Most patients with chronic liver disease who are candidates for orthotopic liver transplantation (OLT) are substantially malnourished, with extreme depletion of both muscle and fat stores (1–3). Even the majority of Child A cirrhotic patients show substantial reductions in at least one nutritional compartment (4). Rapid depletion of nutritional reserves is also commonly observed in patients with acute liver failure (ALF) (2). Anorexia with reduced caloric intake, impaired glycogen storage and increased protein requirements are the predominant causes of malnutrition in these settings (1,5). Impairment of glycogen storage reduces the capacity for gluconeogenesis and results in increased breakdown of adipose tissue and muscle as a consequence of the use of fat and protein as alternative fuel sources (6). However, reduced hepatic synthesis of insulin-like growth factor (IGF)-1, which increases protein synthesis and decreases protein degradation in healthy human skeletal muscle (7), is likely the predominant factor responsible for the exaggerated whole-body protein degradation which occurs in cirrhosis (8). Low plasma levels of IGF-1, which mediates most of the growth-promoting effects of growth hormone, also likely explains the severe growth hormone resistance seen in end-stage cirrhotic patients (9,10).

As discussed above, lipid oxidation is increased in nearly all patients with cirrhosis awaiting OLT. This is most apparent while fasting, when lipid oxidation supplies approximately 75% of energy requirements, more than twice the proportion generated from metabolism of fat in healthy subjects under these conditions. Subtle abnormalities in polyunsaturated fatty acid synthesis and utilisation also occur in cirrhosis, with increases in plasma levels of n-6 and n-9 fatty acids and decreases in n-3 moieties (11,12). In adipose tissue, which provides a longer-term index of dietary intake and physiological status, the principal change is a marked decrease in n-3 polyunsaturated fatty acids (12). Intestinal fat malabsorption due to luminal bile acid deficiency is an additional problem in cirrhotic patients with cholestatic syndromes, such as primary biliary cirrhosis and primary sclerosing cholangitis. Alterations in cholesterol and phospholipid metabolism in end-stage liver disease alter the composition of immune cell membranes and may, as a result, impair immune responsiveness (1).

Based on measured resting energy expenditure, 18% of cirrhotic patients assessed for OLT are hypermetabolic, while an additional 31% are hypometabolic compared to healthy subjects. The presence of resting hyper- or hypometabolism shows no association with cause or duration of cirrhosis or the degree of liver dysfunction (13). Disturbance in splanchnic and systemic haemodynamics resulting in a hyperdynamic circulation may be an important aetiiological factor (14). Resting hypermetabolism is associated with significant loss of muscle, body cell mass and extracellular mass (13). Diet-induced energy expenditure and energy expenditure associated with physical activity, other parameters which must be taken into account when assessing total energy requirements, are typically normal in patients with cirrhosis (5).

Providing adequate nutrition to OLT candidates would seem to be particularly important, as the combined effects of malnutrition and pharmacological immunosuppression in the post-operative period could predispose to complications such as sepsis, wound dehiscence, compromised respiratory function and delayed physical rehabilitation. Furthermore, malnutrition is now well established as an important independent risk factor for mortality in cirrhosis (15,16). Given the high prevalence of malnutrition in patients coming to OLT and the increasing use of OLT as a therapeutic option in both end-stage cirrhosis and ALF, this review addresses the following important issues: (i) does pre-operative malnutrition adversely affect post-OLT outcome? (ii) can nutritional require-
ments be met and malnutrition reversed prior to OLT and does preoperative nutritional intervention improve post-OLT outcome? (iii) can nutritional intervention be left to the immediate post-OLT period? The long-term consequences of successful OLT and immunosuppressive drug regimens on nutritional and metabolic parameters are also considered.

**Does Pre-operative Malnutrition Adversely Affect Outcome Following OLT?**

Several studies performed in both adult and paediatric patients with end-stage chronic liver disease have examined whether pre-operative malnutrition has a significant, negative impact on post-OLT outcome. Several studies performed in both adult and paediatric patients with end-stage chronic liver disease have examined whether pre-operative malnutrition has a significant, negative impact on post-OLT outcome. Nonetheless, as several components of the PNI may be altered by liver disease, the significance of this finding is uncertain.

