion of neoadjuvant therapy and before liver transplantation. Endoscopic ultrasound-guided aspiration of regional hepatic lymph nodes may be advisable to exclude patients with obvious metastasis before neoadjuvant therapy is initiated."

**Neuroendocrine/Gastroenteropancreatic (GEP) Tumors:** Liver transplantation has been proposed as a potentially curative therapy for selected individuals who have neuroendocrine/GEP tumors that are metastatic to the liver. GEP tumors are often slow-growing and can be confined to the liver for an extended period of time;

however, as the disease progresses survival is limited with average five-year survival of 30% (van Vilsteren, 2006; Murray, 2005).

Neuroendocrine/GEP tumors have the capacity to secrete higher than normal amounts of hormones such as insulin and gastrin; alternately they can be nonfunctioning (van Vilsteren, 2006). Individuals may experience a variety of symptoms, some of which may be considered life-threatening. Hyper- or hypoglycemia, cardiac or respiratory distress, congestive heart failure, acromegaly, and Cushing's syndrome may be noted with neuroendocrine/GEP tumors. Gastrointestinal carcinoid tumors may also produce serotonin which can cause a specific set of symptoms, known as the carcinoid syndrome. Symptoms include flushing, diarrhea, bronchoconstriction, cardiac valvular lesions, and telangiectasia. The carcinoid syndrome rarely occurs in the absence of liver metastases (NCI, 2014b).

Although the number of individuals undergoing liver transplantation for neuroendocrine/GEP tumors is limited, improved survival outcomes have been demonstrated (Olausson, 2007; van Vilsteren, 2006; Florman, 2004). Estimated one- and two-year survival rates are 73%–88%, and 87%, respectively. Estimated one-year recurrence-free rate is 77% (van Vilsteren, 2006).

Long-term data are limited; however, liver transplantation may be an acceptable treatment option for selected individuals with neuroendocrine/GEP tumors that are metastatic to the liver and meet the following criteria:

- unresectable, prior complete resection of the primary GEP
- absence of extrahepatic disease
- life-threatening hormonal symptoms that are persistent despite optimal medical and/or interventional therapy, such as chemotherapy, surgical resection, and radiation therapy (van Vilsteren, 2006; Murray, 2005).

**Contraindications to Liver Transplantation**
Many factors affect the outcome of solid organ transplantation. Prior to transplantation a rigorous assessment of the recipient's medical status should be conducted to confirm that transplantation constitutes the best option for managing the patient's disease and that no absolute contraindications exist (Martin, 2010).

Contraindications for liver transplantation are similar to those for other types of solid organ transplantation. Absolute contraindications include the following:

- ongoing alcohol abuse
- severe uncontrolled infection
- multi-organ failure
- nonresectable or disseminated extrahepatic malignancy
- significant cardiopulmonary insufficiency
- and human immunodeficiency virus (HIV) unless the cluster determinant (CD)4 count is >100 cells/$mm^3$, HIV-1 ribonucleic acid (RNA) is undetectable, the patient is on stable antiretroviral therapy for more than three months, and there is an absence of serious complications associated with HIV disease.
- existence of life-threatening uncontrollable intra-abdominal or systemic infections, noncompliance, and known intrahepatic cholangiocarcinoma are also considered absolute contraindications to liver transplantation (Martin, 2010; O'Leary, 2008; Ahmed, 2007; Braun, 2007; Matarese, 2006; Abu Elmagd, 2001; Kaufman, 2001; Steinman, 2001).

In addition to the absolute contraindications noted, relative contraindications which may also negatively affect survival, may include, but not be limited to (Kaufman, 2007; Abu-Elmagd, 2001):

- profound neurologic disabilities
- severe congenital or acquired immunological deficiencies
- multisystem autoimmune diseases
- progressive neuropathy or myopathy that is not amenable to rehabilitation
- any active medical process that is currently not optimally treated and/or stable and that is likely to result in end-organ damage or medical emergency without appropriate management, such as active peptic

ulcer disease, diverticular disease, active hepatitis, cholecystitis, pancreatitis, diabetes mellitus, hypertension, autoimmune disease, or cytopenia
- advanced age
- positive cross-match

**Human Immunodeficiency Virus (HIV):** Historically, HIV positivity has been considered a contraindication to solid organ transplantation. Access to liver transplantation was limited due to questions regarding life expectancy, clinical efficacy, and complications post-liver transplantation caused by interactions between antiviral therapy and immunosuppressive medications, and the increased risk of opportunistic infections (di Benedetto, 2008; Rafecas, 2004;).

More recently liver transplantation has become an acceptable treatment option for selected individuals who are HIV-positive (di Benedetto, 2008; Roland, 2008; Stock, 2008; Murray, 2005; Steinman, 2001). While overall survival is generally lower for individuals with HIV-infection compared to HIV-negative persons, monoinfection (i.e. HIV infection only) does not seem to be a significant risk factor for survival after liver transplantation (Mindikoglu, 2008). Orthotopic liver transplantation appears to be a safe therapeutic option in the short term for selected persons with HIV infection who have end-stage liver disease (di Benedetto, 2008; Mindikoglu, 2008; Roland, 2008; Moreno, 2005; Vogel, 2005; Norris, 2004; Ragni, 2003).

