Nutrition and Diseases of the Liver

1. What are the functions of the liver?

The liver is integral to most metabolic functions of the body and performs over 500 tasks. The main functions of the liver include:

1. metabolism of carbohydrate, protein, and fat
    - Galactose and fructose, products of carbohydrate digestion, are converted into glucose in the hepatocyte or liver cell.
    - Stores glucose as glycogen (glycogenesis) and then returns it to the blood when glucose levels become low (glycogenolysis)
    - Produces "new" glucose (gluconeogenesis) from precursors such as lactic acid, glycogenic amino acids, and intermediates of the tricarboxylic acid cycle.
    - Transamination & oxidative deamination
    - Forms serum proteins and lipoproteins
    - Forms blood-clotting factors such as fibrinogen and prothrombin.
    - Fatty acids from diet & adipose tissue converted to acetyl-cenzyme A.
    - Synthesizes and hydrolyzes triglycerides, phospholipids, cholesterol, & lipoproteins
2. Storage and activation of vitamins and minerals
    - Storage, activation, and transport of many vitamins & minerals. Stores all fat-soluble vitamins in addition to zinc, iron, copper, magnesium, and vit B12. Synthesizes proteins that transport vit A, iron, zinc, and copper.
    - Carotene is converted to vit A, folate & vit D to active forms.
3. bile formation and excretion
    - Bile salts are metabolized and used for the digestion and absorption of fats and fat-soluble vitamins. Bilirubin is a metabolic end product from RBC destruction; it is conjugated and excreted in the bile.
4. conversion of ammonia to urea
    - Hepatocytes detoxify ammonia by converting it to urea, 75% of which is excreted by the kidneys. The remaining urea finds its way back to the gastrointestinal tract.

5. steroid metabolism
    - It inactivates and excretes aldosterone, glucocorticoids, estrogen, progesterone, and testosterone. It is responsible for detoxification of substances including drugs and alcohol.
6. action as a filter and flood chamber
    - Removes bacteria and debris from blood through the phagocytic action of Kupffer cells located in the sinusoids and by storing blood backed up from the vena cava as in right heart failure.

2. How does the anatomy of a healthy and diseased liver differ?

Anatomy of a diseased liver includes:

- Hepatic vein pressure >0 is portal hypertension: always present in liver disease.
- Fatty liver (hepatic steatosis)

- cirrhosis - external surface macronodular/micronodular; necrosis; hepatocytes die; scar tissue..
- increase in fibrous tissue disrupting the normal liver structure,
- widespread inflammation of the liver, usually viral in origin
- bilirubinemia
- primary biliary cirrhosis: obstruction or infection of the small and intermediate sized intrahepatic bile ducts while extrahepatic biliary tree and larger intrahepatic ducts are normal.
- excessive accumulation of copper - Wilson's disease

3. What medical nutrition therapy is appropriate for the different diseases of the liver: hepatitis, cirrhosis, hepatic failure, and portal systemic encephalopathy. What dietary recommendations are appropriate for a person with uncomplicated cirrhosis and end stage liver disease with stage IV hepatic encephalopathy?

Amount of protein is different for various liver diseases!

All liver diseases: high kcal, do not limit CHO, moderate lipid, 25-40% of kcal, if have to go lowfat- 40g/d, supplement vit & min, use water-sol form, ascites - Na restrict, i&o monitor blood K.

Hepatitis: high protein, 1.2-1.5g/kg controversy: high bio-value or encourage dry beans & peas

Cirrhosis: same as above

Hepatic failure: before coma (i.e., stage 1-3) high protein, keep protein high until see problems, then restrict protein.

Portal systemic encephalopathy: (another term for hepatic encephalopathy) - Before coma (i.e. stage 1-3) high protein, keep protein high until see problems, then restrict protein.

Uncomplicated cirrhosis and ESLD with stage IV encephalopathy: Start at 40g protein -----> increase protein 10g/d to 60g until see problems (increase total bilirubin, increase prothrombin time, coma) ----> back off to 50 g. Avoid glutamine-rich products.

4. What are the underlying mechanisms for liver disease and failure due to excessive alcohol consumption? What other items can damage liver and result in disease?

Acute viral hepatitis is a widespread inflammation of the liver and is caused by hepatitis viruses A,B,C,D,&E.