DiCecco et al. (2) alternatively employed a prognostic nutritional index (PNI), based on four parameters found to have prognostic importance in surgical patients, namely serum albumin and transferrin levels, triceps skinfold thickness and delayed hypersensitivity responses (18), to assess the possible association between malnutrition and post-OLT outcome in a cohort of 74 adults transplanted for chronic liver disease. While all patients were considered malnourished prior to OLT, no significant correlation was found between the PNI and post-operative morbidity or mortality. Nonetheless, as several components of the PNI may themselves be altered by liver disease, the significance of this finding is uncertain.

Indeed, several more recent studies in which assessment of nutritional status has been based on consideration of anthropometric indices, body composition analysis or subjective global assessment have each demonstrated that pre-operative malnutrition impacts negatively on the post-OLT outcome (13,19–21).

Moukarzel et al. (19) studied 102 children who underwent OLT for end-stage liver disease secondary to chronic cholestasis. Patients were categorised into two groups, representing the more malnourished (group I) and the better nourished (group II), on the basis of the z score for height. This score indicates an individual patient’s value for height in terms of the number of standard deviations above (positive value) or below (negative value) the 50th percentile for healthy control subjects. At the time of OLT, underlying diagnosis, body weight, height, age and liver synthetic function, including serum albumin levels, did not differ significantly in the two groups. However, the incidences of post-operative infection and mortality were significantly increased in the more malnourished group (Table 1). The incidence of infection during the first 2 post-OLT months was nearly twice as high in the more malnourished group, including infection with cytomegalovirus or herpes simplex virus in 27%, Gram-negative sepsis in 27%, bacterial septicaemia without viral or fungal infection in 24% and invasive fungal infection with at least one other episode of bacterial infection in 10%. An average 2.6 generalised infections per infected patient occurred in the more malnourished group, compared to 1.9 in the better nourished patients. The number of patients requiring re-transplantation was higher in more malnourished patients. A statistically significant correlation between the height z score and the duration of hospitalisation was also apparent, with longer hospitalization required in more malnourished patients. Mortality during post-OLT follow-up ranging from 1 to 4 years was almost three-fold higher in this group. Thus, the height z score was shown to be an important prognostic factor for post-OLT outcome in paediatric patients, even if it is difficult to be certain of the relative contributions to impaired growth of impaired nutritional status and underlying chronic ill health, independent of degree of liver dysfunction.

Pikul et al. (20) subsequently used subjective global assessment of nutritional status (22) to investigate whether or not the degree of pre-operative malnutrition is predictive of post-OLT morbidity or mortality in adult patients transplanted for chronic liver disease. Based on a retrospective chart audit, 68 adult graft recipients were ranked as having normal nutrition or mild, moderate or severe malnutrition. The highest emphasis in categorising the nutritional status of patients was placed on muscle wasting, loss of subcutaneous fat and dietary history. Less emphasis was placed on changes in body weight, due to the potentially confounding influences of ascites and oedema, which are almost invariably present in patients awaiting OLT. The overall incidence of malnutrition at the time of OLT was found to be 79%, with 60% considered to be at least moderately malnourished. Compared to the well-nourished and only mildly-malnourished groups, patients with moderate or severe malnutrition required significantly longer periods of ventilatory support, intensive care and overall hospitalization, and tended to have a higher in-hospital mortality rate (Table 1). Although well-nourished and mildly-malnourished pa-
Nutrition and liver transplantation

### TABLE 1
Post-OLT outcome according to pre-operative nutritional status

<table>
<thead>
<tr>
<th>Authors</th>
<th>Subjects</th>
<th>Mode of nutritional assessment</th>
<th>Nutritional status at time of OLT</th>
<th>ICU days (±SD)</th>
<th>Ventilation days (±SD)</th>
<th>Hospital days (±SD)</th>
<th>Infections&lt;sup&gt;a&lt;/sup&gt; (%)</th>
<th>Mortality&lt;sup&gt;b&lt;/sup&gt; (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moukarzel et al. (19)</td>
<td>Children</td>
<td>Height z score</td>
<td>Better nourished</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>More malnourished</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pikul et al. (20)</td>
<td>Adults</td>
<td>Subjective global analysis</td>
<td>Normal nutrition</td>
<td>2 ± 2</td>
<td>2 ± 1</td>
<td>3 ± 2</td>
<td>31 ± 24</td>
<td>9 ± 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mild malnutrition</td>
<td>8 ± 10</td>
<td>8 ± 10</td>
<td>9 ± 13</td>
<td>31 ± 13</td>
<td>8 ± 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderate malnutrition</td>
<td>29 ± 40</td>
<td>29 ± 40</td>
<td>39 ± 40</td>
<td>29 ± 40</td>
<td>8 ± 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Severe malnutrition</td>
<td>44 ± 36</td>
<td>44 ± 36</td>
<td>44 ± 36</td>
<td>44 ± 36</td>
<td>8 ± 0</td>
</tr>
<tr>
<td>Muller et al. (13)</td>
<td>Adults</td>
<td>Bioelectrical impedance</td>
<td>Body cell mass&lt;sup&gt;c&lt;/sup&gt; ≥ 30% body weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Body cell mass&lt;sup&gt;c&lt;/sup&gt; &lt; 30% body weight</td>
<td></td>
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</tr>
</tbody>
</table>