At present, criteria for liver transplantation include a CD 4 count >100 cells/$mm^3$ , HIV-1 ribonucleic acid (RNA) undetectable, stable antiretroviral therapy for more than three months, and absence of serious complications associated with HIV disease (e.g., opportunistic infection, including aspergillus, tuberculosis, coccidioidomycosis; or resistant fungal infections; or Kaposi's sarcoma or other neoplasm).

**Donor Health**
The health of the donor is also an important factor in liver transplantation outcomes. Hepatitis C virus (HCV) infection in the donor can affect the health of the donor liver, making individuals with persistent, recurrent, or untreated HCV infection unacceptable donors. Likewise, donor candidates who are hepatitis B surface antigen-(HbsAg) positive are also generally excluded from living-donor liver transplant donation to prevent transmission of disease to recipients (Baltz and Trotter, 2003). Factors which may negatively affect recipient outcomes after liver transplantation including ongoing alcohol abuse, active systemic illness, and malignancy, are also considered contraindications to donation.

**Retransplantation of the Liver**
Retransplantation may be appropriate for carefully selected patients experiencing graft loss if an improvement in survival is expected; however, according to the AASLD (Murray, 2005), liver retransplantation should be used with discretion in the emergency setting and avoided in patients with little chance of success. In adults, the most common condition resulting in the need for retransplantation of the liver is recurrent infection with hepatitis C virus (HCV). Retransplantation in patients with HCV is controversial due to concerns of aggressive disease recurrence post retransplantation, and decreased patient and graft survival (Bahril, 2008). Several retrospective cohort studies have examined the outcomes of patients retransplanted for recurrent HCV (Pelletier, 2005; McCashland, 2007; Bahra, 2008; Ghabril, 2008) demonstrating lower patient and graft survival in some studies.

Survival outcomes following liver retransplantation are inferior to primary liver transplantation (OPTN, 1997-2004). The outcome depends on many variables, including graft quality, cold ischemia time, and perioperative factors (Gustafsson, 2007). The urgency of retransplantation, serum bilirubin and creatinine levels, Child-Turcotte-Pugh (CTP) score of 10 or more, and Model for End-Stage Liver Disease (MELD) score of more than 25 are associated with a poor prognosis after retransplantation (Murray, 2005). For deceased donor liver retransplantation performed between 1997 and 2004, patient survival was 73.7% and 54.5%, at one and five years, respectively, while graft survival was 68.7% and 45.9% for one and five years, respectively (OPTN, 1997-2004).

**Professional Societies/Organizations**
**Indications for Transplantation**
**American Association for the Study of Liver Disease (AASLD):** The Practice Guidelines Committee of the AASLD has published several Position Papers and Practice Guidelines regarding the management of liver disease and liver transplantation. These include guidelines for the evaluation of the patient for liver transplantation, management of acute liver failure, diagnosis, management and treatment of hepatitis C,

hepatocellular carcinoma, chronic hepatitis B, biliary cirrhosis, primary sclerosing cholangitis, and alcoholic liver disease.

**American Society of Transplantation (AST):** On behalf of the AST, Steinman et al. (2001) published Referral and Management Guidelines of Patients Eligible for Solid Organ Transplant with criteria for organ transplantation. According to Steinman, acquired immunodeficiency syndrome (AIDS) remains a contraindication for transplantation, unless certain parameters are met, including a CD4 count >200 cells/mm3 for >6 months, HIV-1 RNA undetectable, on stable anti-retroviral therapy >3 months, and no other complications from AIDS (e.g., opportunistic infection, including aspergillus, tuberculosis, coccidioide-mycosis, resistant fungal infections, Kaposi's sarcoma or other neoplasm). Guidelines note the current definition of AIDS is a CD 4 count of 200 cells/$mm^3$ in a patient who is human immunodeficiency virus (HIV) positive; however, in regards to liver transplantation Guidelines note "There is growing experience that HIV-positive patients who have below detectable levels of HIV, no other stigmata of HIV, and with a CD4 count <200 cells/$mm^3$ can do well after transplantation."

**Human Immunodeficiency Virus and Transplantation**
**United Network for Organ Sharing (UNOS):** UNOS notes that a potential candidate for organ transplantation whose test for HIV is positive but who is in an asymptomatic state should not necessarily be excluded from candidacy for organ transplantation, but should be advised that he or she may be at increased risk of morbidity and mortality because of immunosuppressive therapy (2008).

**National Cancer Institute (NCI):** The NCI (2014a) notes that adults with localized and locally advanced unresectable liver cancer may be considered for liver transplantation. Liver transplantation has been associated with five-year survival rates of 20% to 30% for individuals with hemangioendothelioma, fibrolamellar hepatocellular carcinoma, and small (<5 cm) hepatocellular carcinoma in patients with or without cirrhosis. In selected patients with localized and locally advanced unresectable hepatoma, particularly patients with fibrolamellar hepatomas, liver transplantation may offer a potentially curative treatment option. When re-resection is not possible, treatment options for patients with recurrent hepatocellular cancer may include the use of liver transplantation."

