Acute Liver Failure

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Abstract. Acute liver failure in children is associated with a high mortality. Most cases in our setup are due to water borne hepatotropic viruses HAV and HEV. The clinician must be aware of the earliest and the subtle signs of acute liver failure to identify cases early enough and institute supportive therapy. Focus of therapy has to be on prevention, early recognition and appropriate management of complications. Despite good intensive care, about 40-60% children with liver failure die. As and when liver transplantation becomes available in India, it would be an attractive option.
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Key words : *Acute liver failure; Etiology; Management*

Acute liver failure is a clinical syndrome rather than a specific disease entity. It represents the consequences of severe hepatocyte dysfunction and alteration of their structure. There are a multitude of causative factors, which differ between children and adults. Regardless of the antecedent cause, acute liver failure is clinically characterized by multi organ failure including hepatic encephalopathy, a complex coagulopathy, raised intracranial tension, complications of renal dysfunction, cerebral edema, susceptibility to infections and hemodynamic disturbances, all potentially related to impairment of hepatic synthesis or degradation of important chemical mediators in these processes.

Definitions

The classical definitions of fulminant hepatic failure, subacute hepatic failure and chronic hepatic failure have been modified as our knowledge of the natural course of liver failure has increased.

- *Fulminant liver failure (FHF) :* This term is used to describe patients without previous liver disease who develop a rapidly progressive liver failure within four weeks of onset of symptoms.
- *Sub-acute liver failure (SAHF) :* When the onset of progressive or persistent ascites and or encephalopathy occurs after four weeks of persistent or progressive icterus due to acute hepatitis, the child is labeled as having sub-acute liver failure.
- *Chronic liver failure (CLF)* : Occurrence of signs of liver failure such as hepatic encephalopathy and or clinically detectable ascites at least six months after hepatic illness is classified as chronic liver failure.

Etiology

The causes of acute liver failure vary with the age of the child. In neonates, infections or inborn errors of metabolism are common, while viral hepatitis and metabolic causes are more likely in older children. Table 1 summarizes causes of acute liver failure in infancy and childhood. Hepatitis A is the most common form of hepatitis worldwide but it progresses to acute liver failure only in 0.35% of cases[1] and has a case fatality rate of 0.14% for hospitalized patients.[2] Risk factors for the development of fulminant hepatitis A infection include age over 40 years[1], and hepatitis A infection superimposed on underlying chronic liver disease.[3] It is not known at present whether there are differences of risk factors in the pediatric age group. Patients with fulminant hepatitis A have a better prognosis than do those with acute liver failure due to any other cause; upto 70% of them may survive without resorting to transplantation.[4,5]

Hepatitis B is the most common identifiable viral agent responsible for acute liver failure worldwide[1] with fulminant hepatitis occurring in approximately 1 % of cases. Absence of HBeAg and presence of anti-HBeAg seems to increase the risk of acute liver failure in newborns and infants who have acquired the infection vertically from their mothers. Reactivation of latent HBV infection may lead to fulminant disease, and this usually occurs in immuno-compromised patients. Risk of acute liver failure increases 7 – 8 times with co – infection or super-infection of HDV and HBV.[6] Super-infection with HDV may carry greater risk of fulminant hepatitis than simultaneous infection.[7]

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Table 1. Factors Associated with Acute Liver Failure

Viral hepatitis (Isolated / mixed)
- Hepatitis A, B, C, D, E,
- Herpes simplex
- Epstein Barr virus
- Parvovirus B 19
- Varicella zoster
- CMV
- Adenovirus
- Echovirus
- Coxsackie virus

Drug Induced
- Acetaminophen (Paracetamol)
- Isoniazid
- Halothane
- Sodium valproate
- Phenytoin

Metabolic Causes
- Wilsons disease
- Neonatal hemochromatosis
- Tyrosinemia Type 1
- Mitochondrial disorders
- Hereditary fructose intolerance
- Alpha – 1 antitrypsin deficiency
- Niemann – Pick disease
- Indian childhood cirrhosis
- Glycogen storage disease Type IV

Hypo perfusion
- Budd chiari syndrome
- Veno – occlusive disease
- Right sided congestive heart failure
- Cardiogenic shock

Autoimmune hepatitis
Viral infection on underlying chronic liver disease
Unknown causes

The role of HCV in the causation of acute liver failure is unclear. Hepatitis E is increasingly being labeled as the causative agent responsible for acute liver failure.[8] This is especially true for hepatitis E endemic regions.