<sup>a</sup> During first 2 post-OLT months.
<sup>b</sup> During stated post-OLT follow-up period: Moukarzel et al. (19) – 1 to 4 years; Pikul et al. (20) – in-hospital; Muller et al. (13) – mean 447 days.
<sup>c</sup> Statistically significant.

Patients were significantly younger than their more malnourished counterparts, each of these associations between outcome and nutritional status was independent of age. No significant differences in post-operative morbidity measures or mortality were evident in well-nourished and mildly-malnourished patients. Thus, while demonstrating the important adverse effect of moderate to severe malnutrition prior to OLT on post-OLT outcome in adult graft recipients, the results of this study also notably suggested that mild malnutrition is not a clinically relevant entity, at least in terms of predicting an increased risk of post-OLT complications.

Muller et al. (13) also retrospectively documented the impact of pre-operative malnutrition on post-OLT outcome in adults with chronic liver disease, using a combination of anthropometric indices, 24-h urinary creatinine excretion and bioelectrical impedance analysis to assess nutritional status. Transplanted patients with a body cell mass of less than 30% of body weight were found to have over a three-fold increase in post-OLT mortality during a mean follow-up of 447 days compared with their better-nourished counterparts (Table 1), despite similar proportions undergoing elective and emergency transplantation in each group.

A prospective analysis of the prognostic importance of pre-operative malnutrition on post-OLT outcome in adults has recently been reported by Selberg et al. (21). One hundred and fifty graft recipients, randomised to study and validation groups, were followed for a mean 46 months after OLT. Body composition analysis was based on consideration of 24-h urinary creatinine excretion, anthropometric indices and bioelectrical impedance. Kaplan-Meier and log-rank analyses demonstrated that a body cell mass <35% of body weight and hypermetabolism (defined as a measured resting energy expenditure in excess of 20% greater than predicted) independently tended to reduce post-OLT survival. Based on consideration of pre-operative nutritional status and resting energy expenditure, patients could be categorised into high- and low-risk groups, with 5-year post-OLT survival rates of 54% and 88%, respectively.

The possible influence of pre-operative hypermetabolism on long-term, post-OLT outcome has also been assessed in a prospective analysis of 26 cirrhotic patients, including six with hypermetabolism, who were followed for a mean 432 days post-OLT (23). Pre-operative hypermetabolism persisted post-operatively and was found to be associated with worse nutritional and biochemical outcomes following OLT, with less long-term weight gain (or even further weight loss) and significantly higher serum bilirubin, liver transaminase,
alkaline phosphatase and gamma-glutamyltransferase levels than in normometabolic patients. However, the possibility that other influences, such as recurrence of viral hepatitis or the occurrence of chronic rejection, may have at least contributed to graft dysfunction was not addressed.

To date, no studies have specifically investigated the impact of pre-operative malnutrition on post-OLT outcome in patients transplanted for ALF.

Can Nutritional Requirements be Met and Malnutrition Reversed Prior to OLT and Does Pre-operative Nutritional Intervention Improve Post-OLT Outcome?

The demonstration that moderate to severe malnutrition adversely impacts upon post-OLT survival raises the questions of whether nutritional requirements can be met and deficiencies corrected pre-operatively in patients with advanced liver disease and whether such intervention leads to improved post-OLT outcome.