For children with hepatoblastoma the NCI (2013) notes "Orthotopic liver transplantation provides an additional treatment option for patients whose tumor remains unresectable after preoperative chemotherapy." Regarding children with hepatocellular carcinoma, the NCI notes "Orthotopic liver transplantation has been successful in selected children with hepatocellular carcinoma"

**National Comprehensive Cancer Network Guidelines™ (NCCN Guidelines™):** The Guidelines for resectable hepatobiliary cancers note that liver transplantation may be a potentially curative treatment option for highly selected patients with extrahepatic cholangiocarcinoma (2014). Initial treatment with either partial hepatectomy or transplantation can be considered with liver function characterized by a Child-Pugh class A score who fit UNOS criteria. In addition, patients must have operable disease on the basis of performance status and co-morbidity. Regarding candidates who have unresectable disease, the Guidelines note that patients who meet UNOS criteria may be appropriate for transplantation.

**Use Outside of the US**
**British Human Immunodeficiency Association (BHIVA), United Kingdom (UK) and Ireland Liver Transplantation Centres, and British Transplantation Society Standards Committee:** On behalf of the BHIVA, and the UK and Ireland Liver Transplantation Centres, and reviewed and endorsed by British Transplantation Society Standards Committee, O'Grady et al. (2005) published Guidelines for Liver Transplantation in Patients with HIV Infection. HIV specific issues include CD4 counts >200 cells/uL or >100 cells/uL in the presence of portal hypertension, absence of viraemia, absence of AIDS defining illness after immune reconstitution, and therapeutic options available if HIV disease activates. The author notes that these are somewhat empirical and may change with experience.

**Pediatric Gastroenterology Chapter of Indian Academy of Pediatrics/Indian Academy of Pediatrics (2013):** A published consensus statement regarding the management of acute liver failure (ALF) in infants and children notes liver transplantation is the only definite treatment for ALF. Contraindications for pediatric liver transplantation are active uncontrollable and untreatable sepsis, severe cardiopulmonary disease, multi-organ

failure, extrahepatic malignancy, mitochondrial disease, active substance abuse, and HE grade IV encephalopathy with severe neurological impairment.

**Spanish Consensus Conference (2005):** Mira et al. published criteria on behalf of the Spanish Consensus Conference regarding human immunodeficiency virus (HIV) infection and solid organ transplantation for HIV-infected individuals who meet, or do not meet criteria for highly active antiretroviral therapy (HAART). For individuals who do not meet criteria for HAART, the Conference note that CD4 lymphocyte count should be >350cells. For HIV-infected patients who meet the criteria for HAART, individuals:

- Must not have had an acquired immunodeficiency syndrome (AIDS) defining opportunistic infection except tuberculosis, oesophageal candidiasis or P. jiroveci pneumonia
- Must have a CD4 count of >200 or in the case of liver transplant a CD4 count of >100
- Must have an undetectable viral load in plasma < 50 copies at time of transplant or have effective and durable therapeutic options for HIV infection during the post-transplant period

**National Agency for Accreditation and Evaluation in Health (l'Agence nationale d'accre´ditation et d'e´valuation en sante) (AANES)**: The Consensus Conference (2005) also published indications for liver Transplantation for HIV-positive individuals which note that liver transplantation in HIV-infected patients seems feasible, but its benefit-risk ratio in the medium-term is unknown. It can only be currently recommended under the following conditions, "stable control of HIV infection (undetectable viral load, without a well-defined CD4 level); no history of acquired immunodeficiency syndrome defining opportunistic illness (except if it occurred before the highly active antiretroviral therapy implementation); and no general contraindications, which especially implies screening for tumors; with the same indications as patients without HIV infection."

**Summary**
Liver transplantation is a complex surgical procedure involving the replacement of the recipient liver with a liver from a deceased (i.e., cadaveric) or living donor. In the absence of contraindications, liver transplantation and retransplantation are considered appropriate treatment options for selected adults and children.

---

## Coding/Billing Information

**Note:** 1) This list of codes may not be all-inclusive.
2) Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement

**Covered when medically necessary:**

| CPT®* Codes | Description |
|---|---|
| 47133 | Donor hepatectomy (including cold preservation), from cadaver donor |
| 47135 | Liver allotransplantation; orthotopic, partial or whole, from cadaver or living donor, any age |
| 47136 | Liver allotransplantation; heterotopic, partial or whole, from cadaver or living donor, any age |
| 47140 | Donor hepatectomy (including cold preservation), from living donor; left lateral segment only (segments II and III) |
| 47141 | Donor hepatectomy (including cold preservation), from living donor; total left lobectomy (segments II, III and IV) |
| 47142 | Donor hepatectomy (including cold preservation), from living donor; total right lobectomy (segments V, VI, VII and VIII) |
| 47143 | Backbench standard preparation of cadaver donor whole liver graft prior to allotransplantation, including cholecystectomy, if necessary, and dissection and removal of surrounding soft tissues to prepare the vena cava, portal vein, hepatic artery, and common bile duct for implantation; without trisegment or lobe split |

| | |
|---|---|
| 47144 | Backbench standard preparation of cadaver donor whole liver graft prior to allotransplantation, including cholecystectomy, if necessary, and dissection and removal of surrounding soft tissues to prepare the vena cava, portal vein, hepatic artery, and common bile duct for implantation; with trisegment split of whole liver graft into two partial liver grafts (ie, left lateral segment (segments II and III) and right trisegment (segments I and IV through VIII)) |
| 47145 | Backbench standard preparation of cadaver donor whole liver graft prior to allotransplantation, including cholecystectomy, if necessary, and dissection and removal of surrounding soft tissues to prepare the vena cava, portal vein, hepatic artery, and common bile duct for implantation; with lobe split of whole liver graft into two partial liver grafts (ie, left lobe (segments II, III, and IV) and right lobe (segments I and V-VIII)) |
| 47146 | Backbench reconstruction of cadaver or living donor liver graft prior to allotransplantation; venous anastomosis, each |
| 47147 | Backbench reconstruction of cadaver or living donor liver graft prior to allotransplantation; arterial anastomosis, each |

| **HCPCS Codes** | **Description** |
|---|---|
| S2152 | Solid organ(s), complete or segmental, single organ or combination of organs; deceased or living donor(s), procurement, transplantation, and related complications; including: drugs; supplies; hospitalization with outpatient follow-up; medical/surgical, diagnostic, emergency, and rehabilitative services, and the number of days of pre- and post-transplant care in the global definition |