Intake of hepatotoxic drugs in a child who is already suffering from liver disease whether due to infectious, metabolic or any other cause might enhance the probability of precipitating acute liver failure.

Acute Liver Failure in Children : Indian Scenario

Studies done in children in our country with acute liver failure are summarized in Table 2.

Water-borne viral hepatitis viruses account for up for up to 50-70% of all cases of acute liver failure in Indian children. Hepatitis types A and E infections can occur either in isolation or in combination in these patients. Hepatitis C alone is a very cause of acute liver failure in children, but can occur in combination with other viruses. Underlying chronic liver disease eg. Wilson's disease, Indian Childhood Cirrhosis and, Autoimmune hepatitis can also present as acute or sub-acute hepatic failure either alone or as co-infections with hepato-tropic viruses. Up to one-fourth of patients did not have an identifiable

Table 2. Etiological Profile Of Acute Liver Failure In Children : Indian Scenario

Etiology	Arora *et al*[8] Delhi, 1996 n (%)	Bendre *et al*[9] Pune, 1999 n (%)	Poddar *et al*[10] Chandigarh, 2002 n (%)
HAV	4 (10)	12 (33.3)	34 (51)
HEV	6 (15)	1 (2.7)	17 (25)
HAV + HEV	9 (22.5)	4 (11.1)	7 (10)
HAV + Others	1 (2.5)	2 (5.5)	0 (0)
HEV + Others	1 (2.5)	0 (0)	0 (0)
HBV	6 (15)	3 (8.5)	5 (7.5)
HCV	1 (2.5)@	0 (0)	0 (0)
Chronic Liver Disease	4 (10)*	3 (8.3)	0 (0)
Drug Induced	3 (7.5)	2 (5.5)	4 (6.1)
Unknown	5 (12.5)	8 (22.2)	0 (0)
Total No. of patients	40	36	67

*Wilson's disease-1; ICC+HAV-1; ICC+HEV-1
@-HCV+HBV+HEV

etiology and, reflect our limitations in diagnostic facilities.

Precipitating Factors

The possible precipitating factors of acute liver failure include infections, persistent fever, persistent vomiting, hypovolemia, use of hepatotoxic drugs (anti tubercular, antipyretics and anti convulsants etc.), and zinc deficiency in established acute hepatitis.

Clinical Presentation

Pediatric patients with acute liver failure have no history of any major medical problems or blood transfusion elicitable in most cases. Initially the child has non-specific prodromal symptoms such as malaise, nausea, fatigue, loss of appetite, followed 5-7 days later by dark urine and jaundice. However in children who ultimately land up with acute liver failure, there is rapid onset of altered mental status and coma heralding the onset of hepatic encephalopathy.

The clinical appearance of hepatic encephalopathy is variable, depending on the extent and rapidity of hepatic damage, the degree of porto–systemic shunting, and the contribution of precipitating factors. Initial symptoms of encephalopathy may be subtle and are likely to be passed off for the behavioral aberration of the child. Change in personality is one of the earliest signs of hepatic encephalopathy. Patients may pass through various stages of encephalopathy so rapidly that the parents may

Table 3. Early Clinical Indicators of Hepatic Encephalopathy

- Confusion/euphoria
- Combative behavior/restlessness/irritability
- Short attention span
- Disordered sleep or sleep inversion
- Changes in handwriting
- Tremors
- In-coordination or dropping objects
- **Headache/dizziness/nightmares**

not notice early phases. A child with acute onset of combative behavior or being irritable without reason should always be screened for hepatic encephalopathy. Table 3 gives the early indicators of hepatic encephalopathy. Every clinician should carefully ask and/or look for these early manifestations of hepatic encephalopathy in all children with acute hepatitis.

There is increased susceptibility for infections in patients with acute liver failure. Presence of fever, leukocytosis, positive cultures, unexplained drop in BP, reducing urine output, worsening encephalopathy, severe acidosis and DIC indicates sepsis and warrants aggressive investigations for as the probable cause. Vast majority of infections occur within 72 hours of admission. Most often the infecting organism is a bacterial agent (Staphyloccocal & Gram negative sepsis) but fungal infections are not uncommon.

