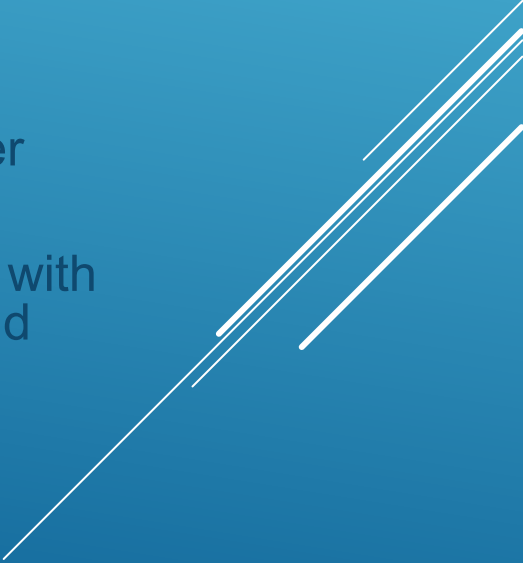


PRE-OPERATIVE HEPATIC ESSENTIALS- WIANA SPRING MEETING

Dr. Peter Kallio DNP, CRNA, APNP, FAANA

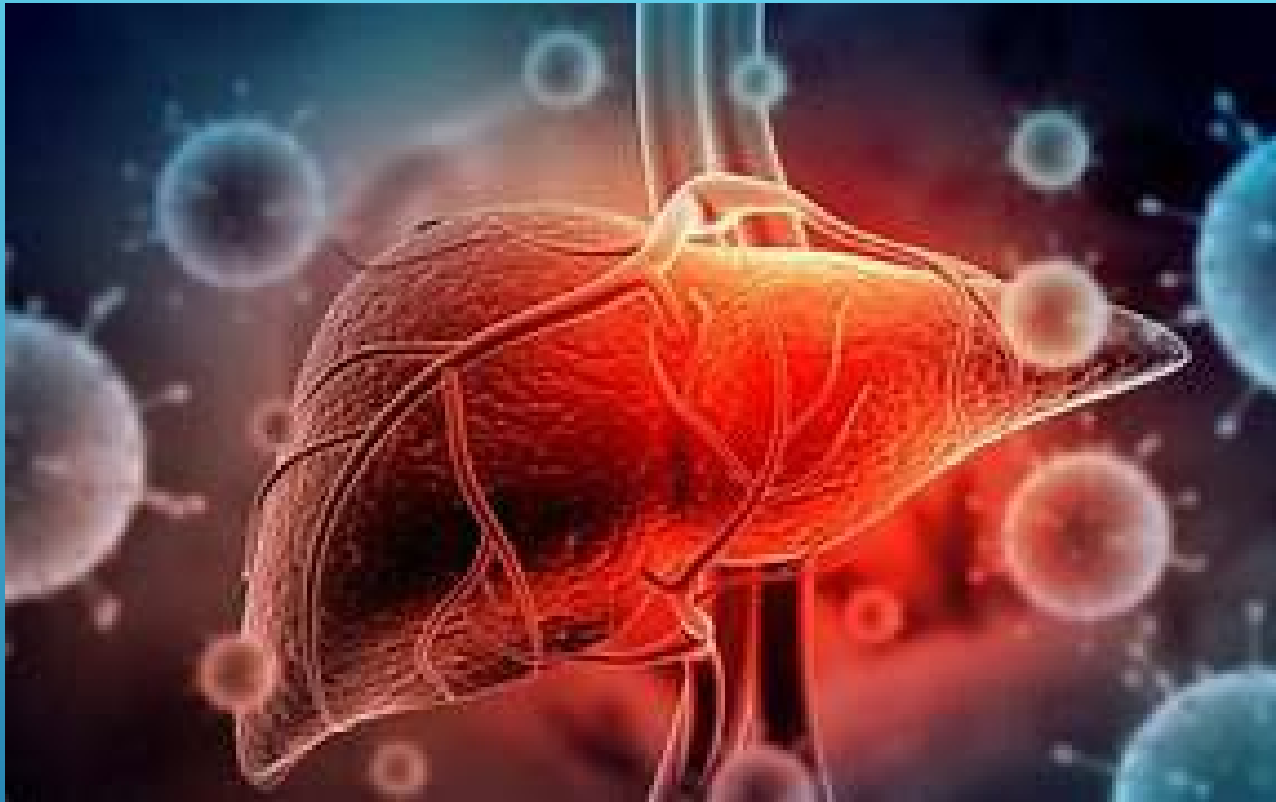
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OBJECTIVES