Since the basal metabolic rate cannot reliably be inferred clinically, indirect calorimetry is required for an accurate assessment of resting energy requirements in individual patients. Where direct measurement of an individual patient’s energy requirements is unavailable or impractical, the Harris-Benedict equation, using ideal body weight +20%, provides a reasonably accurate estimate of resting energy requirements in most cases. Furthermore, available data suggest that a total daily energy intake of 39 kcal/kg ideal body weight maintains energy balance in most clinically stable cirrhotic patients awaiting OLT (24). In malnourished patients, a daily energy intake in the order of 50 kcal/kg is required for caloric repletion (25,26). Increased calories are required to meet exaggerated resting energy demands in patients with ALF (27) and those cirrhotic patients who develop hepatocellular carcinoma (28). Provision of excess calories should be avoided, as this promotes hepatic lipogenesis, liver dysfunction and increased carbon dioxide production, leading to increased work of breathing (29). A daily protein intake in the order of 1.2 g/kg is required to maintain nitrogen balance in cirrhosis, compared to a requirement of 0.8 g/kg in healthy individuals (24,25,30), with higher amounts necessary to facilitate repletion of muscle mass.

Increasing evidence suggests that it is, in fact, possible to meet these nutritional requirements in most malnourished cirrhotic patients awaiting OLT, despite concerns over precipitating hepatic encephalopathy and the frequent necessity to restrict dietary sodium to a maximum of 2 g/day. Instances of improvement in low-grade encephalopathy related to chronic liver disease have even been reported following nutritional intervention (5), perhaps as a consequence of reduced tissue catabolism and release of aromatic amino acids (31). Conversely, Horst et al. (32) found that increasing quantities of dietary protein precipitated or exacerbated hepatic encephalopathy in 35% of cirrhotic patients with a background of this disorder. Supplementation with vegetable, rather than animal, source protein may be advantageous in such patients, especially those whose total daily dietary protein tolerance is $<1$ g/kg body weight, since controlled studies have suggested that a significant improvement in nitrogen balance may be achieved without precipitating or worsening hepatic encephalopathy by this means (33). Patient acceptability of vegetable protein varies widely but 30–40 g of dietary protein can usually be delivered in this way, although concurrent sodium restriction renders such a diet unpalatable. Amino acid formulae enriched with branched chain amino acids have a specific role in improving nitrogen balance without precipitating hepatic encephalopathy in those malnourished cirrhotic subjects otherwise intolerant of protein supplementation. However, this is a relatively small group as most cirrhotic patients requiring nutritional supplementation tolerate standard synthetic amino acid preparations, which generally contain approximately 20% to 25% of total amino acids as branched chain types (1,29).

Evidence as to whether nitrogen balance can be improved prior to OLT by administration of recombinant human growth hormone is conflicting (34,35). Treatment of 10 adult cirrhotic patients using a growth hormone dose of 0.25 IU/kg daily for 7 days resulted in significantly increased levels of IGF-1 and insulin-like growth factor binding protein (IGFBP)-3 (34). Cumulative nitrogen balance also increased significantly over this time. No such changes were apparent in a placebo-treated control group. Conversely, no beneficial effects were observed in a subsequent study performed in 10 children with end-stage cholestatic liver disease awaiting OLT (35). These patients were enrolled in a placebo-controlled, double-blind, crossover trial involving daily treatment with growth hormone at a dose of 0.2 IU/kg or placebo for 28 days during two treatment periods, separated by a 2-week washout phase. Resistance to exogenous growth hormone administration was apparent, with no significant effect on either any body composition or anthropometric measure or levels of IGF-1, IGFBP-1 or IGFBP-3.

While nutritional intervention is beneficial in malnourished patients with chronic liver disease in the non-OLT setting (5,36), no studies have been per-
formed to investigate specifically whether pre-OLT nutritional intervention improves post-OLT outcome in this group. Similarly, it is currently unknown whether pre-operative nutritional intervention influences post-OLT outcome in malnourished patients transplanted for ALF.

