Textbook of Surgery

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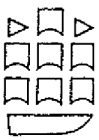

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sels to reduce arterial vasoconstriction, which may make their use valuable in septic shock.

Digitalis. This is often required in cardiogenic shock. In severe septic and haemorrhagic shock digitalis may be occasionally indicated as poor filling of the coronary vessels may impair cardiac function.

Analgesics. Morphine should only be given when pain is severe as sedatives may suffice to relieve anxiety. The intravenous route is preferable to ensure rapid and controlled absorption.

BLOOD TRANSFUSION

Blood is most frequently transfused to restore a depleted blood volume and so permit adequate perfusion of the tissues. It may also be given to overcome a specific defect in the blood components as in restoring red cells in anaemia before an urgent operation or occasionally to supply platelets in thrombocytopenia. Blood transfusion carries some risk and alternative methods should be chosen whenever possible. Anaemia is often better corrected before operation by prescribing oral or parenteral iron. Blood is also used extensively in the preparation of various forms of apparatus, such as an extra-corporeal circulation in cardiac surgery or an artificial kidney for dialysis.

Compatibility

Before transfusion, the serum of the recipient should, whenever possible, be matched with the cells of the donor. Although as many as fifteen, genetically independent, major systems of red cell blood groups have been described, in practice it is necessary to have blood homologous in respect of ABO and Rh antigen D for a transfusion to be successful. In the ABO blood-group system, antigens (agglutinogens) of two types exist in red blood corpuscles. They are denoted A and B; they may occur in the combination A, B and AB or they may be absent. The four blood groups which thus result are given the symbols A, B, AB and O respectively to denote which, if any, of these antigens is present in the cells.

Agglutination of the corpuscles is caused by reaction with antibodies (agglutinins) present in the serum; these are termed anti-A, which reacts with any corpuscles containing antigen A, and anti-B, which reacts similarly with cells containing antigen B. The grouping of the blood of a patient depends on the reaction of the red cells to stock specimens of anti-A and anti-B sera. This should be cross-checked by typing the patient's serum against known A and B red cells. Numerous other blood-antigens exist, of which the most important is the *Rhesus (Rh) Factor*. An Rh-positive person (83 per cent of the British population) possesses the Rh antigen D, which an Rh-negative person lacks. The clinical importance of the Rh system depends primarily on the ability of the D antigen to induce antibody formation when it is introduced into a circulation which lacks it. Rh-negative subjects may be sensitised with Rh-positve blood; an Rh-negative mother may be sensitised when she bears an Rh-positive child. Later transfusions of Rh-positive blood in a thus sensitised Rh-negative patient will then give rise to agglutination and haemolysis of the transfused blood.

Accurate cross-matching of blood is a complex procedure, details of which may be sought in appropriate textbooks. Routine cross-matching can normally be done in two hours, but emergency techniques are available whereby accurate cross-matching can be speeded up and reported in half an hour. If the emergency is greater than this it is preferable to give uncross-matched Group O blood (containing no A or B antigens) which is Rh negative, but it must be accepted that there is an element of risk in using any form of uncross-matched blood.

Complications and hazards of blood transfusion

Blood transfusion is a serious procedure carrying the risk of complications which may be classified into:

1. The dangers associated with transfusion of any fluid; thrombophlebitis, fever, allergic skin rashes and painful joints due to contaminating foreign proteins (less common with plastic disposable transfusion sets), right heart failure from overloading the circulation and air embolism. Over-transfusion causes a rise in the venous pressure and later pulmonary oedema, particularly in the elderly or debilitated or in

those with pre-existing cardio-pulmonary disease. It may be prevented by accurate monitoring of the venous pressure, and where indicated by the use of packed red cells rather than whole blood. Over-transfusion can be treated by the rapid removal of blood by venesection, the use of limb tourniquets inflated to above diastolic pressure and by the administration of diuretics.