- ▶ The learner will understand functions of the liver
 - ▶ The learner will understand hepatic blood flow.
 - ▶ The learner will understand how surgery and stress can affect the liver
 - ▶ The learner will understand the testing to assess liver function
 - ▶ The learner will differentiate between Meld and CPT scoring for the severity of liver disease including its components.
 - ▶ The learner will be able to evaluate and decide if liver disease patients may proceed to elective surgery
 - ▶ The learner will understand how Cirrhosis manifests with symptoms including the differences between viral and alcohol causes.
- 
- A series of four parallel white diagonal lines located in the bottom right corner of the slide, extending from the middle of the right edge towards the bottom left.



ASSESSMENTS?



WHY IS THE LIVER SO
IMPORTANT??

Liver cirrhosis is the 8th most common cause of death in the US

History of risk such as chronic alcohol use, blood transfusion, substance use, tattooing, or family history of liver disease, should be evaluated for chronic liver disease prior to surgery.

Routine evaluation of liver function tests prior to surgery, in patients without known liver disease, is not recommended.

FACTS

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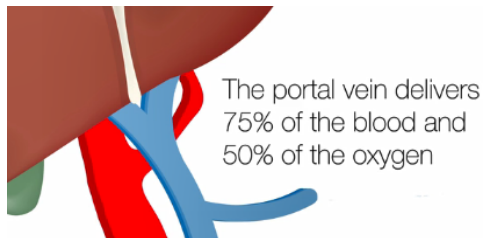
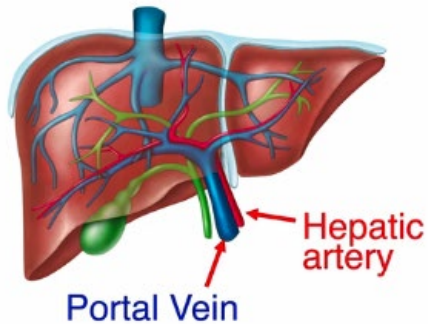
LIVER ANATOMY

Largest internal Organ

Very dispensable: Can act as a reservoir storing up to 1 liter of blood

Functional unit is the Lobule (50-100,000)





- ▶ **Hepatic Blood Flow**
 - ▶ **Approx. 25% of CO**
 - ▶ **Two afferent supplies**
 - ▶ **Portal vein:**
 - ▶ **70% hepatic flow**
Partially Deoxygenated
(venous System)
 - ▶ **Hepatic artery:**
 - ▶ **30% hepatic flow**
 - ▶ **Branch of celiac trunk**
 - ▶ **Each source contributes 50% to O₂ supply**

HEPATIC BLOOD FLOW

HEPATIC BLOOD FLOW CONT...

- ▶ **Extrinsic Regulation**
 - ▶ Pain, hypoxemia, surgical stress leads to decreased hepatic blood flow
 - ▶ Drugs such as BB associated with decreased hepatic flow
 - ▶ PPV, CHF, hypervolemia decreased hepatic flow





POSTOPERATIVE LIVER DYSFUNCTION

- ▶ **Abdominal surgery can decrease hepatic blood flow significantly.**
- ▶ **An elevation of liver enzymes less than twice the normal value is relatively common after abdominal surgery and usually resolves spontaneously within 48 hours.**
- ▶ Causes of decreased oxygen to the liver during surgery can result from anemia, fever, shock, pneumonia, and even surgery itself.
- ▶ Sevoflurane undergoes the greatest degree of metabolism at 8% and only trace amount of isoflurane, desflurane, and nitrous oxide are metabolized.

Liver Physiology

Synthetic: production of many proteins

- Amino acids
- Coagulation factors
- Albumin
- Enzymes for carbohydrate metabolism
- Bile Acids
- Thrombopoetin

Excretory

- Glucuronidation of bilirubin to promote excretion in bile
- Excretion of bile to GI tract for lipid emulsification

Filtration and Detoxification

- CYP450 elimination of toxic materials

WHAT IS THE FUNCTION OF THE LIVER?

Glucose Homeostasis

- Storage of glucose as glycogen
- Glucagon-mediated catabolism of glycogen
- Gluconeogenesis from lactate, glycerol, amino acids

Coagulation

- Synthesize procoagulant proteins and regulators such as protein C, S, antithrombin III
- Abnormal coag labs reflect severe hepatic dysfunction because coagulation factors maintain fxn at 20-30% of normal levels

FUNCTION OF THE LIVER

CONT...