Cerebral edema is a major cause of mortality in patients with acute liver failure. A sustained rise of intra cranial pressure (ICP) to 30mmHg or more is taken as an indication of raised ICP. Fifty to eighty percent of patients with acute liver failure have cerebral edema.[11] most of grade IV patients would have raised ICP. The intra cranial pressure in a child with acute liver failure rises paroxysmally initially and then remains constant. Paroxysmal or sustained systemic hypertension and increase in the tone of the muscles of the arms and/or legs are probably the earliest signs of raised ICP.[12] Impaired or absent pupillary reflexes, bradycardia, sustained severe hypertension and abnormal reflexes are other signs of raised ICP. Increased tone of the muscles may ultimately give rise to de-cerebrate posturing. Other features such as headache, vomiting, bradycardia and pupillary changes occur rarely if at all. In final stages marked hyperventilation, trismus, ophistotonus and respiratory arrest occur.

Factors Precipitating Raised ICP : Body movements, excessive and frequent handling of patients with acute liver failure tend to increase the intracranial pressure. Frequent suctioning or noxious stimuli also contribute to the rise in ICP. If a child is kept in a horizontal decubitus or if there is excessive coughing, sneezing or vomiting, the ICP rises transiently. Sustained severe hypoximia and / or hypercapnia also raise the ICP, as does seizure activity. Hence all these factors must be actively looked for and prevented in these patients.

MANAGEMENT

Acute liver failure is a medical emergency associated with an unpredictable and an often-fatal course; survival depends not only on the capacity of the liver to regenerate, but also on the intensive supportive medical care.

Immediate Intensive Care

The child must be cared for preferably in an ICU setting. It is imperative to establish an adequate intravenous access in the form of intra-venous and CVP lines as parenteral drugs and fluids form a major component of the management efforts in a child with acute liver failure.

A child, who has tachycardia, cold extremities, signs of dehydration, poor pulses and perfusion, needs aggressive fluid resuscitation. Strict protocol based monitoring including cardiac monitoring; input-output charting with an indwelling urinary catheter if required and frequent clinical monitoring would ensure a better management of such critically ill patients. A feeding tube may be used for the purpose of feeding. Appropriate care must also be taken of bladder, bowel, skin, back and eyes. If the child is in grade III or IV hepatic encephalopathy or rapidly progresses into it, elective mechanical ventilation is recommended. A suggested schema of the steps involved in the immediate intensive care is presented in Table 3.

Initial Workup

Initial workup of the child should include identification of the stage of hepatic encephalopathy and also the presence of the precipitating factors as eluded to previously.

Investigations that are necessary in the immediate management of the child with acute liver failure include those to assess hepatocyte function (liver function tests – SGOT, SGPT, alkaline phosphatase, bilirubin, prothrombin time), blood chemistry (electrolytes, urea, creatinine, sugar, calcium, phosphate), and evidence of infection (cultures, blood counts, and X-rays).

After initial stabilization, further investigations are done to determine the etiological factors associated with liver failure.

Ideally all these investigations must be ordered simultaneously because stepwise investigation protocol causes unnecessary delay in arriving at a working diagnosis and line of management to be followed.

Fluid and Metabolic Disturbances (Table 4)

Appropriate management of fluid and metabolic abnormalities can go a long way in the ultimate outcome in patients with acute liver failure.

Infections

Although the initial investigations should be able to

TABLE 4. Schemata for Immediate Intensive Care

- Establish adequate IV access (two peripheral lines and a CVP line)
- Volume resuscitation
- Cardiac monitoring; pulse oximetry
- Nasogastric tube for feeding/drainage
- Urinary catheter
- Strict fluid input/output charting
- Frequent clinical assessment
- Hepatic coma feeds (N_2 – 4% of total calories)
- Care of bowel, back, bladder, skin, eyes
- **If grade 3 or 4 encephalopathy** - ELECTIVE MECHANICAL VENTILATION

identify possible infections, prophylactic antibiotics form a major and important part of any treatment regimen for acute liver failure because uncontrolled infections and subtle infections worsen the prognosis.

Use of aseptic nursing techniques is the first line of defense against septic complications in acute liver failure and should be strictly enforced. Change of intravenous catheters every 72 hours and routine culture of removed catheter tips is essential.

