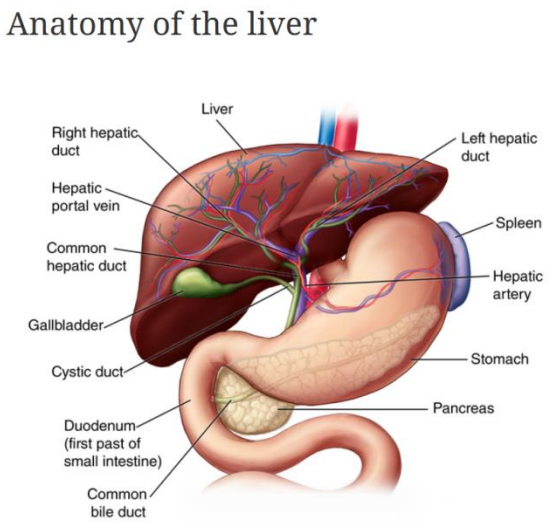
[Anatomy and Functions | Johns Hopkins Medicine]

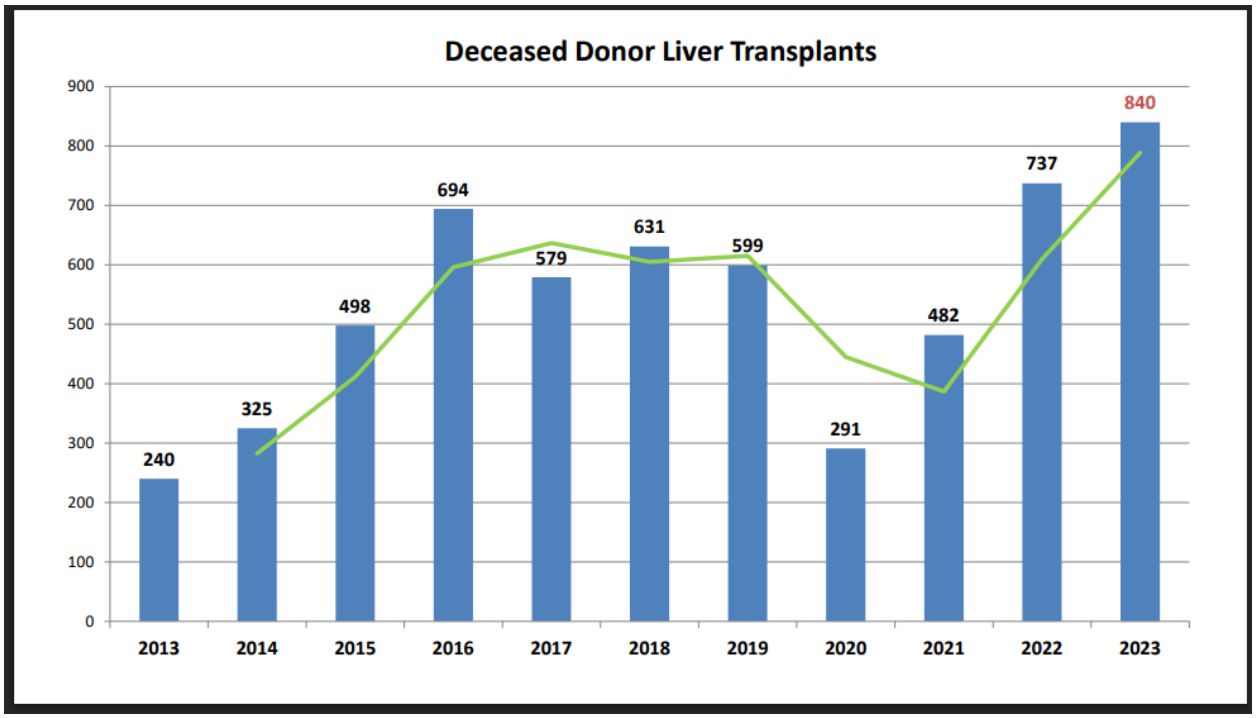


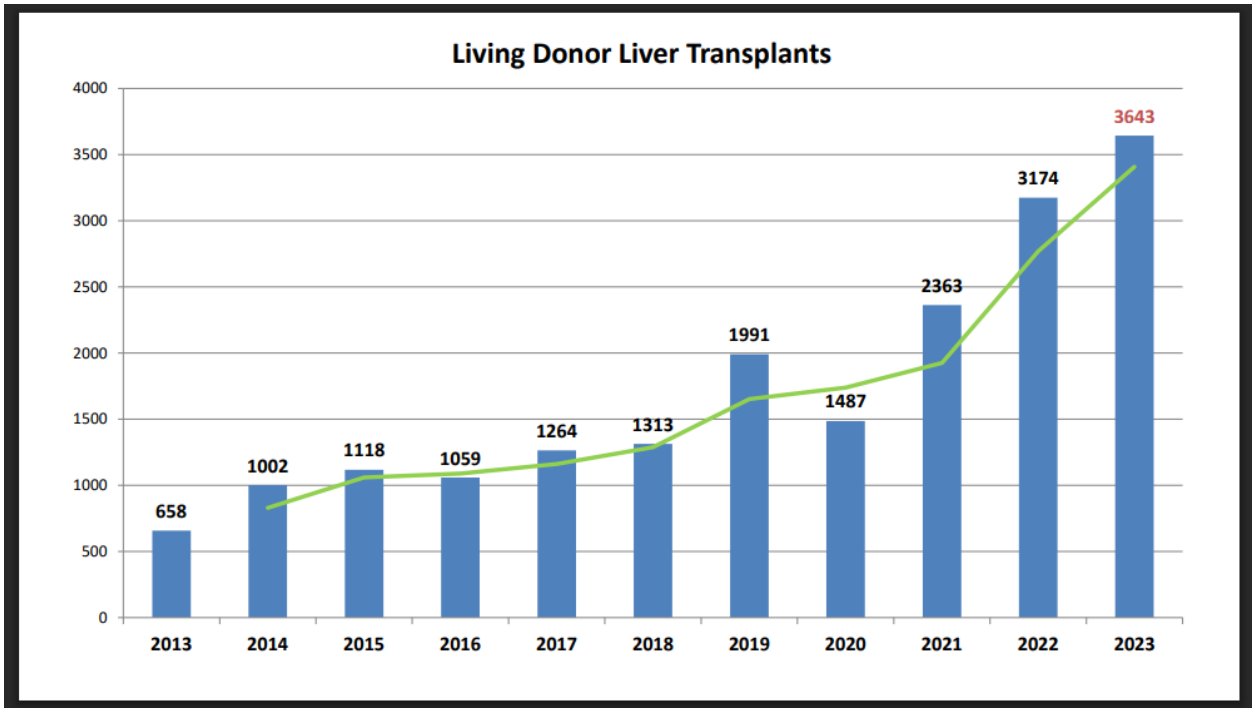
- The liver is located in the upper right-hand portion of the abdominal cavity, beneath the diaphragm
- The liver holds about (13%) of the body's blood supply at any given moment. The liver consists of 2 main lobes. Both are made up of 8 segments that consist of 1,000 lobules (small lobes). These lobules are connected to small ducts (tubes) that connect with larger ducts to form the common hepatic duct. The common hepatic duct transports the bile made by the liver cells to the gallbladder and duodenum (the first part of the small intestine) via the common bile duct
- When the liver has broken down harmful substances, its by-products are excreted into the bile or blood. Bile by-products enter the intestine and leave the body in the form of feces. Blood by-products are filtered out by the kidneys, and leave the body in the form of urine.

Vital functions of the liver include:

- **Detoxification** – Removes toxins and drugs from the blood.
- **Metabolism** – Processes carbohydrates, fats, and proteins for energy.
- **Bile production** – Helps in digestion and absorption of fats.
- **Storage** – Stores vitamins, minerals, and glycogen (energy reserve).
- **Synthesis** – Produces important proteins like albumin and clotting factors.
- **Immune support** – Helps fight infections through specialized immune cells.

https://notto.mohfw.gov.in/WriteReadData/Portal/News/867_1_2013_to_2023_updated_on_28th_July_2024__1_.pdf





https://ieeexplore.ieee.org/document/8777655

liver Transplantation model:

INTRODUCTION: The liver is one of the most important organs in the human body. It helps with digestion, removes toxins from the blood, and plays a key role in many other vital functions. If the liver gets damaged and the problem is not detected early, it can lead to serious health issues or even be life-threatening. In recent years, machine learning (ML) has been used to help doctors detect diseases like liver problems by analysing medical data. However, many of these studies have some weaknesses. They often do not clean or prepare the data well, use only a few basic models, or do not measure how accurate or useful the results really are. This research builds on a previous study that used three basic models: Logistic Regression, K-Nearest Neighbour (KNN).While these models gave some results, they were not very accurate or reliable. In our work, we fix the problems from the earlier study. We use better methods to prepare the data, test more advanced models, and compare their results in a detailed way. This helps us find which models work best for predicting liver disease.

Dataset Description: The dataset used for this study is the Indian Liver Patient Dataset (ILPD), which was obtained from the UCI Machine Learning Repository. The dataset consists of 583 individual medical records of patients from Andhra Pradesh, India. Each record is comprised of 10 biological attributes and 1 target variable that indicates whether the patient is diagnosed with a liver disease.