Drug Metabolism

- Lipid → water soluble for renal excretion (via conjugation)
- Transformation to less pharmacologically active drug forms
- Excretion in bile

Heme Metabolism

- 20% of adult hematopoiesis
- Bile conjugation

FUNCTION OF THE LIVER CONT...

Cholesterol and Lipid Metabolism

- Stores dietary fat as TGs, cholesterol, phospholipids
- Releases fatty acids from TG
- Synthesizes fatty acids from glucose, lipids, protein
- Regulation and elimination of cholesterol

Protein Metabolism

- Create albumin, cytokines, hormones, coag factors
- Nonessential amino acid production
- Protein degradation into urea for elimination

PATHOPHYSIOLOGY OF LIVER DISEASE

Coagulopathy

- Except for factors III (tissue thromboplastin), IV (calcium), and von Willebrand factor, all blood clotting factors are synthesized by the liver.

Impaired Drug Metabolism:

Impaired heme, cholesterol excretion

Impaired protein synthesis → hypoalbuminemia

Impaired protein catabolism → accumulation of ammonia

PATHOPHYSIOLOGY OF LIVER DISEASE CONT.

Hyperdynamic Circulation

- Low systemic BP, increased CO, low SVR

Portal HTN

- Splenomegaly, esophageal, gastric, intra-abdominal varices
- Nausea, anorexia
- Ascites, hepatic encephalopathy
- Decreased hepatic blood flow (esp with impaired autoregulation of arterial blood flow)

Ascites

- Abd distention → atelectasis, restrictive pulm disease
- Spontaneous bacterial peritonitis
- Circulatory instability 2/2 venocaval compression

PATHOPHYSIOLOGY OF LIVER DISEASE

Hepatic Encephalopathy

- Nitrogenous waste build-up (i.e. ammonia), disruption of BBB, increased CNS inhibitory transmission

Impaired Drug Binding

- Low albumin leads to increase in unbound, pharmacologically active fraction of certain drugs
- Clinically apparent with albumin < 2.5 g/dL

Hepatorenal Syndrome

- Renal vasoconstriction as end-stage response to decreased effective arterial blood volume



Causes of Cirrhosis

Alcoholic liver disease

Fatty liver disease

Hepatitis C

CAUSES OF ACUTE LIVER DISEASE

1. **Hepatitis:** Viral hepatitis (such as hepatitis A, B, or C) can lead to acute liver failure.
2. **Medications:** Overdosing on medications like **acetaminophen** (paracetamol) can cause liver failure.
3. **Autoimmune Diseases:** Conditions where the immune system attacks the liver can result in acute liver failure.
4. **Wilson's Disease:** An inherited disorder that leads to copper buildup in the liver.
5. **Acute Fatty Liver of Pregnancy:** A rare condition affecting pregnant women.
6. **Idiopathic:** Sometimes, liver fails without obvious cause

Chronic Cause- Cirrhosis Etiologies

- **Viral Hepatitis-Cirrhosis**

- **Hepatitis B**

- causes chronic infection in 5% of adults
 - **12-20% develop cirrhosis**
 - **6-15% of Hep B cirrhotics develop HCC**
 - Vaccine-preventable

- **Hepatitis C**

- causes chronic infection in majority of adults
 - **30% develop cirrhosis within 20-30 years**
 - Non-vaccine preventable

- **Hepatitis D**

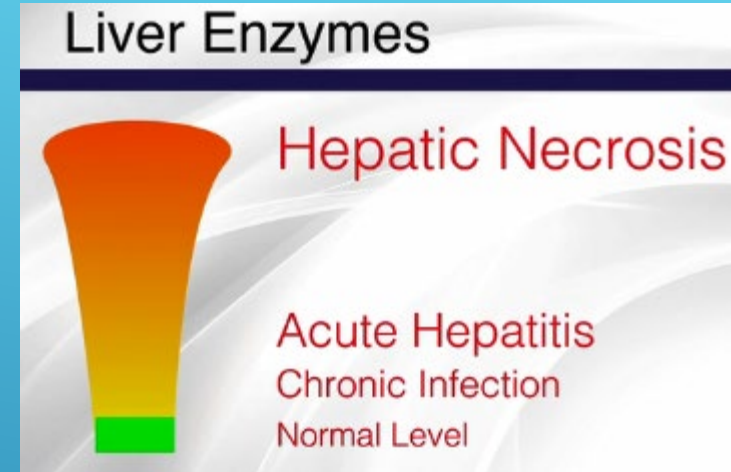
- sub-virus only able to infect people with Hepatitis B
 - Chronic Hepatitis B + Acute Hepatitis D: **Rare disease but those affected progress to cirrhosis 80-90% of the time**