The choice of antibiotics would depend on the offending agent if identified but in general, it should cover both Gram-negative bacteria and Staphylococci. The usual practice is to use a combination of 3rd generation cephalosporins and cloxacillin. Aminoglycosides can be added depending on culture sensitivity pattern and renal function stutus of the patient. If there is no improvement within 72 hrs, it is prudent to step up antibiotics to cover pseudomonas aeruginosa, fungal sepsis and anaerobic organisms depending upon individual patient requirements.

Cerebral Edema (Table 5)

Appropriate management of cerebral edema and raised ICP would be to either prevent, treat or to minimize the aforementioned factors. The head end of the bed should be raised to 20 degrees with the head in the neutral position.[13] Nursing of the patient should be carried out in an ICU setting, with a quiet comfortable atmosphere and minimum handling of the patient. Psychomotor agitation must be carefully and appropriately managed to avoid acute increase in ICP. Correction of hypoxemia or hypercapnia are essential therapeutic steps for cerebral edema since vasodilatation due to hypercapnia can lead to marked increase in ICP. Elective endotracheal intubation, sedation, and use of mechanical ventilation with hyperventilation may be useful in patients who are very agitated and combative.[14] It has been seen that short term hyperventilation with the aim to maintain pCO_2 between 22-26 mm Hg may be helpful in reducing ICP.[11,14]

Mannitol, an osmotic diuretic, is used to lower the ICP. It is effective only in those patients in whom initial ICP is less than 60mm Hg[15] Serum osmolality should be monitored in patients being given mannitol. The drug is contraindicated if serum osmolality exceeds 320 mOsm/kg. In general, intravenous mannitol in doses of 0.5-1 gm/kg must be given as a bolus dose over 5 minutes. Repeated boluses may be necessary to maintain recurrent surges in ICP. The maximum effect occurs 15-60 minutes after infusion. Once renal failure develops it should be used only in combination with ultra-filteration.

The use of steroids in patients with cerebral edema due to acute liver failure has not been found to be of any use,[15, 16] unlike its beneficial effects on patients with brain tumors.

Table 5. Management of Fluid and Metabolic Complications in Acute Liver Failure.

Total fluid intake: normal maintenance requirement (10 % Dextrose in N/5 saline)

Hypotension
- Resuscitate with normal saline, Ringers lactate, plasma or blood.
- Avoid overloading
- If mean arterial pressure (diastolic pressure + 1/3 pulse pressure) is less than 60 mm Hg -start dobutamine

Metabolic acidosis
- Suspect fluid deficit
- Look for sepsis (if no fluid deficit)

Hypokalemia
- Frequent; associated with metabolic alkalosis
- Give KCL infusion/100 ml IV fluid
  3 meq (1.5 ml) if serum $K^+ > 3$ meq/L
  4 meq (2 ml) if serum K^+ 2.5 - 3 meq/L
  5 meq (2.5 ml) if serum K^+ 2 - 2.5 meq/L
  6 meq (3 ml) if serum $K^+ < 2$ meq/L

Metabolic alkalosis
- Increase IV KCL to next step

Hyponatremia ($Na^+ < 120$ meq/L)
- Restrict fluids to 2/3 - 3/4 maintenance
- Restrict Na^+ infusion to less than 2 meq/Kg/day

Hypernatremia
($Na^+ > 150$ meq/L)
- May be precipitated with lactulose administration: reduce/stop lactulose
- Give N/5 fluids including correction fluid

Hypoglycemia (Blood glucose < 40 mg/dl)
- Infuse 50% dextrose (@ 1ml/Kg).
- Maintain blood sugar between 100 – 200 mg/dl.

Hepatic Encephalopathy (Table 6)

The actual treatment of hepatic encephalopathy is relatively simple and does not depend upon the stage of encephalopathy except the nutritional advice.

Colonic cleansing reduces the luminal content of ammonia[17] and decreases the bacterial counts.[18] To achieve adequate cleansing of the bowel, bowel washes need to be given every 6 – 8 hourly with acidic fluid (1 teaspoon vinegar in 1/2 liter plain water). Various laxatives can be used, but non-absorbable disaccharides like lactulose are preferred, because they result in the additional effect of potentiating the elimination or reduction of the formation of nitrogenous waste compounds. Lactulose may be administered either orally or with the help of a naso-gastric tube in doses of 0.5 ml/kg/dose (max. 30ml/dose) four times a day adjusted to produce 2-4 loose acid stools per day. Side effects sometimes seen include dehydration and hypernatremia.