## References

1. Ahmed A, Keefe EB. Current indications and contraindications for liver transplantation. Clin Liver Dis. 2007 May;11(2):227-47.

2. American Association for the Study of Liver Disease. Bruix J, Sherman M. AASLD Practice Guideline: Management of hepatocellular carcinoma: an update. 2010 July. Accessed Apr 12, 2013. Available at URL address: http://www.aasld.org/practiceguidelines/Documents/Bookmarked%20Practice%20Guidelines/HCCUpdate2010.pdf

3. American Association for the Study of Liver Disease. Chapman R, Fevery J, Kalloo A, Nagorney DM, Boberg CM, Shneider B, et al. AASLD Practice Guideline: Diagnosis and management of primary sclerosing cholangitis. 2010 Feb. Accessed Apr 12, 2013. Available at URL address: http://www.aasld.org/practiceguidelines/Pages/default.aspx

4. American Association for the Study of Liver Disease. Lee WM, Larson AM, Stravitz RT. ASLD Position Paper: The management of acute liver failure: update 2011. Accessed Apr 12, 2012. Available at URL address: http://www.aasld.org/practiceguidelines/Documents/AcuteLiverFailureUpdate2011.pdf

5. American Association for the Study of Liver Disease. O'Shea RS, Dasarathy S, Mc Cullough AJ, Practice Guideline Committee of the American Association for the Study of Liver Diseases and the Practice Parameters Committee of the American College of Gastroenterology. AASLD Practice Guidelines: Alcoholic liver disease. 2010 January. Accessed Apr 12, 2013. Available at URL address: http://www.aasld.org/practiceguidelines/Documents/Bookmarked%20Practice%20Guidelines/AlcoholicLiverDisease1-2010.pdf

6. American Gastroenterological Association. Medical position statement on the management of hepatitis C. Gastroenterol. 2006 Jan;130(1):225-130.

7. Ascher NL, Yeh H, Naji A, Olthoff KM, Shaked A, Barker CF. Liver transplantation. In: Townsend CM, Beauchamp RD, Evers BM, Mattox KL, editors. Sabiston textbook of surgery, 19th ed. Philadelphia, PA.: Saunders; 2012.

8. Asian Pacific Association for the Study of the Liver (APASL) Hepatitis C Working Party , McCaughan GW, Omata M, Amarapurkar D, Bowden S, Chow WC, et al. Asian Pacific Association for the Study of the Liver consensus statements on the diagnosis, management and treatment of hepatitis C virus infection. J Gastroenterol Hepatol. 2007 May;22(5):615-33.

9. Bahra M, Neumann UP, Jacob D, Berg T, Neuhaus R, Langrehr JM, et al. Outcome after liver re-transplantation in patients with recurrent chronic hepatitis C. Transpl Int. 2007 Sep;20(9):771-8. Epub 2007 Jul 6.

10. Baltz AC, Trotter JF. Living donor liver transplantation and hepatitis C. Clin Liver Dis. 2003;7:651-65.

11. Barshes NR, Lee TC, Balkrishman R, Karpen S, Carter B, Goss J. Orthotopic liver transplantation for biliary atresia: the U.S. experience. Liver Transplan. 2005 Oct;11(10);1193-1200.

12. Beavers KL, Bonis PAL, Lau J. Technology Assessment: liver transplantation for patients with hepatobiliary malignancies other than hepatocellular carcinoma. 2001. Accessed Apr 12, 2013. Available at URL address: http://www.cms.gov/medicare-coverage-database/details/technology-assessments-details.aspx?TAId=11&NCAId=47&ver=8&NcaName=Liver+Transplantation+for+Malignancies+other+than+Hepatocellular+Carcinoma&CoverageSelection=National&KeyWord=liver+transplantation&KeyWordLookUp=Title&KeyWordSearchType=And&bc=gAAAACAAEAAA&

13. Becker NS, Rodriquez JA, Barshes NR, O'Mahony CA, Goss JA, Aloia TA. Outcomes analysis for 280 patients with cholangiocarcinoma treated with liver transplantation over an 18-year period. J Gastrointest Surg. 2008 Jan;12(1):117-22. Epub 2007 Oct 26.

14. Burroughs A, Hochhauser D, Meyer T. Systemic treatment and liver transplantation for hepatocellular carcinoma: two ends of the therapeutic spectrum. Lancet Oncol. 2004 Jul;5:409-18.

15. Carithers RL Jr. Liver transplantation. American Association for the Study of Liver Diseases. Liver Transpl. 2000 Jan;6(1):122-35.