- **Alcoholic Cirrhosis**

- **Only 10-15% develop cirrhosis**
 - **1-6% of alcoholic cirrhotic per year develop HCC**

“LFTs”

- No single test can assess function
- Hepatocyte Destruction
 - AST/ALT (SGOT/SGPT)
 - Alkaline Phosphatase
 - LDH



LFT'S CONTINUED

- **Hepatocyte synthetic function:**
 - **PT/INR and aPTT: clotting factors (best indicator**
 - **Platelets: thrombopoietin**
 - **Total Bilirubin**
 - **Albumin Not as accurate due to longer half-life**
 - **Pre-albumin: shorter half-life, more accurate**

CIRRHOSIS FACTS

Chronic liver inflammation leads to scarring of the liver

This disrupts the vascular structures that causes and increased resistance to blood flow in the liver called Portal HTN

Ascites

Most common cause of hospitalization
in patients with cirrhosis

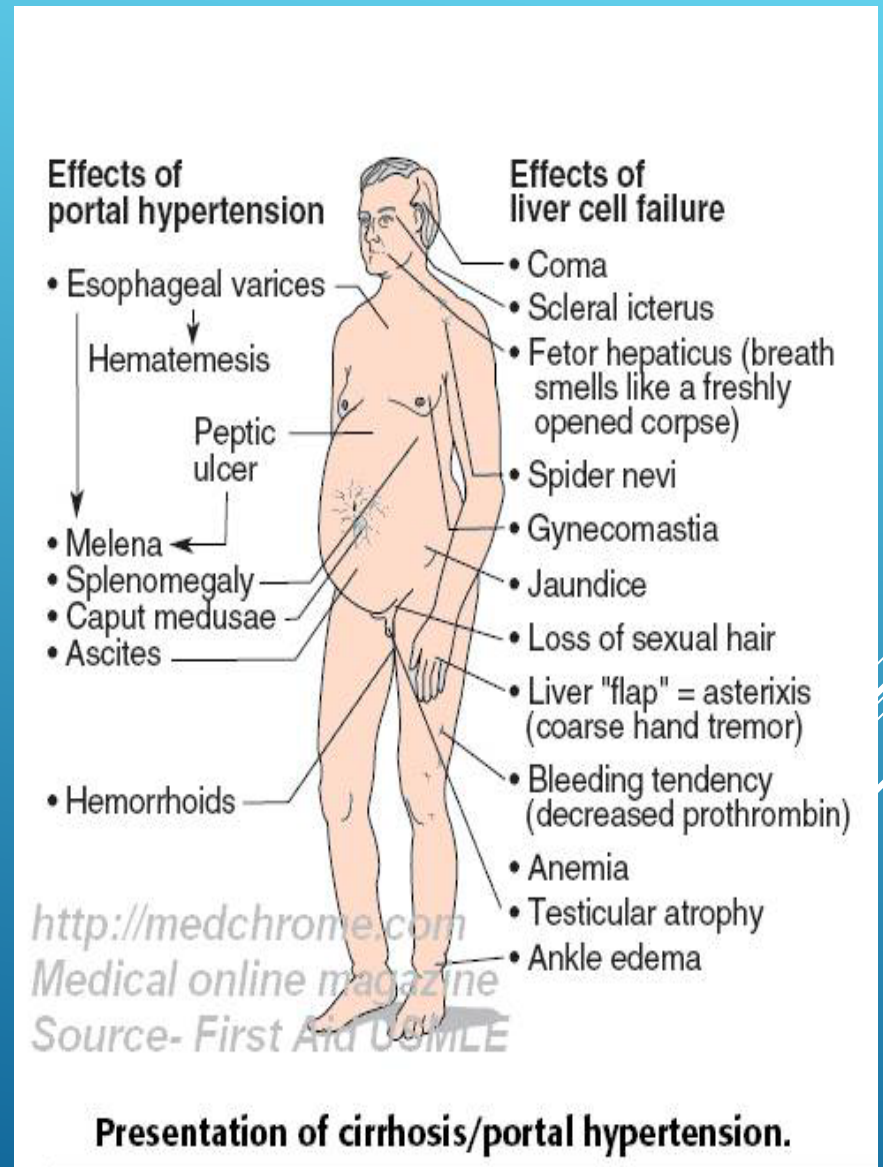
Cardiac Effects of Cirrhosis

Hyperdynamic state
Decreased SVR
Increased cardiac output
Increased heart rate
Decreased blood pressure

PRE-OP EVALUATION IN CIRRHOTIC PATIENTS

► Clinical Assessment:

- **Social history:** alcohol use, sexual history, IVDA, previous transfusions
- **Stigmata of cirrhosis on physical exam:** jaundice, ascites, caput medusae, varices, spider angiomas, palmar erythema, asterixis,





CAPUT MEDUSAE

- ▶ Caput medusae, sometimes called a palm tree sign, refers to the appearance of a network of painless, swollen veins around your bellybutton.