2. The especial dangers of using blood.
   (a) *Infection*. Accidental bacterial contamination of the blood at the time of collection is rare, and the storage of blood at an acid pH between 2 and 6 °C prevents bacterial proliferation and survival. Occasionally bacterial endotoxins may be present in transfused blood and on transfusion lead to a severe pyrexial reaction with cardiovascular collapse. The main source of bacterial contamination is the drip insertion site. While syphilis, malaria and brucellosis may also be transmitted, the most serious problem is serum hepatitis due to the transmission of a virus (p. 235).
   (b) *Hyperkalaemia*. Prolonged storage of blood causes a rise in the plasma potassium concentrations to 20 to 30 mmol per litre but there is little danger of producing hyperkalaemia because the stored cells when transfused act as a sponge. Hypokalaemia may be a problem.
   (c) *Hypocalcaemia*. Citrate is added to stored blood as an anticoagulant and acts by removing all ionised calcium. An excess of citrate in stored blood may also remove calcium ions from the recipient's blood and so potentiate the action of potassium on the heart leading to impairment in myocardial contraction. There are muscle tremors and circulatory depression. With massive transfusions of blood the patient should therefore be protected by giving calcium gluconate, 1 g for every 1000 ml of blood transfused. The risk of citrate intoxication is particularly important in children or in the presence of liver disease. The injection of ionised calcium solutions may only be partially helpful and where rapid and massive transfusions are required citrated blood is better avoided.
   (d) *Hypothermia*. The rapid transfusion of large quantities of cold blood may lead to a general reduction in the body temperature. Cooling of the heart may predispose to cardiac arrest and blood should be warmed during infusion.
   (e) *Haemostasis*. The storage of blood results in a reduction in the number of platelets and the loss of factors essential for coagulation. Where large transfusions are being given rapidly, the recipient's own coagulation factors are diluted so that oozing of blood may become general.

Serological incompatibility

The clinical picture of a patient who receives a transfusion of incompatible blood is that of headache, fever, rigors, paraesthesiae, dyspnoea, severe loin pain, jaundice which commences about 12 hours after transfusion, haemoglobinuria, occasionally oliguria and even anuria due to renal tubular damage. Severe collapse with low blood pressure may occur. Diagnosis may be difficult since fever and rigors may result from pyrogens present in the transfusion apparatus or infected blood. Loin pain although characteristic may not occur, or the patient may be anaesthetised during the transfusion so that this symptom will not be manifest. When untoward reaction occurs the transfusion must be stopped, the blood carefully rechecked, and the pathologist informed and supplied with a specimen of blood and urine from the patient. The donor's blood should also be rechecked. Collapse may require the use of intramuscular methedrine and occasionally intravenous noradrenaline. Loin pain may be severe enough to require morphine for its relief. A careful record is kept of the urinary output and a catheter should be inserted into the urinary bladder. Damage to the kidney is related to the rate of urine production and its *p*H; alkalinisation of the urine prevents the precipitation of haemoglobin within the tubules and therefore attempts are made to initiate a diuresis and alkalinise the urine, by giving 20 per cent mannitol and sodium bicarbonate. Should there be oliguria or anuria, the prognosis is reasonably good providing the general condition can be maintained during the critical period of three weeks before

tubular recovery and diuresis occur. Detailed management of such patients is considered on p. 273.

An incompatible blood transfusion is preventable by meticulous care in the checking of blood before its administration, both in the pathological laboratory and again in the ward or operating theatre.

Blood substitutes

The potential dangers of blood transfusion and the high cost and occasional scarcity of blood have led to the search for some form of substitute. For the treatment of shock, the essential characteristic of a substitute solution is that it should restore and maintain the volume of fluid circulating in the vascular system of the shocked patient.

Plasma. At one time plasma was available in a dried form which, by the addition of sterile water, could be stored for many years without refrigeration. Dried plasma is now being replaced by plasma protein fraction, which is a 4.5 g per 100 ml protein solution with the same colloid osmotic pressure as reconstituted dried plasma. Plasma protein fraction, mainly albumin, is superior to dried plasma because it is ready for infusion (not requiring the delay of reconstitution) and does not carry the risk of homologous serum hepatitis.

Plasma is rarely indicated for the treatment of the shocked patient. In emergency circumstances Ringer's lactate or other buffered saline solution is as effective with fewer complications. Rapid expansion of blood volume can be brought about by the administration of dextran (q.v.).

Fresh frozen plasma obtained from one individual and so carrying little risk of hepatitis, contains most of the factors responsible for blood clotting, particularly factors V and VIII which are destroyed in stored blood.

Dextran. Dextran is a glucose polymer of high molecular weight produced by the fermentation of sucrose by *Leuconostoc mesenteroides*. Various molecular ranges have been produced, but for the emergency treatment of haemorrhage the most useful are dextran 110 and dextran 70. Low molecular weight dextran of 30 000 to 40 000 is said to reduce in shock the clumping of red blood cells in the microcirculation, but its role has not been fully substantiated and in the treatment of shock dextrans 110 and 70 are preferred. They have a colloidal osmotic pressure comparable with plasma and can be given to patients of any blood group. They are easily stored and there is no risk of hepatitis.

