

Review Article

Jaundice: a basic review

Muhammad Waseem Abbas*, Talha Shamshad, Muhammad Aizaz Ashraf, Rukhsar Javaid

Nishtar Medical College, Multan, Pakistan

Received: 18 February 2016

Accepted: 22 March 2016

***Correspondence:**

Dr. Muhammad Waseem Abbas,

E-mail: wiz46221@outlook.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Jaundice is a complex disease. Jaundice is actually the high bilirubin level in the body. Yellowing of skin, mucous membranes and skin are common presentations of jaundice. Jaundice has various variants including pre-hepatic jaundice (due to hemolysis of red blood cells), hepatic jaundice (due to defect in capture, conjugation and excretion of bilirubin by liver) and post hepatic jaundice (due to the obstruction of extra hepatobiliary system). The causes of various variants of Jaundice is either acquired or congenital. High plasma bilirubin level can cause various manifestations involving satiety, gastrointestinal bleeding, diarrhea, anemia, edema, weight-loss and can be fatal because it can cause psychosis, lethargy, seizures, coma or even death. High bilirubin level can help in the diagnosis of Jaundice. Differential diagnosis of various variants of Jaundice can be carried out on the basis of bilirubin level (conjugated and unconjugated), ultrasonography and other radiological techniques. The proper management of Jaundice is high water intake and low fat diet. The primary effective treatment for pre-hepatic jaundice and neonatal physiological jaundice is phototherapy. Infusion of immunoglobulins is also used for treatment of pre-hepatic jaundice. Proper nutrition, steroids and immunosuppressant are used for treatment of hepatic jaundice. The treatment for post hepatic jaundice is decompression and surgery.

Keywords: Jaundice, Hyperbilirubinemia, Hemolysis, Hepatobiliary, Obstruction

INTRODUCTION

Jaundice is defined as a yellowing of skin, mucous membranes and sclera due to the deposition of yellow-orange bile pigment i.e. bilirubin.¹ The bilirubin is an endogenously synthesized pigment that can be toxic specially in newborn children.² The bilirubin in unconjugated form has a typical spectrographical peak at 450 nm.³ The word Jaundice is actually a derivative of French word 'Jaune' which means 'yellow'.¹ Jaundice indicates the hyper bilirubinemia and that excessive level of bilirubin may be in conjugated or unconjugated form. The clinical presentations of jaundice appear when bilirubin level exceeds 34.2 $\mu\text{mol/L}$ or 2 mg/dL.⁴ The substrate for the production of bilirubin is heme group. The heme is catabolized at alpha carbon bridge by an enzyme heme oxygenase and results in the liberation of

iron, carbon monoxide and biliverdin. The biliverdin is further acted upon by biliverdin reductase to form bilirubin.⁵ 80 % of bilirubin is derived from the heme group of haemoglobin. This haemoglobin comes from the destruction of red blood cells in the reticuloendothelium of liver, spleen and bone marrow. The remaining 20% of bilirubin comes from multiple sources like myoglobin, cytochromes etc.^{6,7} 3.8 mg/kg or approximately 250-300 mg bilirubin is produced daily in normal adults. The amount of bilirubin production in neonates is much higher than adults.⁸ The bilirubin produced is then transported to the liver in the bound form with plasma albumin. The dissociation constant for first albumin binding site is $K_d=7 \times 10^7 \text{M}^{-1}$.⁹ Conjugation of bilirubin takes place in the liver by UDP-gluconyltransferase and this conjugation is essential for water solubility and elimination.^{6,7} The activity of UDP-gluconyltransferase

is influenced by age, gender, thyroid hormones and microsomal enzyme inducing agents, such as phenobarbital, rifampicin etc.¹⁰⁻¹⁴ Conjugated bilirubin is excreted into the bile. The bile is then passed to the duodenum via biliary system. Inside the intestine some bilirubin is metabolized by the intestinal flora into urobilinogens and then reabsorbed. These urobilinogens are then removed by the kidney and excreted via urinary system.^{6,7} The production and metabolism of bilirubin is shown in Figure 1a.¹⁵