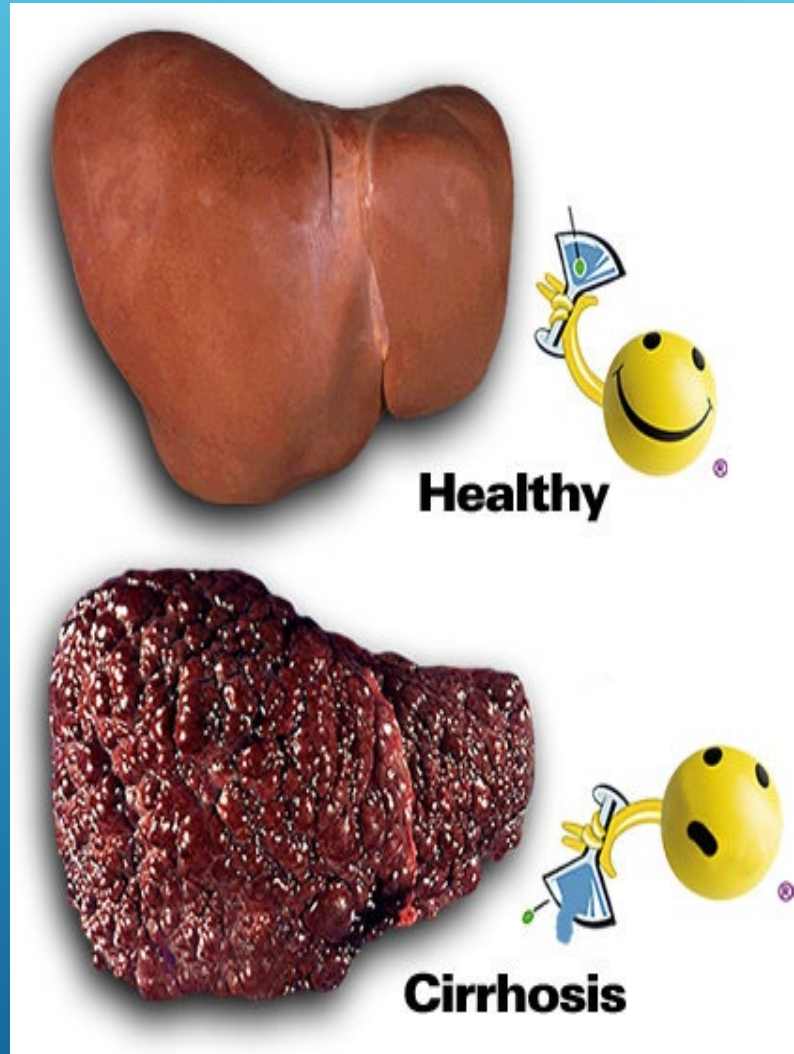
Asterixis



Symptoms of Cirrhosis

- **Portal Hypertension**
 - Ascites, complicated by SBP
 - Esophageal varices
 - Splenomegaly
- **Jaundice/Icterus**
 - Yellowing of the skin and sclera
 - Lack of glucuronidation of bilirubin, primarily unconjugated hyperbilirubinemia
 - Pruritis
- **Hepatic Failure**
 - **Hypoalbuminemia**
 - Peripheral Edema
 - Changes in drug activity
 - **Hyperammonemia**
 - Hepatic encephalopathy
 - Asterixis(hand Flapping)
 - Hyper-reflexia
 - **Hyperestrogenemia**
 - Palmar erythema
 - Spider angiomas
 - Hypogonadism
 - Gynecomastia
 - **Coagulopathy**
 - Decreased synthesis of coagulation factors and Proteins C & S
 - Decreased absorption of fat-soluble Vitamin K
 - Thrombocytopenia