16. Casas-Melley AT, Malatack J, Consolini D, Mann K, Raab C, Flynn L, et al. Successful liver transplant for unresectable hepatoblastoma. J Pediatr Surg. 2007 Jan;42(1):184-7.

17. Centers for Disease Control and Prevention. 1993 Revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. MMWR. 1992 Dec 18;41(RR-17). Last review date: 2001 May 2. Accessed Apr 12, 2013. Available at URL address: http://www.cdc.gov/mmwr/preview/mmwrhtml/00018871.htm

18. Centers for Disease Control and Prevention. Department of Health and Human Services. HIV/AIDS. Updated 2013 Mar 20. Accessed Apr 12, 2013. Available at URL address: http://www.cdc.gov/hiv/

19. Christie T, Jiwani B, Asrat G, Montessori V, Mathias R, Montaner J. Ethical and scientific issues surrounding solid organ transplantation in HIV-positive patients: Absence of evidence is not evidence of absence. Can J Infect Dis Med Microbiol. 2006 Jan;17(1):15-8.

20. Clavien PA. Tenth Forum on Liver Transplantation: are HIV-infected patients candidates for liver transplantation? J Hepatol. 2008 May;48(5):695-6. Epub 2008 Feb 29.

21. Clavien PA, Lesurtel M, Bossuyt PM, Gores GJ, Langer B, Perrier A, et al. Recommendations for liver transplantation for hepatocellular carcinoma; an international consensus conference report. Lancet Oncol. 2012 Jan;13(1):e11-22. Epub 2011 Oct 31.

22. Di Benedetto F, De Ruvo N, Beretta M, Massetti M, Montalti R, Di Sandro S, et al. Hepatocellular carcinoma in HIV patients treated by liver transplantation. Eur J Surg Oncol. 2008 Apr;34(4):422-7. Epub 2007 Jun 25.

23. Di Benedetto F, De Sandro S, De Ruvo N, Berretta M, Montalti R, Guerrini GP, et al. Human immunodeficiency virus and liver transplantation: our point of view. Transplant Proc. 2008 Jul-Aug;40(6):1965-71.

24. Duclos-Vallee JC, Feray C, Sebagh M, Teicher E, Roque-Aphonso AM, Roche B, et al. Survival and recurrence of hepatitis C after liver transplantation in patients coinfected with human immunodeficiency virus and hepatitis C virus. Hepatol. 2008 Feb;47(2):407-17.

25. ECRI Institute. Health technology Forecast [database online]. Plymouth Meeting (PA): ECRI; [updated 2008 Nov 5]. Kidney/liver transplantation in human immunodeficiency virus (HIV) + patients. Available at URL address: http://www.ecri.org.

26. Emond J. Living-related liver transplantation: selection of recipient and donors. In: Norman DJ, Turka LA, editors. Primer on transplantation. 2nd ed. Mt. Laurel, NJ: American Society of Transplantation; 2001. p. 529-35.

27. European Association for the Study of the Liver. EASL clinical practice guidelines: management of chronic hepatitis B. J Hepatol. 2009 Feb;50(2):227-42. Epub 2008 Oct 29.

28. Florman S, Toure B, Kim L, Gondolesi G, Roayaie S, Krieger N, et al. Liver transplantation for neuroendocrine tumors. J Gastrointest Surg. 2004;8(2):208-12.

29. Forman LM. To transplant or not to transplant recurrent hepatitis C and liver failure. Clin Liver Dis. 2003;7:615-29.

30. Freeman RB, Gish RG, Harper A, Davis G, Vierling J, Lieblein L, et al. United Network for Organ Sharing (UNOS). Model for end-stage liver disease (MELD) exception guidelines: results and recommendations from the MELD exception study group and conference (MESSAGE) for the approval of patients who need liver transplantation with diseases not considered by the standard MELD formula. MELD Supplement. 2006. Accessed Apr 3, 2012. Available at URL address: http://www.unos.org/CommitteeReports/board_main_Liver&IntestinalOrganTransplantationCommittee_12_18_2006_14_53.pdf

31. Ghabril M, Dickson R, Wiesner R. Improving outcomes of liver retransplantation: an analysis of trends and the impact of Hepatitis C infection. Am J Transplant. 2008 Feb;8(2):404-11.

32. Ghany MG, Strader DB, Thomas DL, Seeff LB, American Association for the Study of Liver Disease. Diagnosis, management, and treatment of hepatitis C: an update. Hepatol. 2009 Apr;49(4): 1335-74

33. Ghobrial RM. Changing faces of liver retransplantation: it is all about selection. Liver Transpl. 2007 Feb;13(2):188-9.

34. Guariso G, Visona Dalla Pozza L, Manea S, Salmaso L, Lodde V, Facchin P, et al. Italian experience of pediatric liver transplantation. Pediatr Transplant. 2007 Nov;11(7):755-63.

35. Gurusamy KS, Ramamoorthy R, Sharma D, Davidson BR. Liver resection versus other treatments for neuroendocrine tumors in patients with resectable liver metastases. Cochrane Database Syst Rev. 2009 Apr 15; (2): CD007060.

36. Gustafsson BI, Backman L, Friman S, Herlinius G, Lindner P, Mjornstedt L, et al. Retransplantation of the liver. Transplant Proc. 2006 Jun;38(5):1438-9.