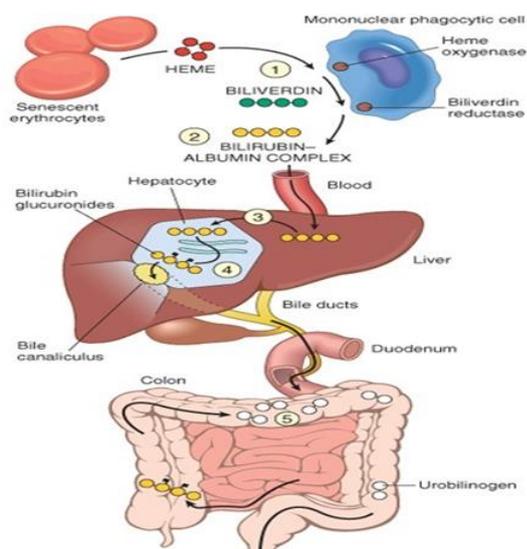


Figure 1a: Production and metabolism of bilirubin.

Types

On the basis of causes Jaundice can be classified into three types.⁴

- Pre-hepatic Jaundice
- Hepatic Jaundice
- Post hepatic Jaundice
- Pre-hepatic Jaundice

Pre hepatic jaundice is such type of jaundice which is caused due to hemolysis therefore it is also known as hemolytic jaundice. The major cause of enhanced hemolysis is defective plasma membrane of red blood cells. This vulnerable cell membrane cannot bear the shear stress and hence ruptures resulting in hemolysis thus causing the increased serum bilirubin level.^{16,17} Overview of pre-hepatic jaundice is given in Figure 1(b).¹⁸

Etiology

The pre hepatic jaundice is mainly caused due to hemolysis. The causes of pre-hepatic/hemolytic jaundice are classified into two groups:

Congenital Causes

Congenital causes of hepatic jaundice involve following:^{19,20}

- Spherocytosis
- Elliptocytosis
- Congenital LCAT deficiency
- Thalassemia
- Sickle cell anemia
- Stomatocytosis
- Acanthocytosis
- Echinocytes
- GSH synthase deficiency
- Pyruvate kinase deficiency
- G6PD deficiency
- Erythroblastosis fetalis

Acquired causes

Acquired causes of pre-hepatic jaundice involve following:^{19,20}

- Resorption of extensive hematomas
- Auto immune hemolysis
- Transfusion reactions
- Trauma
- Microangiopathy
- Hemolytic uremic syndrome
- Long distance runners
- Disseminated intravascular clot
- Infections e.g. malaria, etc.
- Toxins e.g. snake venoms, etc.
- Chemicals e.g. nitrites, aniline dyes, etc.
- Paroxysmal nightly hemoglobinuria
- Thrombotic thrombocytopenic purpura
- Hypophosphatemia
- Vitamin B12 deficiency
- Folic acid deficiency

Clinical presentations

Patients with hemolytic jaundice are presented with Anemia, Yellowing of sclera, dark yellow-brown colored urine, yellowish skin and high bilirubin levels.²¹

Hepatic jaundice

Hepatic jaundice is a type of jaundice in which the basic defect lies within the liver mainly in the hepatocytes. The liver captures bilirubin from plasma proteins mainly albumin, then after conjugation excretes in the bile via biliary system. Any pathology of the liver leading to defect in capture, conjugation and excretion can cause hepatic jaundice. Main enzyme of conjugation is UDP-Glucuronyltransferase. This is commonly immature at birth and its under-activity can cause so called Neonatal Physiological Jaundice. Further this enzyme can be defective due to the genetic mutation of the UGT1A gene

on chromosome 2. This gene encodes for UDP-Gluconyltransferase and thus the defective conjugating enzyme leads to the hepatic jaundice.²²⁻²⁴ Any defect in the hepatic excretory mechanism of bilirubin can also cause hepatic jaundice. The excretory mechanisms involve hepatocytic bile acid-independent secretion, hepatocytic bile acid-dependent secretion and bile ductular secretion. Any defect in the above mentioned excretory mechanisms can lead to the accumulation of bilirubin in blood causing hepatic jaundice.²⁵⁻³⁴ Overview of hepatic jaundice is given in Figure 1b.¹⁸

Etiology

Hepatic jaundice is caused due to the defect in capture, conjugation and excretion of bilirubin by liver.³⁵⁻³⁸ Hepatic causes of the jaundice can be classified in to two types:

Congenital causes

Congenital causes of hepatic jaundice are following:^{38,39}

- Wilson’s Disease
- Rotor’s Syndrome
- Haemochromatosis
- CriglerNajar syndrome
- Gilbert’s syndrome
- Dubin-Johnson’s syndrome

Acquired causes

Acquired causes of hepatic jaundice are following:^{38,39}

- Viral Hepatitis
- Alcoholic Hepatitis
- Auto immune Hepatitis
- Drug related Hepatitis (e.g. NSAIDs)
- Sepsis
- Pregnancy
- Systemic Diseases (e.g. celiac disease)
- Malnutrition
- Physical Trauma
- Hepatic Adenoma

Clinical presentations

The clinical presentations of hepatic jaundice include abdominal pain, fever, vomiting and nausea along with the complications involving satiety, gastrointestinal bleeding, diarrhea, anemia, edema, weight-loss and associated weakness, if unchecked leading to mental disturbances like kernicterus, coma or even death.⁴⁰

Post hepatic jaundice

Post hepatic jaundice is such type of a jaundice in which the cause lies in the biliary portion of hepatobiliary system. The major cause of post hepatic jaundice is extra-hepatic biliary obstruction. Therefore it is also known as

obstructive jaundice.⁴¹ Overview of post hepatic jaundice is given in Figure 1b.¹⁸

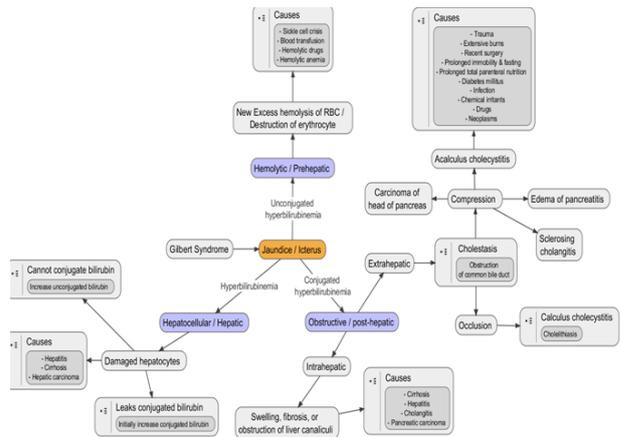


Figure 1b: Overview of types and causes of jaundice.

Etiology

The major cause of post hepatic jaundice is extra-hepatic biliary obstruction.⁴¹ The causes of obstruction may be classified into two types:

Congenital causes

The congenital obstruction involves following:^{41,42}

- Biliary Atresia
- Cystic Fibrosis
- Idiopathic dilation of common bile duct
- Pancreatic biliary malfunction
- Choledochal Cyst

Acquired Causes

The acquired obstruction involves following:⁴²⁻⁴⁹

- Portal biliopathy
- Cholecystitis
- Trauma
- Pancreatitis
- Strictures
- Choledocholithiasis
- AIDS
- Intra-Abdominal Tuberculosis
- Tumors
- Common bile duct Obstruction

The classification of obstruction on the basis of anatomical location is give in Table 2a.⁴⁵

Clinical presentation

The clinical manifestations of obstructive jaundice are dark urine, pale stools and generalized pruritus. History of fever biliary colic, weight loss, abdominal pain and

abdominal mass are also the representatives of obstructive jaundice.⁴² Obstructive Jaundice may lead to various complications including cholangitis, pancreatitis, renal and hepatic failure.

Table 2a: Classification of obstruction on the basis of anatomical location.