**Can Nutritional Intervention in Malnourished Patients be Left to the Immediate Post-OLT Period?**

Post-OLT resting energy expenditure is not substantially different from pre-operative values, despite the anticipated high caloric demands resulting from the stress of surgery and the administration of large doses of corticosteroids and, as pre-operatively, may reasonably be estimated in most patients from the Harris-Benedict equation using ideal body weight plus 20% (37). Special attention should be paid to the energy requirements of those shown to be hypermetabolic pre-operatively, since hypermetabolism persists for at least 12 months following successful OLT in this group (23). Glucose utilisation by the transplanted liver is typically reduced during the first few hours of engraftment, as a consequence of impaired mitochondrial respiration and inactivity of the tricarboxylic acid cycle. During this time, energy is preferentially generated from the oxidation of fatty acids (38,39). After approximately 6 h, preferential substrate utilisation shifts from fat to glucose in normally-functioning liver grafts, while the failing liver continues to utilise predominantly fat. Some authors recommend that, immediately after OLT, glucose should be administered in small quantities and without insulin in order not to suppress peripheral fat mobilisation (39). In clinical practice, adequacy of substrate utilisation post-OLT is readily monitored by assessment of blood glucose, lactate and triglyceride levels. Measurement of the arterial ketone body (acetoacetate and hydroxybutyrate) ratio is also useful.

The increased protein catabolism seen in cirrhotic patients pre-OLT is further exacerbated post-OLT, with breakdown of protein predominantly from skeletal muscle, possibly as a result of the additional influence of high doses of corticosteroids (37,40,41). Despite a daily protein intake of 1.2 g/kg, over 80% of graft recipients show a persistently negative nitrogen balance for at least the first post-operative month (37). Daily protein requirements are correspondingly increased during this time. Whether nitrogen balance may alternatively be improved by adopting immuno-suppressive regimens which are less reliant on large doses of corticosteroids or with the short-term use of exogenous growth hormone supplements, as already referred to, is unknown. In general, non-protein energy requirements in the OLT recipient are similar to those in other patients who have undergone major abdominal surgery.

While an appropriately designed, large-scale, long-term study limited to patients who are substantially malnourished is yet to be performed, limited available evidence nonetheless suggests that early post-OLT nutritional support by either parenteral or enteral routes may be of some benefit. Evidence that parenteral nutrition may be efficacious comes from Reilly et al. (42), who randomly allocated 28 patients transplanted for Child’s C cirrhosis to receive either glucose infusion without additional nutritional support or total parenteral nutrition (TPN) using standard amino acids with or without additional branched chain amino acids for 7 days in the immediate post-transplant period. The TPN diets provided 1.5 g protein/kg body weight/day and 35 kcal/kg/day. Glucose was infused at a rate of 5 mg/kg/min, with the balance of energy provided by a fat emulsion. The two TPN-supplemented groups achieved respirator independence earlier than the control group, with positive nitrogen balance attained sooner and the requirement for intensive care being a mean 2.3 days shorter in these former groups. There were no significant differences in outcome between the two TPN-supplemented groups.

However, evidence from both experimental and clinical studies indicates that, where possible, the enteral route is preferable for providing nutritional support in critically ill patients. Enteral nutrition maintains the integrity of gut mucosa and is associated with reduced incidences of bacterial translocation and infective complications compared to parenteral nutrition (43,44). Although impaired gastric emptying results in enteral feeding via the nasogastric route being poorly tolerated immediately following OLT, direct access to the jejunum via a feeding tube has the potential to overcome this problem. Wicks et al. (45) investigated the practicality of such an approach by comparing the efficacy and tolerability of early jejunal feeding with that of TPN after OLT. Twenty-four transplant recipients were randomised to receive either enteral feeding via a nasojejunal tube, intra-operatively placed within the first 25 cm of jejunum, or TPN. Patients requiring gut surgery, such as a Roux biliary-enteric anastomosis, as part of the transplantation procedure were excluded. Naso-jejunal feeding or TPN were commenced within 18 and 24 h of OLT, respectively, the latter time being affected by delays in preparation and lack of ready availability at certain times. Energy requirements of individual patients were determined using the Harris-Benedict formula. The energy distribution of the isotonic, nu-
tritionally complete enteral solution used was 16.6% protein, 52.6% carbohydrate and 30.8% fat, the latter equally distributed between medium- and long-chain triglycerides. The parenteral feed contained crystalline L-aminoacids, carbohydrate in the form of dextrose, fat emulsion, vitamins and minerals. Nutritional support via the nasojejunal tube or TPN was ceased when 70% of daily requirements could be met by a normal diet, the remaining 30% being provided by supplement drinks.