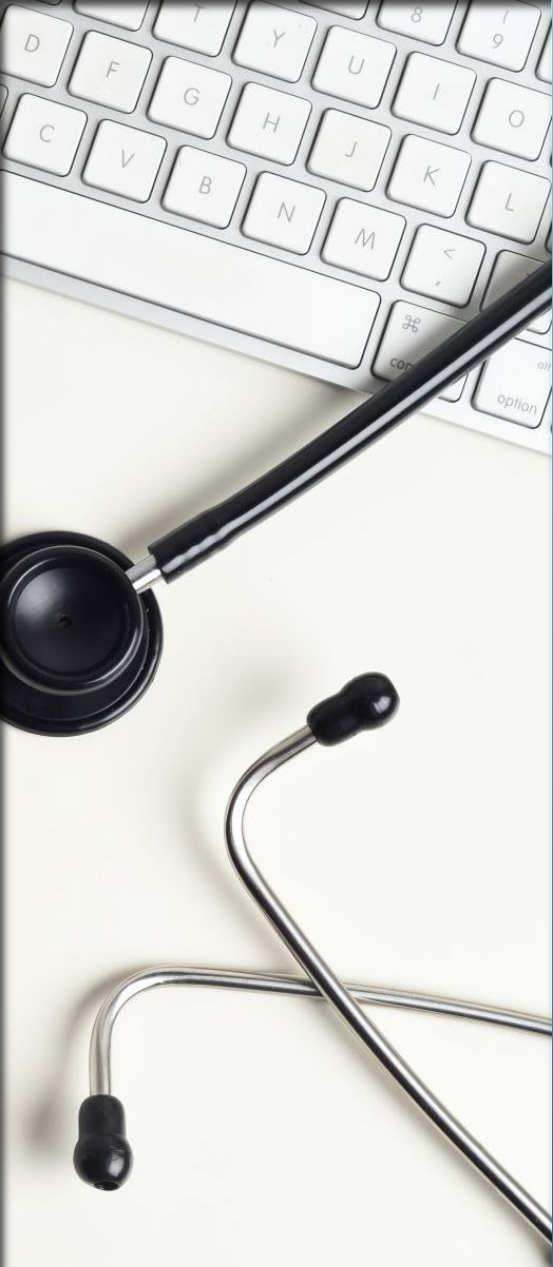
WHEN THE LIVER FAILS



Treatment of Cirrhosis

- **Damage is irreversible**
- **Eliminate offending agents**
- **Reduce Symptoms**
 - Transjugular Intrahepatic Portosystemic Shunt (**TIPS**)
 - Connects portal vein with hepatic vein
 - Relieves portal hypertension by bypassing the liver
 - Considered a bridge to transplant
 - Causes increase in hyperammonemia and symptoms
- **Transplant is only definitive treatment**
- **The most common indication for liver transplantation is cirrhosis due to hepatitis C virus (HCV),**

Aspect	Hepatitis	Cirrhosis
Reversibility	May be reversible depending on the cause	Irreversible due to permanent scarring
Liver Enzymes (AST, ALT)	Often very elevated, especially in acute hepatitis	May be only slightly abnormal in early stages
AST/ALT Ratio	Equal to one or less; indicates acute viral hepatitis or drug-related liver toxicity	Higher than one; suggests cirrhosis
Symptoms	Can come on rapidly	Tends to develop more gradually
Portal Hypertension	Less common	More common due to scarring



A 36-year old female comes to the pre-op clinic for evaluation prior to an inguinal hernia repair. On review of systems, she complains of malaise and nausea for the past week. She drinks socially and works as a reporter for a travel magazine. On physical examination, jaundice and a temperature of 101 F (38.5 C) were noticed.

Laboratory studies show:

ALT 756 (10-65) AST 568 (10-37)

Alkaline phosphatase 89 (50-136)

Bilirubin, Total 3.7 (0.2-1.0)

Albumin 4.0 (3.4-5.0)

PT 10 (9-12) INR 1.03 (0.9-1.1) PTT 25 (23-34)

ACUTE HEPATITIS

CLINICAL CASE 1

WHEN IS ELECTIVE SURGERY CONTRAINDICATED?