Contrary to the prevalent views, there is no need for restriction of proteins in the diet for Grade I and II encephalopathy but vegetable proteins are preferred. Micronutrients, Vitamin C, Vitamin E and zinc also need to be given. Anticonvulsants may be required if seizures are present. Phenytoin or phenobarbitone are the usually administered anticonvulsant. No sedatives should be

Table 6. Management of Cerebral Edema in Acute Liver Failure

Cerebral Edema Indicators

- Paroxysmal or sustained severe hypertension
- Muscle tone changes
- Decerebrate posturing
- Bradycardia
- Pupillary changes
- Reflexes (brisk/sluggish)

Treatment of Raised ICP

- Raise head end of bed 30° - 45°
- Place head in neutral position
- Minimum handling of the patient
- Elective ventilation (aim is to maintain pCO_2 between 22 - 26 mm Hg)
- Mannitol 20% : 3 - 5 ml/kg/dose by rapid IV push; max 6-8 doses can be given at 4-6 hourly interval
- If no recovery, thiopental infusion can be resorted to (for those who are on ventilator)
- ICP monitoring if feasible, goal to keep ICP < 20 mm Hg and CPP > 50 mm Hg
- **No role of steroids**

Factors that Increase ICP

- Body movement and handling
- Frequent suctioning/noxious stimuli
- Horizontal decubitus
- Severe hypoxemia/hypercapnia
- Coughing/sneezing/vomiting
- Seizures

given as they interfere with the assessment of the status of consciousness of the child.

Coagulopathy (Table 7)

The conventional approach to the treatment of severe coagulopathy associated with acute liver failure includes administration of Vit K in doses of 5-10 mg intravenously or subcutaneously per day to increase the concentration of Vit K dependent factors. Coagulation defects require administration of fresh frozen plasma or blood preferably fresh if invasive procedures have to be done or if there is active bleed. Prophylactic transfusion may be given if platelet count is less than 50,000. DIC is managed with fresh frozen plasma or whole blood and antibiotics if there is evidence of infection. Gastrointestinal bleed may respond to cold saline washes every 4 hourly, injection ranitidine in doses of 3 mg/kg/day and antacids in doses of 15-30 ml 4 hourly after gastric lavage. Exchange plasmapheresis causes a rapid improvement of coagulation abnormalities and has little or no risk of volume overload, and may remove anticoagulant or fibrinolytic released during hepatocellular necrosis.

Table 7. Management of Hepatic Encephalopathy

Bowel washes

- With acidic fluid (1 teaspoon vinegar in 1/2 litre plain water), 6-8 hrly

Lactulose

- Oral/NG tube - 0.5 ml/kg/dose (max. 30ml/dose) four times/day at a rate adjusted to produce 2-4 loose acid stools per day.
- Side effects: Dehydration, hypernatremia

Enteral feedings

- No restriction of proteins for Grade I and II encephalopathy; vegetable proteins preferred.
- Micronutrients, Vit. C, E, zinc

Anticonvulsants (if seizures present)

- Dilantin/phenobarbitone : 2-3 mg/kg/day
- **No sedatives**

Renal Failure and Hepatorenal Syndrome (HRS) (Table 8)

Since there is sodium retention one should restrict sodium and water intake to 2/3 or less depending on the urinary output of the child. Hemodialysis or peritoneal dialysis may be required in unresponsive cases. However patients with HRS are usually hypotensive, hence use of continuous arteriovenous hemofilteration (CAVH) or ultrafilteration (CAVU) rather than conventional hemodialysis may be preferable[19]. Use of CAVH to treat fluid overload and pulmonary edema while awaiting liver transplantation may be useful for a critically ill patient with HRS. Use of dopamine in doses of 2-5 ugm/kg/min, which causes renal vasodilatation, can be used as adjunctive therapy. However, its role remains doubtful.

Table 8. Management of Coagulopathy

For GI bleeds

- Cold saline washes 4 hrly
- Inj. Ranitidine 3 mg/kg/day
- Antacids: 15-30 ml, 4 hrly after gastric lavage

Coagulation defects

- Fresh frozen plasma; blood (fresh)
  (If invasive procedures to be done or active bleed)
- Vit K - 5-10 mg IV/day
- Prophylactic transfusion if platelet count <50,000 cells/cu.mm

DIC

- FFP or whole blood; antibiotics if infection

Prothrombin time

- Good monitoring tool

Monitoring Protocols (Table 9, 10, 11)

A carefully formulated monitoring protocol for patients with acute liver failure on intensive medical management is a must for the management to be effective. Protocol based management and monitoring has been time and again shown to be the most effective way of improving the outcome in such patients. These protocols may be suitably modified according to individual patient requirements, and availability of staff and resources.

