related to the symptomatology of renal failure. The values are relevant because any prophylactic effect of furosemide or mannitol, at least in experimental ischaemic renal failure, is a result of improved solute excretion.

References

1 *Kassirer JP.* Clinical evaluation of kidney function – glomerular function. New Engl J Med 1971; 285: 385–9.

2 *Zideman DA, Dudley HAF, Bevan DR.* Osmolar output in the perioperative period. Anaesthesia 1978; 33: 788–93.

Monitoring the liver

Leo Strunin MD FFARCS FRCP(C), Professor and Head, Department of Anaesthesia, Foothills Hospital at the University of Calgary, Calgary, Alberta.

Assessment and monitoring of liver function begins with a case history and physical examination of the patient.[1] Liver function tests are of limited value unless performed on a regular basis and, in general, are best suited for assessment of chronic liver disease rather than acute episodes. In addition, attention should also be paid to blood gas values and the patient's cardiovascular status. Renal function should also be assessed as there are often concomitant renal problems in patients with severe liver disease. The site of biliary obstruction may be determined by various imaging techniques such as ultrasound, liver scanning and percutaneous hepatic cholangiography.

Screening for viral hepatitis must always be considered because of the risk of infecting operating room personnel. This disease may be caused by a variety of viruses but Viral B and Non A/Non B hepatitis are the most relevant. The presence of these may be inferred from the history, which should include country of origin, drug therapy, exposure to injections and blood transfusions, surgery, alcohol intake, and sexual habits. Serological testing[1] for antigenic and antibody markers of viral hepatitis can now establish potentially infectious patients.

Cirrhosis is the pathological finding in chronic liver disease; in this condition there is obstruction to blood flow through the hepatic parenchyma. The three common causes are: alcohol abuse, immune disease and hepatitis B infection. Cirrhosis may lead to the development of oesophageal varices and gastrointestinal bleeding as well as secondary renal, cardiac and respiratory failure.

In the presence of chronic liver disease the synthetic storage and excretory functions of the liver may be disturbed and these can be assessed, partly, by standard liver function tests. Jaundice alone may merely indicate some abnormality of the biliary tree and may be due to: increased bile pigment production, defective uptake and transport, defective conjugation or defective excretion of bilirubin. One or more of these factors may be present at the same time. The critical test in the jaundiced patient is the return to normal of the prothrombin time by the administration of intramuscular Vitamin K, in a dose of 10–20 mg six hourly for 24 hours. Patients whose bilirubin is grossly raised (in excess of 150 $\mu mol \cdot L^{-1}$) are at risk of developing postoperative renal failure and measures should be taken to promote a diuresis pre-, per- and postoperatively in such individuals. This can be accomplished by adequate fluid loading and use of diuretics as necessary.

Patients' hepatic reserve may be estimated by assessment of bilirubin, albumin, the presence of ascites, neurological disorder and assessment of the nutritional state[2] or alternatively the assessment may be made using bilirubin, albumin, prothrombin time and encephalopathy and the patients graded accordingly.[3] By these means the potential surgical risk may be estimated and the outcome following major surgery determined.

Preoperative monitoring requires attention to changes in the cardio-respiratory system, assessment of renal function, perhaps by using urine output, and if necessary, tests of haemostasis to determine that the liver's output of clotting factors is adequate. In the postoperative period, unexplained nausea, jaundice or complaints of feeling "unwell" should focus attention on the possibility that the patient is developing hepatitis. This may be confirmed by abnormal changes in liver function tests unrelated to surgical trauma or pre-existent liver disease.

References

1 *Strunin L, Davies JM.* The liver and anaesthesia. Can Anaesth Soc J 1983; 30: 208–217.

2 *Child GC.* The liver and portal hypertension. In Major Problems in Clinical Surgery, Volume 1. Edited by Child GC, Philadelphia, London and Toronto: WB Saunders (1966).

3 *Pugh RNH, Murray-Lyon IM, Dawson JL, Pietroni MC, Williams R.* Transection of the oesophagus for bleeding varices. Br J Surg 1973: 60: 646–9.

Murphy's Law and the anaesthetic machine

Douglas B. Craig MD FRCP(C), Professor, Department of Anesthesia, Health Sciences Centre, University of Manitoba, Winnipeg, Manitoba.

Murphy's Law: if anything can go wrong, it will.

The anaesthetic gas machine provides a daily reminder of the validity of Murphy's Law. A catalogue of the problems which have been reported with anaesthetic machines is beyond the scope of this presentation and is available elsewhere.[1–4] The interaction of human factors, particularly training and vigilance,[5–8] with the apparatus design and safety features, must be recognised when considering the role of the anaesthetic machine in anaesthetic mishaps.

Publication of the Canadian Standards Association Standard Z168.3, as a preliminary standard in 1978 and as a final standard in 1980,[9] can be viewed as the end result of careful consideration of the many design and operational problems which had been recognized with earlier anaesthetic machine models. Table I lists the essential requirements of this standard. Compliance with CSA standard Z168.3 has not been uniform across Canada. While in one province (Manitoba) every anaesthetic machine met the basic requirements (excluding vaporizer section) as early as 1980,[10] similar universal solutions have not been the case in the other provinces.

TABLE I Components of Canadian anaesthetic machine standard (Z168.3)

O_2 Right
O_2 Downstream
O_2 Knob-touch coded
O_2 Supply failure device
O_2 Supply failure alarm
O_2 Flush valve — Single purpose / Non-locking / Protected
O_2 Reserve supply
Standard, single common gas outlet
Pipeline inlets
Pipeline gauges
Backflow check valves
Cylinder yokes-pin indexed
Colour coding
Vapourizers – design/performance
Vapourizers – keyed filling devices
Hypoxic mixture alarm*

*Recommended in Preface but not mandatory part of standard.

The most significant requirements of CSA standard Z168.3 concern oxygen delivery, in particular the position of the oxygen flow meter to the right of the bank of flow meters. Accommodation of this requirement eliminates the previous, unacceptable and hazardous situation whereby units of American origin (oxygen right) and of British origin (oxygen left) were found, not only in the same country but also in the same hospital.

Safe use of the anaesthetic gas machine requires the following:

a. Equipment meeting current standards: Accommodation of standards is possible either with appropriate upgrading of selected existing equipment or the acquisition of new equipment certified to meet the relevant standard or standards.

b. Institution of an effective preventive maintenance program, using either in-house or contracted services.

c. Appropriate pre-use equipment check procedures: The components of a check list for the anaesthetic machine are summarized in Table II. Specific details of the individual procedures can be found in current textbooks[11] or from the manufacturer's information provided with the equipment.