▶ Contraindications to Elective Surgery :

- ▶ AST/ALT increased to $>3\times$ normal or any elevation in total bilirubin
 - ▶ Warrants further work-up first
 - ▶ 6-34% incidence of cirrhosis in asx pts with abnormal LFTs
- ▶ Acute liver failure
- ▶ Acute renal failure
- ▶ Acute viral, alcoholic hepatitis
- ▶ Decompensated cardiomyopathy
- ▶ Refractory hypoxemia
- ▶ Severe refractory coagulopathy



Child-Turcotte-Pugh (CTP) Class



Why was it developed:
Predict mortality during surgery



What is it currently
used for: Prognosis of liver disease



Calculation: See chart



Score: A (5-6 pts), B (7-9 pts), C (10-15 pts)

Parameter	1pt	2pts	3pts
Ascites	Absent	Mild	Moderate
Bilirubin (mg/dL)	< 2	2-3	> 3
Albumin (g/dL)	> 3.5	2.8-3.5	< 2.8
INR	< 1.7	1.7-2.20	> 2.20
Encephalopathy	None	Grade I-II (or suppressed with medication)	Grade III-IV (or refractory to medication)

Now used to dictate non-surgical treatment, need for transplantation, post-operative prognosis

Correlates with post-op complications:

- Liver failure, worsening encephalopathy, bleeding, infection, renal failure, hypoxia, refractory ascites

Utilizes subjective parameters

Classes A, B, C have post-op mortality rates of 10, 30, 80%, respectively at 90 days (5)

elective surgery (5):

- well tolerated in pts with CTP A
- permissible with preop preparation in pts with CTP B
- contraindicated in patients with CTP C

CHILD-PUGH SYSTEM

MODEL FOR END-STAGE LIVER DISEASE

MELD SCORE

▶
$$3.78 \times \log_e \text{ serum bilirubin (mg/dL)} +$$
$$11.20 \times \log_e \text{ INR} +$$
$$9.57 \times \log_e \text{ serum creatinine (mg/dL)} +$$
$$6.43 \text{ (constant for liver disease etiology)}$$

NOTES:

If the patient has been dialyzed twice within the last 7 days, then the value for serum creatinine used should be 4.0

Any value less than one is given a value of 1 (i.e. if bilirubin is 0.8, a value of 1.0 is used) to prevent the occurrence of scores below 0 (the natural logarithm of 1 is 0, and any value below 1 would yield a negative result)



Objective, weighs each variable, cutoffs determined through linear regression analysis (5)



Scores of 0-11, 12-25, and >26 experience post-op mortality rates of 5-10, 25-54, and 90%, respectively at 90 days (5)



Model from Mayo Clinic incorporates age, ASA class, and etiology of cirrhosis for 7, 30, 90 day and 1 and 5 year post-op mortality rates

MODEL FOR END- STAGE LIVER DISEASE



- ▶ <https://www.mdcalc.com/meld-score-model-end-stage-liver-disease-12-older>

MELD CALCULATOR

Case

- 61 y.o. M with PMH of ESLD secondary to chronic Hepatitis C with minor alcohol component. ++ Ascites, on Lactulose
- Symptoms: Actually, looks fairly healthy other than large abdomen, no real complaints except minor SOB
- **Labs**
 - **Total Bili: 3.0**
 - **INR 1.76**
 - **Creatinine: 0.76**
 - **Platelets: 42**
- **Calculations**
 - **CTP Class C**
 - **MELD Score: 25**
 - **ASA 4**

What is the age?

61

What is the **ASA score**?

4

Enter 3 for compensated cirrhosis
Enter 4 for decompensated cirrhosis

What is the bilirubin?

3

(mg/dl)

What is the creatinine?

1.76

(mg/dl)

What is the INR?

1.76

What is the etiology of
cirrhosis?

- ☒ Alcoholic or Cholestatic
☐ Viral/Other

Compute

Reset



Probability of Mortality

7 days

30 days

90 days

1 year

5 years

9.986 %

35.057 %

50.201 %

59.869 %

92.02 %

What is the age?

61

What is the **ASA score**?

4

Enter 3 for compensated cirrhosis
Enter 4 for decompensated cirrhosis

What is the bilirubin?

3

(mg/dl)

What is the creatinine?

1.76

(mg/dl)

What is the INR?

1.76

What is the etiology of
cirrhosis?