37. Heimbach JK. Hilar cholangiocarcinoma and liver transplantation. Transplantation. 2009 Aug15;88(3):299-300.

38. Heimbach JK. Successful liver transplantation for hilar cholangiocarcinoma. Curr Opin Gastroenterol. 2008 May;24(3):384-8.

39. Kaiser GM, Sotiropoulos GM, Jauch KW, Lohe F, Hirner A, Kalff JC, et al. Liver transplantation for hilar cholangiocarcinoma. Transplant Proc. 2008 Nov;40(9):3191-3.

40. Keefe EB. Hepatic failure and liver transplantation. In: Goldman L, Schafer AI, editors. Cecil medicine, 24th ed. Philadelphia, PA: Saunders Elsevier; 2011.

41. Kemmer N, Sherman KE. What is the impact of HIV infection on survival after liver transplantation? Nat Clin Pract Gastroenterol Hepatol. 2008 Aug;5(8):426-7. Epub 2008 Jun 24.

42. Liver Transplantation. NIH Concens Statement Online 1983 Jun 20-23 [cited 2006 Apr 11];4(7):1-15.

43. Markmann JF, Markmann JW, Desai NM, Baquerizo A, Singer J, Yersiz H, et al. Operative parameters that predict the outcomes of hepatic transplantation. J Am Coll Surg. 2003;196:566-72.

44. Marsh JW, Geller DA, Finkelstein SD, Donaldson JB, Dvorchik I. Role of liver transplantation for hepatobiliary malignant disorders. Lancet Oncol. 2004 Aug;5:480-8.

45. Martin P, Rosen HR. Liver Transplantation. In: Feldman M, Friedman LS, Brandt LJ, editors. Feldman: Sleisenger and Fordtran's gastrointestinal and liver disease, 9th ed. St. Louis, MO: Saunders; 2010.

46. Mazzaferro V, Chun YS, Poon RT, Schwartz ME, Yao FY, Marsh JW, et al. Liver transplantation for hepatocellular carcinoma. Ann Surg Oncol. 2008 Apr;15(4):1001-7. Epub 2008 Jan 31.

47. McCashland T, Watt K, Lynden E, Adams L, Charlton M, Smith AD, et al. Retransplantation for hepatitis C: results of a U.S. multicenter retransplant study. Liver Transpl. 2007 Sep;13(9):1246-53.

48. McDiarmid SV. Special considerations in pediatric liver transplantation. In: Norman DJ, Turka LA, editors. Primer on transplantation. 2nd ed. Mt. Laurel, NJ: American Society of Transplantation; 2001. p. 600-4.

49. Mekeel KL, Langham MR Jr., Gonzales-Peralta RP, Hemming AW. Liver transplantation in very small infants. Pediatr Transplant. 2007 Feb;11(1):66-72.

50. Mindikoglu AL, Regev A, Magder LS. Impact of human immunodeficiency virus on survival after liver transplantation: analysis of United Network for Organ Sharing database. Transplantation. 2008 Feb 15;85(3):359-68.

51. Miro JM, Torre-Cisnero J, Moreno A, Tuset M, Queredo C, Laguno M, et al. GESIDA/GESITRA-SEIMC, PNS and ONT consensus document on solid organ transplant (SOT) in HIV-infected patients in Spain (March, 2005). Enferm Infecc Microbiol Clin. 2005 Jun-Jul;23(6):353-62.

52. Moreno S, Fortun J, Quereda C, Moreno A, Perez-Elias MJ, Martin-Davila P, et al. Liver transplantation in HIV-infected recipients. Liver Transpl. 2005 Jan;11(1):76-81.

53. Morioka D, Egawa H, Kasahara M, Ito T, Haga H, Takada Y. Outcomes of adult-to-adult living donor liver transplantation: a single institution's experience with 335 consecutive cases. Ann Surg. 2007 Feb;245(2):315-25.

54. Murray K, Carithers RL. AASLD Practice Guidelines: evaluation of the patient for liver transplantation. Hepatol. 2005 June;41(6).

55. National Cancer Institute. Adult primary liver cancer treatment (PDQ©) [a]. Updated 2014 Feb 28. [a] Accessed April 7, 2014 . Available at URL address: http://www.cancer.gov/cancertopics/pdq/treatment/adult-primary-liver/HealthProfessional

56. National Cancer Institute. Childhood liver cancer treatment (PDQ©). Updated 2013 March 29. Accessed April 7, 2014. Available at URL address: http://www.cancer.gov/cancertopics/pdq/treatment/childliver/HealthProfessional

57. National Cancer Institute. Gastrointestinal carcinoid tumors treatment (PDQ©). [b] Updated 2014 Feb 28. Accessed Apr 7, 2014. Available at URL address: http://www.cancer.gov/cancertopics/pdq/treatment/gastrointestinalcarcinoid/HealthProfessional/page1

58. National Comprehensive Cancer Network® (NCCN). NCCN GUIDELINES™ Clinical Guidelines in Oncology™. © National Comprehensive Cancer Network, Inc. 2014, All Rights Reserved. Clinical practice guidelines in oncology: hepatobiliary cancers. V2.2014. Accessed April 7, 2014. Available at URL address: http://www.nccn.org/professionals/physician_gls/PDF/hepatobiliary.pdf

59. National Institutes of Health (NIH). MedlinePlus Medical Encyclopedia: Familial hypercholesterolemia. Updated 2014 Feb 26. Accessed Apr 7, 2014. Available at URL address: http://www.nlm.nih.gov/medlineplus/ency/article/000392.htm

60. Neuberger J, Gimson A, Davies M, Akyol M, O'Grady J, Burroughs A, et al. Selection of patients for liver transplantation and allocation of donated livers in the UK. Gut. 2008 Feb;57(2):252-7. Epub 2007 Sep 25.