Attribute	Description
Age	Patient age in years
Gender	Male or Female
Total_Bilirubin	Total bilirubin level (mg/dL)
Direct_Bilirubin	Direct bilirubin level (mg/dL)
Alkaline_Phosphotase	ALP enzyme level (U/L)
Alamine_Aminotransferase	ALT enzyme level (U/L)
Aspartate_Aminotransferase	AST enzyme level (U/L)
Total_Proteins	Total protein in blood (g/dL)
Albumin	Albumin level (g/dL)
Albumin_and_Globulin_Ratio	Ratio of albumin to globulin
Liver_Disease (Target)	1 = Disease, 2= No Disease

Output:

Table 1: Performance Metrics Table

Model	Accuracy	ROC-AUC	Sensitivity	Specificity
Logistic Regression	73.71%	0.78	0.91	0.24
KNN	68.00%	0.76	0.78	0.39
SVM	73.71%	0.75	1.00	0.00
Decision Tree	64.00%	0.70	0.76	0.30
Random Forest	72.00%	0.88	0.85	0.35
Naive Bayes	57.71%	0.77	0.43	0.98
XGBoost	72.57%	0.91	0.84	0.41
Gradient Boosting	70.29%	0.88	0.84	0.30

https://pmc.ncbi.nlm.nih.gov/articles/PMC7603533/#:~:text=Liver%20transplantation%20is%20the%20standard,With%20regards%20to%20alcohol%E2%80%90related%20liver

Liver transplant is indicated for patients with **end-stage liver disease** when other therapies fail. Classic indications include **decompensated cirrhosis** (from hepatitis B/C, alcohol, NASH/NAFLD, autoimmune or other causes), **acute fulminant liver failure**, and **hepatocellular carcinoma (HCC)** arising in the setting of chronic liver disease

Decompensated cirrhosis: Decompensated cirrhosis is the advanced stage of liver cirrhosis where the liver can no longer perform its vital functions properly. It presents with serious complications like jaundice, ascites, variceal bleeding, and hepatic encephalopathy

Acute fulminant liver failure: Acute fulminant liver failure is a rapid decline in liver function, typically within days to weeks, in a person without pre-existing liver disease. It is marked by sudden jaundice, coagulopathy, and hepatic encephalopathy, often leading to multi-organ failure.

Hepatocellular carcinoma (HCC): Hepatocellular carcinoma (HCC) is the most common primary liver cancer, usually arising in the setting of chronic liver disease or cirrhosis. It often presents late with

symptoms like weight loss, abdominal pain, and liver mass, and has a poor prognosis if not detected early.

Transplant is also used for **metabolic/congenital disorders** (e.g. Wilson's disease, α-1 antitrypsin, hemochromatosis, tyrosinemia) and **cholestatic diseases** (primary biliary cholangitis, primary sclerosing cholangitis) once advanced fibrosis or decompensation occurs

Metabolic/genetic liver diseases: Metabolic/genetic liver diseases are inherited disorders that affect liver function due to enzyme or protein deficiencies. Examples include Wilson's disease (copper buildup), hemochromatosis (iron overload), and alpha-1 antitrypsin deficiency.

Cholestatic diseases: Advanced primary biliary cholangitis (PBC) or primary sclerosing cholangitis (PSC) when liver failure or cholangiocarcinoma risk emerges.

https://unos.org/news/policy-changes/updates-to-medical-urgency-scoring-of-liver-transplant-candidates-in-effect/

- Click Here to check MELD/PLED Guide : MELD PELD Calculator User Guide

In practice, any chronic liver disease that has progressed to **PLED** or **MELD ≥15–20** with complications (ascites, encephalopathy, variceal bleeding) needs Transplantation.

The **MELD calculator** is a clinical tool used by **UNOS (United Network for Organ Sharing)** to prioritize liver transplant candidates aged **12 years and older**. It calculates a **numerical score (6 to 40)** representing the urgency of a patient's need for a liver transplant.

MELD (≥12 years): calculated from bilirubin, INR, creatinine (and Na). Score roughly predicts 90-day mortality. In 2016, UNOS added serum sodium to MELD (MELD-Na), and in 2023 further revised MELD (MELD 3.0) to include serum albumin and a gender adjustment to improve accuracy

How to Use the MELD Calculator

1. **Enter Patient Information:**
    - **Date of Birth**
    - **Date Added to Waiting List** (can be today if not yet listed)

2. **Enter Lab Values:**
    - **Bilirubin (mg/dL):** 0–99
    - **Serum Sodium (mEq/L):** 100–200
    - **INR:** 0.5–99
    - **Creatinine (mg/dL):** 0.01–40
    - **Albumin (g/dL):** 0.5–9.9
3. **Dialysis History:**
    - Indicate if the patient had 2+ dialysis sessions or 24 hours of **CVVHD** within the week prior to the creatinine test.
4. **Sex (for adults ≥18):**
    - Based on sex assigned at birth or gender-affirming treatment.