- ☐ Alcoholic or Cholestatic
☒ Viral/Other

Compute

Reset

Probability of Mortality



7 days

30 days

90 days

1 year

5 years

19.227 %

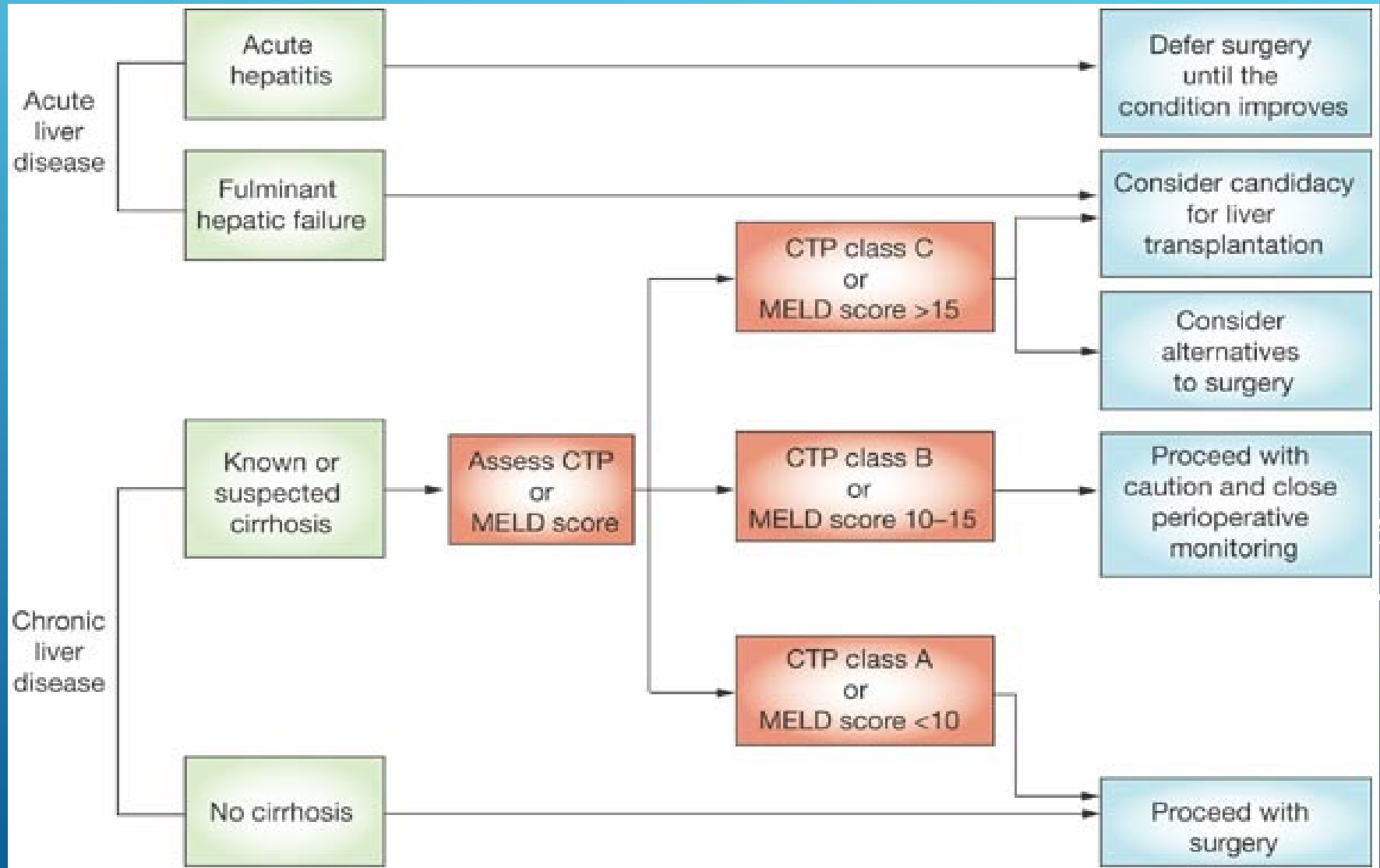
58.361 %

75.708 %

75.971 %

98.071 %

ALGORITHM FOR PRE-OP ASSESSMENT OF PATIENTS WITH LIVER DISEASE





► <http://www.mayoclinic.org/meld/mayo-model9.html>

MAYO MELD GUIDE



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- ▶ (3) Befeler AS, Palmer DE, Hoffman M, Longo W, Solomon H, DiBisceglie AM. *The Safety of Intra-abdominal Surgery in Patients with Cirrhosis: Model for Endstage Liver Disease Score is Superior to Child-Turcotte-Pugh Classification in Predicting Outcome*. Arch Surg 2005 Jul;140(7):650-4.
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- ▶ (6) Hanje J, Patel T. *Preoperative Evaluation of Patients with Liver Disease*. Nature Clinical Practice: Gastroenterology and Hepatology. May 2007 vol4 No 5
- ▶ (7) Wiklund Richard. *Preoperative Preparation of Patients with Advanced Liver Disease*. Critical Care Medicine 2004 Vol 32 No 4