Intestinal mucosal integrity, as determined by the differential urinary excretion of carbohydrates of varying molecular weights, was found to be only transiently and mildly impaired on the first post-OLT day and had improved to baseline by day 3. In addition, transplant recipients did not have clinically important malabsorption and were capable of adequately absorbing enteral feed when the problem of impaired gastric emptying was bypassed. Although intestinal absorptive capacity, as assessed by the urinary excretion of 3-O-methyl-D-glucose and D-xylene, was significantly reduced on the first post-operative day, substantial recovery was evident by the third day. Indeed, enteral nasojejunal feeding was found to be well tolerated and of comparable efficacy to that of TPN. Anthropometric indices were, by comparison with pre-operative values, maintained on the 10th post-operative day in each group. Neither ventilator-dependence nor length of hospitalisation differed significantly in the two groups. Pescovitz et al. (46) alternately demonstrated that jejunal feeding can safely be achieved in most patients by tube jejunostomy at the time of OLT. An overall complication rate of 16.7% was reported, including instances of mechanical obstruction of the tube, small intestinal obstruction, catheter displacement and infection.

The feasibility of early enteral nutrition in the post-OLT setting having been established, Hasse et al. (47) subsequently attempted to investigate whether such an approach leads to improved short-term outcome within the first 21 days of transplantation. Thirty-one patients were randomised at the time of OLT to receive nasojejunal tube feeding commencing 12 h after OLT or maintenance intravenous fluids until at least 66% of measured energy and protein needs were met by oral intake. Prior to OLT, 64% and 47% of the tube-fed and control groups, respectively, were considered to be at least moderately malnourished by subjective global assessment. Nasojejunal tube feeding was well tolerated by the majority of patients and facilitated a significantly greater intake of calories and protein over the first 12 post-OLT days than in the control group. Nitrogen balance on day 4 was also significantly better in the tube-fed group. A significantly reduced incidence of viral infection was reported in the tube-fed compared to the control group (0% versus 18%), with trends towards a reduced incidence of bacterial infection (14% versus 29%) and overall fewer infected patients (21% versus 47%) also documented. Conversely, early post-OLT tube feeding did not significantly influence total hospitalisation costs or, in contrast to the earlier findings of Reilly et al. using TPN (42), how long patients were on a ventilator or how long they were in intensive care. It may be pertinent that the majority of patients allocated to the control group had been well nourished prior to OLT. Certainly, the possibility that any post-OLT differences between intervention and control groups might have been more apparent had enrollment in the study been limited to patients with at least moderate malnutrition could not be excluded.

No studies have yet compared the possible effects of pre- and post-operative nutritional intervention on post-OLT outcome in either the end-stage cirrhosis or ALF setting.

Long-term Nutritional Considerations Following OLT

While nutritional and metabolic parameters remain highly variable during long-term follow up after OLT, some data suggest that protein turnover has, in general, decreased, although not to normal levels, by 12 months (48). Mean weight change at this time was +4.9 kg in one series, ranging widely between −16.5 kg and +32.7 kg (23). Significant increases in both muscle and fat stores have been reported by 8 weeks of OLT, with magnetic resonance spectroscopy demonstrating a significant increase in saturated fatty acids with reduced unsaturated fatty acids (12). As discussed earlier, hypermetabolism tends to persist for at least 12 months post-OLT in those cirrhotic patients who are hypermetabolic pre-operatively and is associated with a relatively poor nutritional outcome (23).

Use of immunosuppressive drugs following OLT results in the development of a number of risk factors for cardiovascular disease. In a retrospective study of over 300 liver graft recipients followed for a median 18 months, hyperlipidaemia was evident in 66%, while hypertension, obesity and diabetes mellitus were also present in a substantial proportion of patients (49). Increasing evidence suggests that tacrolimus is associated with a less adverse cardiovascular risk profile than cyclosporin, with significantly reduced prevalences at 12 months of hypertension (33% versus 82%), hypercholesterolaemia (0% versus 33%) and obesity (29% versus 46%), together with significantly lower triglyceride levels (50). The prevalence of hyperglycaemia is
also reduced (49). Corticosteroids also contribute to post-OLT disturbances of these parameters (51,52). In patients with stable graft function, the withdrawal of prednisolone over time reduces the prevalences of hypertension, hyperlipidaemia, obesity and diabetes mellitus in the post-OLT setting (51). Attention to factors influencing cardiovascular risk after OLT is particularly pertinent, given the increasing age of the recipient population and the attendant increase in pre-existing atherosclerosis in older individuals. Taken together, these findings highlight the need for long-term metabolic and dietary evaluation along with nutritional counselling in liver graft recipients.

References