61. O'Grady J, Taylor C, Brook G. Guidelines for liver transplantation in patients with HIV infection (2005). HIV Med. 2005 Jul;6 Suppl 2:149-53.

62. Olausson M, Friman S, Herlenius G, Cahlin C, Nilsson O, Jansson S, et al. Orthotopic liver or multivisceral transplantation as treatment of metastatic neuroendocrine tumors. Liver Transpl. 2007 Mar;13(3):327-33.

63. O'Leary JG, Lepe R, Davis GL. Indications for liver transplantation. Gastroenterology. 2008 May;134(6):1764-76.

64. Olthoff KM. Cadaver liver donor selection criteria. In: Norman DJ, Turka LA, editors. Primer on transplantation. 2nd ed. Mt. Laurel, NJ: American Society of Transplantation; 2001. p. 536-9.

65. Organ Procurement and Transplant Network (OPTN) and the Scientific Registry of Transplant Recipients (SRTR). All Kaplan-Meier graft survival rates for transplants performed: 1997-2004. Health Resources and Services Administration, Healthcare Systems Bureau, Division of Transplantation, Rockville, MD. Based on data as of 2014 Apr 4. Accessed Apr 7, 2014. Available at URL address: http://optn.transplant.hrsa.gov/latestData/rptStrat.asp

66. Organ Procurement and Transplantation Network and the Scientific Registry of Transplant Recipients: Annual Report 2011. Accessed Apr 7, 2014. Available at URL address: http://srtr.transplant.hrsa.gov/annual_reports/2011/pdf/03_%20liver_12.pdf

67. Organ Procurement and Transplant Network (OPTN). Policies. Organ Distribution: allocation of livers. Health Resources and Services Administration, Healthcare Systems Bureau, Division of Transplantation, Rockville, MD. Updated 2014 Mar 7. Accessed Apr 7, 2014. Available at URL address: http://optn.transplant.hrsa.gov/policiesAndBylaws/policies.asp

68. Parfitt JR, Marotti P, Alqhamdi M, Wall W, Khakhar A, Suskin NG, et al. Recurrent hepatocellular carcinoma after transplantation: Use of a pathological score on explanted livers to predict recurrence. Liver Transpl. 2007 Mar 29;13(4):543-551 [Epub ahead of print]

69. Pediatric Gastroenterology Chapter of Indian Academy of Pediatrics, Bhatia V, Bavdekar A, Yachha SK; Indian Academy of Pediatrics. Management of acute liver failure in infants and children: consensus statement of the pediatric gastroenterology chapter, Indian academy of pediatrics. Indian Pediatr. 2013 May 8;50(5):477-82.

70. Pelletier SJ, Schaubel DE, Punch JD, Wolfe RA, Port FK, Merion RM. Hepatitis C is a risk factor for death after liver retransplantation. Liver Transpl. 2005 Apr;11(4):434-40.

71. Pfitzmann R, Nussler NC, Hippler-Benscheidt M, Neuhaus R, Neuhaus P. Long-term results after liver transplantation. Transpl Int. 2008 Mar;21(3):234-46. Epub 2007 Nov 21.

72. Postma R, Haagsma EB, Peeters PM, van den Berg AP, Sloof MJ. Retransplantation of the liver in adults: outcome and predictive factors for survival. Transpl Int. 2004 Jun;17(5):234-40. Epub 2004 May 29.

73. Qin JM, Takada Y, Uemoto S, Tanaka K. Present status and recent advances in living donor liver transplantation for malignant hepatic tumors. Hepatobiliary Pancreat Dis Int. 2008 Apr;7(2):126-34.

74. Rafecas A, Rufi G, Figueras J, FabregatJ, Xiol X, Ramos E, et al. Liver transplantation without steroid induction in HIV-infected patients. Liver Transpl. 2004 Oct;10(10):1320-3.

75. Rea DJ, Heimbach JK, Rosen CB, Haddock MG, Alberts SR, Kremers WK, et al. Liver transplantation with neoadjuvant chemoradiation is more effective than resection for hilar cholangiocarcinoma. Ann Surg. 2005 Sep;242(3):451-8; discussion 458-61

76. Roland ME, Barin B, Carlson L, Frassetto LA, Terrault NA, Hirose R, et al. HIV-infected liver and kidney transplant recipients: 1- and 3-year outcomes. Am J Transplant. 2008 Feb;8(2):355-65. Epub 2007 Dec 18.

77. Roland ME, Carlson LL, Frassetto LA, Stock PG. Solid organ transplantation: referral, management, and outcomes in HIV-infected patients. AIDS Read. 2006 Dec;16(12):664-8, 675-8.

78. Roland ME, Stock PG. Review of solid-organ transplantation in HIV-infected patients. Transplantation. 2003 Feb 27;75(4):425-9.

79. Rosen CB, Heimbach JK, Gores GJ. Surgery for cholangiocarcinoma: the role of liver transplantation. HPB(Oxford). 2008;10(3):186-9.