Acetaldehyde , a toxic by-product of alcohol metabolism, causes damage to mitochondrial membrane structure and function. Complications from excessive alcohol consumption stem largely from acetaldehyde. Hydrogen produces fatty liver and hyperlipemia, high blood lactic acid, and low blood sugar. The accumulation of fat, the effect of acetaldehyde on liver cells, and other factors as yet unknown lead to alcoholic hepatitis. Several variables may predispose some individuals to alcoholic liver disease. These include genetic polymorphisms of alcohol-metabolizing enzymes, gender (female more than male), coexposure to other drugs, infections with hepatotropic viruses, immunologic factors, and poor nutritional status.The pathogenesis of alcoholic liver disease progresses in 3 stages: hepatic steatosis, fatty liver, and cirrhosis. The first two stages are reversible with abstinence from alcohol.

There are several other causes of liver disease. **Hepatitis: Infectious mononucleosis (viral), toxic chemicals, viral infection, excessive use of alcohol.** Liver tumors, systemic diseases such as rheumatoid arthritis, systemic lupus erythematosus, polymyalgia, rheumatic/temporal arteritis, polyarteritis nodosa, systemic sclerosis, and Sjogren's syndrome. Liver disease can also occur due to nonalcoholic steatohepatitis caused by obesity, diabetes mellitus, parenteral nutrition, and jejunoileal bypass. Parasitic, bacterial, fungal, and granulomatous liver diseases also occur.

5. What are the functions of bile salts? What can happen if bile and bile salts are not available?

Bile salts, made by liver cells from cholesterol, are essential for the digestion and absorption of fats, fat soluble vitamins, and some minerals. Bile also contains immunoglobulins that support the integrity of the intestinal mucosa. In addition, it is the primary excretory pathway for the minerals copper and manganese. If bile and bile salts are not available, all of these functions are impaired.

6. What are the key lab values and other ways to assess nutritional status in liver diseases and how reliable are they in determining nutritional status (protein energy nutritional status also)?

Labs & Clinical signs:

- Serum ammonia
- H&H - liver not makking glubulin
- Aklaline phosphostase - tissue damage
- BUN
- AST- cells lysing, i.e., liver damage
- ALT - cells lysing, i.e., liver damage
- **Bilirubin** - End Stage w/jaundice. High bilirubin is neurotoxic. High unconjugated --> liver not working. 2nd reason - excessive RBC breakdown. Blockage - usually conjugated.
- K
- Blood glucose - when insulin is needed
- TG& FFA
- **Prolonged prothrombin time**
- Alb - not a good indicator (liver stops making. Can be eating high Pro & still have low alb & pre-alb.
- LDH - lactic dehydrogenase ---> tissue damage
- Ascites & edema

7. What impact do diseases of the liver have on nutritional status and why? In other words, how might some of these patients present, what might their nutritional status be and what specific nutrients are of greatest concern?

Clinical manifestations occur:

- hypoglycemia - can't quickly put glucose in blood. .e., have lost glucose control.
- fluid imbalance
- bleed more easily - bruise (not making clotting factors)
- elevated serum bilirubin >20mg/dL ---> jaundice
- albumin goes down ---> edema

- problems with aldosterone - when to get rid of or keep Na, not make urine or too much.

Patients are likely to be malnourished. Protein is a big problem. Fat-soluble vitamins. supplement vitamins & min (use water soluble forms); if ascites, restrict Na. Monitor blood K if kidney involvement. In ESLD, restrict protein ec. of abnormal aromatic to branched chain problem. Some institutions give hepatic aid to bring BCAA up.

8. How to use SGA?

SGA is a method to use when you can't depend on lab values. This is an "eyeball" technique that requires good clinical judgment as the info is collected by observation and interviews. This type of evaluation has been found to be extremely useful and cost-effective. SGA has been used in liver disease and transplantation and has demonstrated an acceptable level of reliability and valididy. This method uses a few readily available parameters obtained by an experienced clinician. The SGA gives a broad perspective but is not sensitive to changes in nutritional status.

- Four elements of pt.Hx
  - Recent loss of body wt.
  - Changes in usual diet
  - Presence of significant gastrointestinal symptoms
  - Patient's functional capacity
- Three elements of physical exam
  - loss of subcutaneous fat
  - muscle wasting
  - presence of edema or ascites
- Deltoid muscle wasted
- Shoulders look squared off
- Muscle wasting at quadriceps femoris
- Anterior thigh
- Significant wt loss
  - > 1 to 2% in 1 week
  - > 5% in 1 month
  - > 7.5% in 3 months
  - > 10% in 6 months
  - > 40% life threatening
  - unplanned or recent loss of >10%
  - >20% in surgical pt.