Classification of obstruction on the basis of anatomical location		
Upper third obstruction	Middle third obstruction	Lower third obstruction
Polycystic Liver Disease	Mirizzi Syndrome	Pancreatic Tumors
Oriental Choangiohepatit	Cystic Fibrosis	Ampullary Tumors
Sclerosing Cholangitis	Intrabiliary Parasites	Duodenal Diverticula
Iatrogenic injury to the Bile Duct	Choledochal Cysts	Penetrating Duodenal Ulcer

Differential diagnosis

The pre-hepatic jaundice can be differentiated from hepatic and post hepatic jaundice exclusively on the basis of elevated serum levels of unconjugated bilirubin and urobilinogen, which are raised in case of pre-hepatic jaundice. The serum levels on conjugated bilirubin, alkaline phosphatase, Alanine transferase and Aspartate transferase are seen normal in the case of pre-hepatic jaundice. The urinary excretion of conjugated bilirubin is also not present in pre-hepatic jaundice.⁵⁰ The hepatic jaundice can be differentiated from post hepatic and pre hepatic jaundice on the basis of five times high bilirubin levels. In hepatic jaundice due to hepatitis the bilirubin levels may be ten times higher than their maximum values.^{38,51} Hepatic jaundice can be differentially diagnosed from post hepatic jaundice on the basis of abdominal ultrasonography and other radiological technique.³⁸ However the hepatic jaundice can be differentiated from pre-hepatic jaundice on the basis of diagnostic markers, like alpha-1 Antitrypsin, Ceruloplasmin, Immunoglobulins, etc.^{35,38,39,51} Elevated serum bilirubin level along with the conjugation is a key diagnosis of post hepatic jaundice. Serum bilirubin is usually less than 20 mg/dL. In pancreatic cancer the serum bilirubin may rise up to 40 mg/dL. Serum gamaglutamyltranspeptidase (Serum GGT), alkaline phosphatase and transaminases may be elevated. Tumour markers like CA-125, CA19-9 and CEA are usually elevated in cancerous obstruction.⁴² The diagnosis of obstructive jaundice can further be confirmed by ultrasonography, plain abdominal x-ray, computed tomography, contrast-enhanced multi sliced computed tomography, endoscopic retrograde cholangiopancreatography (ERCP), Percutaneous trans-hepatic cholangiography (PTC), Endoscopic Ultrasound, Magnetic Resonance cholangiopancreatography (MRCP),

Cholescintigraphy, Radionuclide scanning angiography and Staging Laparoscopy.^{4,43,44}

Therapeutic approaches and managements

Pre-hepatic jaundice

Infusion of immunoglobulins is used as primary treatment for pre-hepatic jaundice.⁵² Phototherapy is considered as an effective treatment of high levels of bilirubin in pre-hepatic jaundice.^{53,54} Bilirubin rapidly decreases within two hours of onset of phototherapy.⁵⁵ However the duration of therapy and the strength of light treatment depend upon the severity of hyperbilirubinemia.⁵⁴⁻⁵⁶ Metaloporphyrins are also considered as a treatment possibility of pre-hepatic jaundice, because these metaloporphyrins target the hemeoxygenase enzyme to limit the production of bilirubin.⁵⁷

Hepatic jaundice

Treatment and Management of hepatic jaundice involves⁵⁸

- Phototherapy - for neonatal jaundice.
- Phenobarbital can be used for treatment of neonatal physiological jaundice however it is not frequently used due to certain drawbacks involving somnolence and febrile seizures.
- Supportive therapy - fluids, rest, pain relief - for Hepatitis A.
- Abstinence from alcohol and cessation of medications contributing to liver dysfunction.
- Steroids - for autoimmune hepatitis.
- Immunosuppressant - for autoimmune hepatitis.
- Interferon - for chronic hepatitis B and C.
- Liver transplantation for fulminant hepatitis and end stage liver failure.

Post hepatic jaundice

Low fat diet should be given to patient suffering from post-hepatic jaundice to minimize the discomfort due to fat ingestion and diarrhea.^{35,59} The treatment of the post hepatic obstructive jaundice is mechanical decompression however the complications and other symptoms are also necessarily treated. Decompression can be done by surgical bypass, percutaneous insertion of stents, removal of lesions and endoscopic insertion of stents.⁴⁵ Dexchlorophenramine, Hydroxyzine, Cholestyramine, Ursodeoxycholic acid and Naltrexone are used as a therapeutic approach in treatment and management of post hepatic jaundice.^{35,59}