Blood component replacement

With modern techniques it is now possible to prepare and administer with safety products, fractions and concentrations of whole blood.

Of the cellular components, red cells are easily separated and are useful for the treatment of anaemia in patients in whom circulatory over-loading may be a hazard. To minimise damage to red cells and encourage their rapid recovery after thawing, red cells freed from donor plasma, leucocytes and platelets, can be frozen. Although frozen blood cells are being increasingly used, especially in the United States, red cells freed from plasma and other cellular elements can also be preserved by the addition of adenine to the conventional citrate phosphate dextrose to enhance red cell viability. Platelets can also be separated and presented as either a platelet-rich plasma or as a platelet concentrate. Although the function of platelets is partially impaired in the preparation of these products, they can be effective in arresting bleeding due to severe thrombocytopenia. It is not yet possible to transfuse white cells satisfactorily because they carry histocompatibility antigens.

The other products which are available include antihaemophiliac globulin (A.H.G.) concentrate and factor IX concentrate, the former as a plasma cryoprecipitate. Desiccated human fibrinogen is commercially available and albumin has also been concentrated and has the advantage that it is a hepatitis-free product. Salt-poor albumin is available for use in patients with sodium retention.

WATER AND ELECTROLYTE BALANCE IN SURGICAL PATIENTS

In health the volume and composition of the body fluids remain relatively constant, but in disease and after injury the regulatory mechanisms which maintain this constancy may be impaired to an extent that the surgeon may have to intervene and

ence; the former may be associated with a blow or crushing force to the lower chest or abdomen, or from gunshot or stab wounds. Indirect violence may result from sudden deceleration, produced by a fall from a height or a head-on collision between vehicles. In the presence of disease, such as glandular fever or malaria, even minor trauma may rupture the liver. Damage to other intra-peritoneal organs or the lungs may also be sustained. The extent varies from contusion of liver substance to complete rupture or separation of a portion of a lobe, the right lobe being principally affected. There are often lacerations on the anterior or superior surface and a subcapsular haematoma may form. Profuse bleeding and leakage of bile may be serious consequences.

Clinical features

A history of closed injury to the lower chest or upper abdomen may be obtained, or the presence of an open wound in the area may suggest the diagnosis. Pain, initially in the right upper quadrant, tends later to be more general and may be referred to the right shoulder or scapular region. Tenderness and guarding in the right hypochondrium is usual and the amount of shock is variable, increasing with the degree of internal haemorrhage. When considerable quantities of blood have escaped free fluid may be detected and an increased but fixed dullness found on the right side. In late stages abdominal distension and ileus occur. The clinical picture may be overshadowed by that of associated lesions.

Treatment

Many liver injuries do not require surgery and provided that blood transfusion can control shock, conservative treatment by bed rest and analgesics is sufficient. If bleeding is not controlled or there is evidence of spreading peritonitis from an associated lesion, laparotomy is required. Loose or pulped liver should be removed and lacerations sutured. Careful exploration to detect other injuries must be performed and the peritoneal cavity drained to prevent the accumulation of bile and blood. Secondary haemorrhage, liver abscess and a biliary fistula are the commonest post-operative complications. Following operation antibiotics should be administered if there is severe liver necrosis, a retained foreign body or associated bowel damage.

The risk of delayed rupture of a subcapsular haematoma warrants observation of suspected cases of liver damage in hospital for 10 to 14 days.

INFECTIONS OF THE LIVER

Virus hepatitis

This condition is the most common cause of jaundice in adults. At least two viruses have been isolated. (1) Hepatitis A virus (HAV), responsible for *infective hepatitis*, is the more common, being excreted in the faeces and may be carried by flies. It has an incubation period of 15 to 50 days and a mortality of 1 to 2 per 1000. (2) Hepatitis B virus (HBV) causing *serum hepatitis*; this is transmitted only by injection, after which the incubation period is 50 to 160 days. The usual source is a blood or plasma transfusion, but infection may follow any injection with a contaminated hypodermic needle or close physical contact. An infected blood donor is capable of transmitting the disease for many years and HBV infection carries a much higher mortality than HAV. Potent sources are massive transfusions, such as those used in heart-lung bypass, renal dialysis, pooled human plasma and blood products such as human fibrinogen or anti-haemophilic globulin. A variety of laboratory tests are used in the detection of HB antigen (HB Ag) and HB antibody (HB Ab), the elimination of HB Ag carriers being particularly important in the selection of blood donors. Australia antigen can be identified by electron microscopy or immunological tests and is specific for serum hepatitis. The test is valuable in identifying symptomless carriers as well as in determining the aetiology of some forms of cirrhosis and chronic liver disease.