80. Samuel D, Weber R, Stock P, Duclos-Vallee JC, Terrault N. Are HIV-infected patients candidates for liver transplantation? J Hepatol. 2008 May;48(5):697-707. Epub 2008 Feb 27.

81. Shimoda M, Kubota K. Multi-disciplinary treatment for cholangiocellular carcinoma. World J Gastroenterol. 2007 Mar 14;13(10):1500-4.

82. Shneider B, Emre S. Pediatric liver transplantation: past, present, and future. Liver Transplan 2006 Apr;12: 511-513.

83. Steinman TI, Becker BN, Frost AE, Olthoff KM, Smart FW, Suki WN, et al.; Clinical Practice Committee, American Society of Transplantation. Guidelines for the referral and management of patients eligible for solid organ transplantation. Transplantation. 2001 May 15;71(9):1189-204.

84. Stock PG, Roland ME. Evolving clinical strategies for transplantation in the HIV-positive recipient. Transplantation. 2007 Sep 15;84(5):563-71.

85. Sudan DL. Transplantation for cholangiocarcinoma. Liver Transpl. 2006 Nov;12(11 Suppl 2):S83-4.

86. Terrault N, Carter JT, Carlson L, Roland ME, Stock PG. Outcome of patients with hepatitis B virus and human immunodeficiency virus infections referred for liver transplantation. Liver Transpl. 2006 May;12(5):801-7.

87. Tiao GM, Bobey N, Allen S, Nieves N, Alonso M, Bucuvalas J, et al. The current management of hepatoblastoma: a combination of chemotherapy, conventional resection, and liver transplantation. J Pediatr. 2005;146:204-11.

88. Tien P, Veterans Affairs Hepatitis C Resource Center Program, National Hepatitis C Program Office. Management and treatment of hepatitis C virus infection in HIV-infected adults: recommendations from the Veterans Affairs Hepatitis C Resource Center Program and National Hepatitis C Program Office. Am J Gastroenterol. 2005 Oct;100(10):2338-54. Erratum in: Am J Gastroenterol. 2005 Nov;100(11):2609.

89. Ueda Y, Takada Y, Haga H, Nabeshima M, Marusawa H, Ito T, et al. Limited benefit of biochemical response to combination therapy for patients with recurrent hepatitis C after living-donor liver transplantation. Transplantation. 2008 Mar 27;85(6):855-862.

90. Ulrich F, Pratschke J, Neumann U, Pascher A, Puhl G, Fellmer P, et al. Eighteen years of liver transplantation experience in patients with advanced Budd-Chiari syndrome. Liver Transpl. 2008 Feb;14(2):144-50.

91. United Network for Organ Sharing (UNOS). MELD/PELD Calculator Documentation. © 2012 United Network for Organ Sharing. Accessed Apr 7, 2014. Available at URL address: http://www.unos.org/docs/MELD_PELD_Calculator_Documentation.pdf

92. Uribe M, Buckel E, Ferrario M, Hunter B, Godoy J, Gonzalez G, et al. Pediatric liver retransplantation: indications and outcome. Transplant Proc. 2007 Apr;39(3):609-11.

93. van Vilsteren FG, Baskin-Bey ES, Nagorney DM, Sanderson SO, Kremers WK, Rosen CB. Liver transplantation for gastroenteropancreatic neuroendocrine cancer: defining selection criteria to improve survival. Liver Transpl. 2006 Mar;12(3):448-56.

94. Varela M, Sanchez W, Bruix J, Gores GJ. Hepatocellular carcinoma in the setting of liver transplantation. Liver Transpl. 2006 Jul;12(7):1028-36.

95. Wong SN, Reddy KR, Keefe EB, Han S-H, Gaglio PJ, Perillo RP, et al. Comparison of clinical outcomes in chronic hepatitis B liver transplant candidates with and without hepatocellular carcinoma. Liver Transpl. 2007 Mar;13(3):334-42.

96. Wu Y, Johlin FC, Rayhill SC, Jensen CS, Xie J, Cohen MB, et al. Long-term, tumor-free survival after radiotherapy combining hepatectomy-Whipple en bloc and orthotopic liver transplantation for early-stage hilar cholangiocarcinoma. Liver Transpl. 2008 Mar;14(3):279-86.

97. Yan JQ, Peng CH, Li HW, Shen BY, Zhou GW, Yang WP, et al. Preliminary clinical experience in liver retransplantation. Hepatobiliary Pancreat Dis Int. 2007 Apr;6(2):152-6.

98. Yao FY. Expanded criteria for hepatocellular carcinoma: down-staging with a view to liver transplantation--yes. Semin Liver Dis. 2006 Aug;26(3):239-47.

99. Yao FY. Selection criteria for liver transplantation in patients with hepatocellular carcinoma: beyond tumor size and number? Liver Transpl. 2006 Aug;12(8):1189-91.

100. Yao FY, Ferrell L, Bass NM, Bacchetti P, Ascher NL, Roberts JP. Liver transplantation for hepatocellular carcinoma: comparison of the proposed UCSF criteria with the Milan criteria and the Pittsburgh modified TNM criteria. Liver Transpl. 2002 Sep;8(9):765-74.

101. Zetterman RK. Liver transplantation for alcoholic liver disease. Clin Liver Dis. 2005:9:171-81.

102. Zhang KY, Tung BY, Kowdley KV. Liver transplantation for metabolic liver diseases. Clin Liver Dis. 2007 May;11(2):265-81.