CONCLUSION

Jaundice is very common disease. Yellowing of skin, sclera and mucous membranes are common manifestations of jaundice due to defect in production,

metabolism and excretion of bilirubin. The causes of jaundice are either congenital or acquired. Serum bilirubin level and ultrasonography are used for differential diagnosis. High water intake and low fat diet are best proper managements of jaundice. The treatment of jaundice varies with the type of jaundice.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Muhammad Iqbal, Abbas Ali, Shamshad Ahmad, Muhammad Ashraf Khan, Javaid Iqbal, Mansoor Ahmed, Haris Ali Khan, Romais Mehdi, Naveed Asghar, Muhammad Umer bin Arshad and Sajid Hussain Khosa.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

REFERENCES

- Roche SP, Kobos R. Jaundice in the adult patient. *Am Fam Physician.* 2004;69(2):299-304.
- Tiribelli C, Ostrow JD. The molecular basis of bilirubin encephalopathy and toxicity: report of an EASL single topic conference. *J Hepatol.* 2005;43:156-6.
- Blanckaert N, Heirwegh KP, Compernelle F. Synthesis and separation by thin-layer chromatography of bilirubin-IX isomers. Their identification as tetrapyrroles and dipyrrolic ethyl anthranilate azo derivatives. *Biochem J.* 1976;155(2):405-17.
- Briggs CD, M Peterson. Investigation and management of obstructive jaundice. *Surgery.* 2007;25(2):74-80.
- Drummond GS, Kappas A. Chemoprevention of severe neonatal hyperbilirubinemia. *Semin Perinatol.* 2004;28:365-8.
- Roche SP, Kobos R. Jaundice in the adult patient. *Am Fam Physician.* 2004;69(2):299-304.
- Kamisako T, Kobayashi Y, Takeuchi K, Ishihara T, Higuchi K, Tanaka Y. Recent advances in bilirubin metabolism research: the molecular mechanism of hepatocyte bilirubin transport and its clinical relevance. *J Gastroenterol.* 2000;35(9):659-64.
- Berk PD, Howe RB, Bloomer JR, Berlin NI. Studies of bilirubin kinetics in normal adults. *J Clin Invest.* 1969;48:2176-90.
- Brodersen R. Bilirubin, Solubility and interaction with albumin and phospholipid. *J Biol Chem.* 1979;254:2364-9.
- Muraca M, Fevery J. Influence of sex and sex steroids on bilirubin uridine diphosphate-glucuronosyltransferase activity of rat liver. *Gastroenterology.* 1984;87:308-13.
- Black M, Fevery J, Parker D, Jacobson J, Billing BH, Carson ER. Effect of phenobarbitone on plasma (14C) bilirubin clearance in patients with unconjugated hyperbilirubinaemia. *ClinSciMol Med.* 1974;46:1-17.
- Lankisch TO, Moebius U, Wehmeier M, Behrens G, Manns MP, Schmidt RE, et al. Gilbert's disease and atazanavir: from phenotype to UDP glucuronosyltransferase haplotype. *Hepatology.* 2006;44:1324-32.
- Van Steenberg W, Fevery J, De Groote J. Thyroid hormones and the hepatic handling of bilirubin II. Effects of hypothyroidism and hyperthyroidism on the apparent maximal biliary secretion of bilirubin in the Wistar rat. *J Hepatol.* 1988;7:229-38.
- Van Steenberg W, Fevery J. Effects of uridine diphosphate glucuronosyl transferase activity on the maximal secretion rate of bilirubin conjugates in the rat. *Gastroenterology.* 1990;99:488-99.
- Maitra A. Pancreas. In: Vinay Kumar, Abul K. Abbas, Jon C Aster. *Robbins Basic Pathology.* 9th ed. Philadelphia, PA: Elsevier. 2013; 645-656.
- Wickramasinghe SN, Wood WG. Advances in the understanding of the congenital dyserythropoietic anaemias. *Br J Haematol.* 2005;131:431-46.
- Glader B. Anemia: general consideration. In: Greer JP, eds. *Wintrobe's Clinical Hematology.* Chapter 27. Lippincott, Williams & Wilkins Co; 2004:965-75.
- Jacques G. Types of jaundices. *Visual Understanding Environment (VUE).* Enigma. 2009;18:55.
- Galanello R, Piras S, Barella S, Leoni GB, Cipollina MD, Perseu L. Cholelithiasis and Gilbert's syndrome in homozygous β thalassaemia. *Br J Haematol.* 2001;115:926-8.
- Bosma PJ, Chowdhury NR, Goldhoorn BG et al. Sequence of exons and the flanking regions of human bilirubin - UDP - glucuronosyltransferase gene complex and identification of a genetic mutation in a patient with Crigler-Najjar syndrome, type I. *Hepatology.* 1992;15:941-7.
- Bektaş M, Dökmeci A, Cinar K, Halici I, Oztas E, Karayalcin S. Endoscopic management of biliary parasitic diseases. *Dig Dis Sci.* 2010;55(5):1472-8.
- Rajmakers MT, Jansen PL, Steegers EA, Peters WH. Association of human liver bilirubin UDP-glucuronosyltransferase activity with a polymorphism in the promoter region of the UGT1A1 gene. *J Hepatol.* 2000;33:348-51.
- Persico M, Persico E, Bakker CT, Rigato I, Amoroso A, Torella R. Hepatic uptake of organic anions affects the plasma bilirubin level in subjects with Gilbert's syndrome mutations in UGT1A1. *Hepatology.* 2001;33(3):627-32.
- Ostaneck B, Furlan D, Mavec T, Lukac-Bajalo J. UGT1A1 (TA)_n promoter polymorphism—a new case of a (TA)₈ allele in Caucasians. *Blood Cells Mol Dis.* 2007;38(2):78-82.
- Dumont M, D'Hont C, Lamri Y, Durand-Schneider AM, Jacquemin E, Feldmann G. Effects of phalloidin and colchicine on diethylmaleate-induced