Clinical features

Nausea, anorexia, malaise and mild abdominal pain precede the onset of jaundice by several days. The liver enlarges towards the end of this stage, after which the jaundice appears rapidly. The liver is usually palpable and often the spleen. The jaundice

disappears slowly after about 10 days, but may last longer in older patients. In protracted cases liver biopsy or laparotomy may be necessary to exclude extrahepatic biliary obstruction.

Features of obstructive jaundice may develop in some cases of virus hepatitis making the differential diagnosis difficult. This may be due to 'bile thrombi' blocking the minute biliary ducts. A hepatitis-like clinical picture is occasionally seen after halothane (Fluothane) anaesthesia, being a hepato-cellular jaundice due to idiosyncrasy to the drug. More than one halothane anaesthetic is usually responsible, the first being followed by undiagnosed fever and a transient rise in serum bilirubin. The second anaesthetic is followed immediately or within two weeks by jaundice, which may be fatal.

Treatment

Pooled non-specific immunoglobulin effectively prevents infective hepatitis in personnel exposed to the virus. Protection against serum hepatitis needs specific high-titre Australia antigen immunoglobulin, but is useful in medical workers who have been at risk in renal dialysis or cardiac by-pass units.

Acute pyogenic infections

Pathology

Most liver abscesses formerly arose from portal system infection, often secondary to appendicitis in young people. This is now rare, due to earlier diagnosis and the use of antibiotics. Severe pyogenic infections are now usually secondary to obstruction of the biliary tract by stones or stricture. However there are still four main routes along which infection reaches the liver.

1. *Portal vein.* Portal pyaemia may result from suppuration in the pelvis or gastro-intestinal tract, where conditions such as appendicitis, diverticulitis and occasionally strangulated haemorrhoids are responsible. The mechanism is either through septic emboli or pylephlebitis, a septic thrombophlebitis of the portal vein. Actinomycosis may reach the liver by the portal vein from the ileocaecal region. In the newborn, umbilical sepsis may reach the liver along the umbilical vein.

2. *Cholangitis.* Infection in the obstructed bile ducts above a gallstone, stricture or cancer is now the commonest cause of liver abscess. In the Far East ascaris or liver flukes (*Clonorchis sinensis*) in the bile ducts often lead to suppuration. Cholangitic abscesses are often multiple.

3. *Hepatic artery.* Pyaemic liver abscesses may complicate staphylococcal osteomyelitis or pneumonia.

4. *Direct spread.* Penetrating liver wounds, secondary infection of an amoebic abscess or spread from a subphrenic abscess are rare causes of liver infection.

The liver may be enlarged by multiple small abscesses or a single, thick-walled abscess. Multiplicity is usual in portal pyaemia, septicaemia or suppurative cholangitis. The portal vein may contain pus and blood clot and the abscesses are mainly in the right lobe, in relation to the portal tracts. Microscopy shows a heavy parenchymal infiltration with polymorphonuclear leucocytes around the abscesses. When the infection is due to a cholangitis, the foci are in the smaller bile duct radicles. In pyaemia and septicaemia metastatic abscesses may be found in the lungs, kidneys or brain. Most liver abscesses are due to Gram-negative bacilli, such as *Esch. coli* or *Proteus vulgaris*, but *Staph. pyogenes* and *Strept. faecalis* are also common; *Salmonella typhi* and *Brucella* are sometimes found.

Clinical features

There are general signs of severe, deep-seated infection with swinging temperature, rigors, profuse sweating and tachycardia. Hypotension and shock may occur in Gram-negative bacteraemia. Tenderness and enlargement of the liver, jaundice and ascites are characteristic. The mortality of pyogenic liver abscess is high.

Investigations

Repeated blood cultures are essential; they are more likely to be positive when taken during or immediately after a rigor. There is leucocytosis and anaemia and the serum bilirubin may be raised. X-rays reveal a high, immobile right diaphragm and fluid-levels may be present if the organisms are producing gas. An ultrasound scan may demonstrate