Outcome

The overall outcome of liver failure remains dismal.

Table 9. Hepatorenal Syndrome.

Diagnosis
- Indicated by decreasing urine output with increasing blood urea and creatinine
- Urine Na^+ <10 meq/L (ATN urine Na^+ >20 meq/L)
- Urinary creatinine: Plasma creatinine ratio >30
- Urinary osmolality 100 mosm. Higher than plasma osm.

Treatment
- Restrict Na^+ and water intake to 2/3 or less according to urinary output
- Hemodialysis, peritoneal dialysis

Table 10. Intensive Monitoring of a Child with Acute Liver Failure During the Stay in the Intensive Care Unit.

Clinical examination
- Pulse rate, respiratory rate, blood pressure, and temperature *every 4 hourly.*
- Fluid intake/output charting *every 8 hourly*
- Neurological/coma grading *every 12 hourly*

Biochemical testing *every 12 hourly*
- Na^+, K^+, blood urea
- Blood sugar;

Coagulopathy *every 24 hourly*
- Prothrombin time

Table 11. Parameters to be Monitored in a Child with Acute Liver Failure.

Parameters to be monitored *once daily*
- Weight
- Liver span
- Ascites
- Evidence of bleeding
- Infection
- Review prescription
- Biochemical: prothrombin time

Parameters to be monitored twice weekly
- LFT
- Urea, creatinine
- Calcium and phosphate

Parameters to be monitored as required
- Evidence of infection: blood counts, blood cultures, urine cultures, ESR and CRP, Chest X-ray
- Urinary electrolytes, creatinine and osmolality.
- Other investigations as required

Despite good supportive care and nursing in intensive care units, 40-70% of children with acute liver failure die. Several useful prognostic factors have been identified from studies done in children with acute liver failure. Those with grade III or IV hepatic encephalopathy had higher mortality (60-100%). Early stages (grade 1 or II) of encephalopathy were associated with a better outcome.[8,9,10] Coagulopathy is a maker of bad outcome. Prolonged prothrombin time of more than 40 sec as compared to controls was associated with a higher risk of death (OR 45.0).[8] Similar observations in non-survivors

Table 12. Typical Prescription for a Child with Acute Liver Failure

- Inj. Cefotaxime/ Cloxacillin
- IV fluids N/5 saline in 10% Dextrose
- KCL (to be added as per serum K^+ conc.)
- Inj. Vit C-500 mg
- Bowel washes 6 hrly/ lactulose through NG tube
- 20% Mannitol
- Inj. Ranitidine IV, 12 hourly
- Inj. Vit. K 5-10 mg/day × 3-5 days
- Hepatic coma feeds (Nitrogen - 4% of total calories)
- Raise head end (30° - 45°)/ head in neutral position
- Minimum handling, quiet room
- Input–output charting
- Monitoring instruction

have been made from Pune[9] and Chandigarh.[10] Associated infections (localized and systemic) are major reasons for deterioration of clinical profile as well as mortality, Arora *et al*[8] observed that evidence of chest infection on X-ray chest or a positive blood culture had very high risk of mortality (OR 18.0). In this study the mortality in patients with infection was 85% in comparison with 25% in those with no infection. In a study by Poddar *et al*[10], 9 out of 36 children with ascites had spontaneous bacterial peritonitis (SBP), and 7 (78%) of them died in comparison to 15% without SBP. Thus an active search for evidence of infections should be made in all patients of acute liver failure and prophylalctic antibiotics should be given. Sub-acute hepatic failure had the worst (67%) and acute liver failure occurring within 7 days of onset of illness was associated with better outcome (11%).[8,10] Water borne hepato-tropic viral infections (HAV and HEV), either singly or in combination accounted for more than two-third of cases of acute liver failure in children. Fortunately, these patients have a better outcome than those with other etiologies.

Other parameters incriminated with a bad outcome are a total serum bilirubin more than 15 mgs/dl, low levels of serum ALT/AST and serum albumin below 2.5 gms/dl.[8,9,10]

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