Calculation Of MELD:

MELD = 1.33 (if female) + 4.56 × ln(bilirubin) + 0.82 × (137 – sodium) – 0.24 × (137 – sodium) × ln(bilirubin) + 9.09 × ln(INR) + 11.14 × ln(creatinine) + 1.85 × (3.5 – albumin) – 1.83 × (3.5 – albumin) × ln(creatinine) + 6

There exceptions to the MELD score

- https://www.uchicagomedicine.org/conditions-services/transplant/liver-transplant/understanding-meld-for-liver-transplant

There is an exception to the MELD system when a patient is categorized as Status 1A and 1B.

Status 1A patients have sudden and severe onset liver failure and a life expectancy of hours to a few days without a liver transplant.

Status 1B patients are chronically ill pediatric patients.

Less than 1% of all liver transplant candidates, adult and pediatric, are in these categories at one time.

Status 1A/1B: The highest priority, reserved for acute liver failure (Status 1A, life expectancy days) and certain critical pediatric cases (Status 1B). Patients at Status 1 get bypass priority over MELD/PELD list

Regional and International Allocation Criteria

https://www.aasld.org/liver-fellow-network/core-series/clinical-pearls/pediatric-liver-transplant-prioritization#:~:text=Despite%20this%2C%2045,offering%20the%20liver%20to%20an

- Allocation policies vary globally. In the **United States (UNOS/OPTN)** system, candidates are ranked primarily by MELD/PELD score. All transplant centers follow national policy: *Status 1A* (acute liver failure) gets top priority, then by descending MELD/PELD. *Status 1B* is a special pediatric category. Since 2020, UNOS allocates livers by national "acuity circles" (instead of local zones) to prioritize sickest patients. Policy changes are frequent: for example, in July 2023 UNOS updated MELD/PELD formulas (adding albumin, sex, creatinine to scores) and refined pediatric criteria. A National Liver Review Board standardizes exception points for cases not captured by MELD/PELD

https://www.nhsbt.nhs.uk/organ-transplantation/liver/is-a-liver-transplant-right-for-you/liver-transplant-tests/how-do-doctors-decide-if-you-need-a-liver-transplant/#:~:text=What%20score%20do%20you%20need,list%20for%20a%20liver%20transplant

- By contrast, many other regions set **threshold criteria**: For example, the **United Kingdom** uses a UKELD score (bilirubin, INR, creatinine, sodium); national policy requires a **minimum UKELD ≥49** to list and aims for >50% 5-year survival post-transplant

https://pmc.ncbi.nlm.nih.gov/articles/PMC10025588/#:~:text=Adult%20patients%20wait%20listed%20for,%28A1

- **MELD score and Clinical Severity Score (CSS):** The **MELD** score is a global index (6–40) based on blood tests (bilirubin, INR, creatinine, sodium) that estimates how sick a patient isA higher MELD means more urgent need for transplant. In India, doctors also use a **Composite Clinical Severity Score (CSS)** to rank patients. CSS starts with the MELD/PELD score and **adds points** for other factors: serious complications (e.g. recurrent bleeds, infections, severe breathing or kidney problems), liver cancer, new organ failures, and how long the patient has waited.

https://www.india.gov.in/website-directorate-general-health-services#:~:text=The%20National%20Organ%20and%20Tissue,transplant%20services%20are%20also%20available

Key organizations: India has a tiered transplant network:

- **NOTTO (National Organ and Tissue Transplant Organization):** This is the national body under the Ministry of Health. NOTTO sets transplant policies, runs the national registry, and oversees organ sharing. (As an official portal notes, NOTTO is set up under the Directorate-General of Health Services, MoHFW.)
- **ROTTO / SOTTO (Regional/State Organ & Tissue Transplant Organizations):** Under NOTTO, there are regional/state centers that register donors and recipients and coordinate local transplants. For example, **ROTTO-SOTTO Mumbai** serves Maharashtra and nearby states; it maintains transplant registries and manages donation/transplant activity in that region. Each state has a similar SOTTO office.
- **LTSI (Liver Transplant Society of India):** This is a professional society of transplant surgeons and doctors. LTSI issues clinical guidelines (like the ones cited above), runs annual conferences, and encourages best practices and research. For instance, LTSI helped develop the national liver transplant allocation policy and supports the new Indian Liver Transplant Registry