- choleresis and ultrastructural appearance of rat hepatocytes. *Liver.* 1994;14(6):308-13.
26. Pauli-Magnus C, Stieger B, Meier Y, Kullak-Ublick GA, Meier PJ. Enterohepatic transport of bile salts and genetics of cholestasis. *J Hepatol.* 2005;43:342-57.
 27. Pauli-Magnus C, Meier PJ. Hepatobiliary transporters and drug-induced cholestasis. *Hepatology.* 2006;44:778-87.
 28. Geier A, Wagner M, Dietrich CG, Trauner M. Principles of hepatic organic anion transporter regulation during cholestasis, inflammation and liver regeneration. *Biochim Biophys Acta.* 2007;1773:283-308.
 29. Kaplan MM, Righetti A. Induction of rat liver alkaline phosphatase: the mechanism of the serum elevation in bile duct obstruction. *J Clin Invest.* 1970;49:508-16.
 30. Blanckaert N, Compennolle F, Leroy P, Van Houtte R, Fevery J, Heirwegh KP. The fate of bilirubin-IX α glucuronide in cholestasis and during storage in vitro. Intramolecular rearrangement to positional isomers of glucuronic acid. *Biochem J.* 1978;171:203-14.
 31. Van Hootegem P, Fevery J, Blanckaert N. Serum bilirubins in hepatobiliary disease: comparison with other liver function tests and changes in the postobstructive period. *Hepatology.* 1985;5:112-7.
 32. Billing BH. Intestinal and renal metabolism of bilirubin, including enterohepatic circulation. In: Donald Ostrow J, ed. *Bile Pigments and Jaundice.* New York: Marcel Dekker Inc; 1986:255-70.
 33. Fulop M, Katz S, Lawrence C. Extreme hyperbilirubinemia. *Arch Intern Med.* 1971;127:254-8.
 34. Medley MM, Hooker RL, Rabinowitz S, Holton R, Jaffe BM. Correction of congenital indirect hyperbilirubinemia by small intestinal transplantation. *Am J Surg.* 1995;169:20-7.
 35. Lidofsky SD, Kobos R. Jaundice. In: Sleisenger and Fordtran's *Gastrointestinal and Liver Disease.* 8ed. Philadelphia, Saunders Elsevier; 2006:301-16.
 36. Beekingham IJ, Ryder SD. ABC of diseases of the liver, pancreas and biliary system: investigation of liver and biliary disease. *BMJ.* 2001;322:33-6.
 37. Ryder SD, Beekingham IJ. ABC of diseases of the liver, pancreas and biliary system: other causes of parenchymal liver disease. *BMJ.* 2001;322:290-2.
 38. Roche SP, Kobos R. Jaundice in the adult patient. *Am Fam Physician.* 2004;69:299-304.
 39. Merriman RB, Peters MG. Approach to the patient with jaundice. In: Yamada T *Textbook of Gastroenterology.* 4ed. Philadelphia. Lippincott Williams and Wilkins; 2003:911-28.
 40. Mathew KG. *Medicine: Prep manual for undergraduates.* 3/e. Elsevier. India; 2008:296-7.
 41. Vendemiale G, Grattagliano I, Lupo L, Memeo V, Altomare E. Hepatic oxidative alterations in patients with extra-hepatic cholestasis. Effect of surgical drainage. *J Hepatol.* 2002;37(5):601-5.
 42. Malhi H, Gores GJ, Malhi H, Gores GJ. Review article: the modern diagnosis and therapy of cholangiocarcinoma. *Aliment Pharmacol Ther.* 2006;23(9):1287-96.
 43. Barkun JS, Chaudhury P, Barkun AN. Approach to the Jaundiced Patient. *ACS Surgery: principles and practice.* 2006.
 44. Yusuf TE, Bhutani MS, Yusuf TE, Bhutani MS. Role of endoscopic ultrasonography in diseases of the extrahepatic biliary system. *J Gastroenterol Hepatol.* 2004;19(3):243-50.
 45. Baron TH. Palliation of malignant obstructive jaundice. *Gastroenterol Clin North Am.* 2006;35(1):101-12.
 46. Gurusamy KS, Samraj K, Gurusamy KS, Samraj K. Primary closure versus T-tube drainage after laparoscopic common bile duct stone exploration. *cochrane database of systematic reviews.* 2007;(1):CD005641.
 47. Gurusamy KS, Samraj K, Gurusamy KS, Samraj K. Primary closure versus T-tube drainage after open common bile duct exploration. *Cochrane Database of Systematic Reviews.* 2007;(1):CD005640.
 48. Tai CK, Tang CN, Ha JP, Chau CH, Siu WT, Li MK. Laparoscopic exploration of common bile duct in difficult choledocholithiasis. *SurgEndosc.* 2004;18(6):910-4.
 49. Wamsteker EJ, Wamsteker EJ. Updates in biliary endoscopy 2006. *Current Opinion in Gastroenterology.* 2007;23(3):324-8.
 50. Goljan, Edward F. *Rapid Review Pathology,* 2nd ed., Elsevier Health Sciences. 2007:368-9.
 51. Giannini EG, Testa R, Savarino V. Liver enzyme alteration: a guide for clinicians. *CMAJ.* 2005;172:367-79.
 52. Bratlid D, Nakstad B, Hansen T. National guidelines for treatment of jaundice in the newborn. *Acta Paediatrica.* 2011;100:499-505.
 53. Bhutani V, Maisels M, Stark A, Buonocore G. Management jaundice and prevention of severe neonatal hyperbilirubinemia in infants >35 weeks gestation. *Neonatology.* 2008;94:64-7.
 54. Schwartz H, Haberman B, Ruddy R. Hyperbilirubinemia: current guidelines and emerging therapies. *Pediatr Emerg Care.* 2011;27(9):884-9.
 55. Bhutani VK, Committee on Fetus and Newborn, American Academy of Pediatrics. Phototherapy to prevent severe neonatal hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics.* 2011;128(4):1046-52.
 56. Watson R. Hyper bilirubinemia. *Crit Care Nurs Clin North Am.* 2011;21:97-120.
 57. Stevenson D, Wong R. Metalloporphyrins in the management neonatal hyperbilirubinemia. *Seminars in Fetal & Neonatal Medicine.* 2010;15(3):164-8.
 58. Farwell JR, Lee YJ, Hirtz DG, Sulzbacher SI, Ellenberg JH, Nelson KB. Phenobarbital for febrile seizures - effects on intelligence and on seizure recurrence. *N Engl J Med.* 1990;322:364-9.

59. Bergasa NV. Medical palliation of the jaundiced patient with pruritus. *Gastroenterol Clin N Am.* 2006;35:113-23.

Cite this article as: Abbas MW, Shamshad T, Ashraf MA, Javaid R. Jaundice: a basic review. *Int J Res Med Sci* 2016;4:1313-9.