To Our Readers

We are grateful to our readers for the specific suggestions they have offered to us regarding the papers in Update 3 of this series.

The current issue contains two articles. The first deals with nutrition support in the critically ill patient, specifically in the setting of respiratory failure and weaning from mechanical ventilation, and the second extensively discusses the practical issues involved in nutrition intervention in the surgical patient and complications encountered in specific settings.

Apart from sharing your ideas with us will regard to the above articles, your suggestions regarding future articles for the Update will be most welcome. The CRNSS fax number, postal and e-mail addresses are indicated on the cover page.

CRNSS will be shortly inaugurating its Diet counseling and Research Unit. It is hoped that this service will prove useful not only in the treatment, but also in the prevention of diet-related diseases in the community.

Sarath Gopalan
Hon Director, CRNSS,
and Editor

Edited by: Sarath Gopalan (Editor) and Shailee Saran (Assistant Editor) for CRNSS. Designed and produced by Media Workshop India Pvt Ltd.

Nutrition Support Systems in Hospitalised Patients

Dr Vinod K. Puri
Director,. Critical Care Service
Providence Hospital, Southfield, MI
Associate Clinical Professor of Surgery
Wayne State University
Detroit, MI, USA

In this communication, three different special clinical situations that may need nutrition support are discussed.

THE CRITICALLY ILL PATIENT

The last decade has seen a declining emphasis on total parenteral nutrition (TPN) and confirmation of enteral nutrition (EN) as the preferred route of delivery of nutrients. The advantages of using the gut in patients are obvious. EN is more physiologic and cost effective1. Avoidance of catheter-related infections when using EN are of no small consequence to the hospitalised patient.

However, it is not clear if all the advantages stated are applicable to the critically ill patient2. Certainly, there are skeptics who doubt the crucial role of nutrition in recovery from a critical illness or injury3. Since the critically ill patient poses special challenges, we continue to resort to TPN to provide short-term nutritional support to these patients. Besides difficulty of access to transpyloric location of gastrointestinal tract, a patient's level of consciousness and risk of aspiration present major difficulties. The need to heavily sedate or paralyse the patient for treatment of respiratory failure is not uncommon. It is often difficult to determine daily volume of intravenous fluids that the patient needs when:-

- Fluid overload is common.
- Cardiopulmonary reserves are limited.
- Renal dysfunction is present.
- Hepatic dysfunction is also present.

  Moreover, the above conditions can change drastically from day to day. Other considerations relate to the fact that electrolyte imbalance of Na, K, Cl, Mg, P and Ca concentration of electrolytes changes with therapy. Acid-base disturbances and cardiac arrhythmias add to the instability.

Gastric emptying as well as intestinal motility and absorption are significantly affected by disease and drugs such as narcotics. In the critically ill patients, how do we take into account the unpredictability of absorption of nutrients? How do we quantify the loss of delivered nutritional ingredients in diarrhoea? Subclinical aspiration of stomach contents may manifest first as deteriorating pulmonary gas exchange or a worsening chest X-ray.

There are other reasons in the ICU to depend upon tailor-made solutions in volume and concentration:-

Respiratory failure is common and may be aggravated by:

- Hyperosmolar solutions.
- Excess CO_2 production from glucose loads.

Hermodynamic instability is common:

- Shock, low cardiac output and use of diuretics will affect decisions to suspend or reduce nutritional support.
- Dialysis or hemofiltration will allow a certain level of nutritional support to be maintained.
- Sepsis-special considerations regarding composition and control of glucose levels.
  Body weight is an unreliable guide to nutritional therapy in the ICU.
- Methods of monitoring metabolic needs are cumbersome and not in general use.

It has been documented that enteral nutrition is frequently interrupted and patients rarely receive 100 per cent of the targeted calories4.

RESPIRATORY FAILURE

The influence of nutritional support on the course of respiratory failure and success in weaning from mechanical ventilation are of great interest to critical care practitioners. However in a review article, Askanazi and colleagues concluded in 1982, "At present there are insufficient data to make definite recommendations regarding the optimum form of nutritional support for acutely ill patients with respiratory compromise."5 The respiratory system may be considered in three subdivisions:
* A drive mechanism (central nervous system).
* A pump (respiratory muscles).
* A gas exchange organ (lung).

Besides an effect on all these three systems, malnutrition may affect immune defences. Arora and Rochester carried out studies in patients with Chronic Obstructive Pulmonary Disease (COPD) which established a relationship between general nutrition and mass of diaphragms as well as lung function6. Several studies in the early 1980s emphasised the pitfalls of overfeeding in patients with marginal ventilatory capacity7,8. The high glucose loads popular at the time have universally been acknowledged to be deleterious. More rational provision of calories with glucose and lipid mixtures are now the accepted form of nutritional support.

WEANING FROM MECHANICAL VENTILATION

The effect of nutritional therapy on weaning from mechanical ventilation has been suggested in a small study by Larca and Greenbaum9. These authors compared eight patients who were successfully weaned after prolonged nutritional support, with six patients who did not respond to similar treatment and died in the hospital. Bassili and Deitel in 1981 reported that 93 per cent (13/14) patients who received 1,300-1,600 kcal/day were successfully weaned as compared to 54 per cent (18/33) of those receiving 400 kcal/day10. At present, these studies will be difficult to carry out, as the standard of care for ventilator dependent patients has evolved to providing 1,500-1,800 calories and nutritional supplements beyond the initial two to three days of ICU stay.

Thus an extensive review by a task force documented only one randomised clinical trial of benefit of high fat, low carbohydrate diet in acute lung injury11.

Thus, though clinicians continue to provide nutritional support via TPN or enteral nutrition in patients requiring mechanical ventilation, they often do it in the absence of any firm data that alters the course of respiratory failure.

REFERENCES

1. Moore, F.A., Moore, E.E., Jones, T., et al: TEN vs TPN following major abdominal trauma-reduced septic mortality. J Trauma, 29:916, 1989.
2. Heyland, D.K., MacDonald, S., Keefe, L., et al: Total parenteral nutrition in the critically ill patient. A meta-analysis. JAMA, 280:2013, 1998.
3. Koretz, R.: Nutritional supplementation in ICU: How critical is nutrition for the critically ill? Am J Respir Crit Care Med, 151:570, 1998.
4. Kemper, M., Weissman, C. and Heyman, Al: Caloric requirements and supply in critically ill surgical patients. Crit Care Med, 20:344, 1992.
5. Askanazi, J., Weissman, C., Rosenbaum, S.H., et al: Nutrition and the respiratory system. Crit Care Med, 10:163, 1982.
6. Arora, N. and Rochester, D.F.: Effect of general nutritional and muscular states on the human diaphragm. Am Rev Resp Dis, 115:84, 1977.
7. Askanazi, J., Rosenbaum, S.H., Heyman, Al, et al: Respiratory changes induced by large glucose loads of total parenteral nutrition. JAMA, 243:1444, 1980.
8. Dark, D.S., Pingleton, S.K. and Kerby, G.R.: Hypercapnia during weaning. A complication of nutritional support. Chest, 1:141, 1988.
9. Larca, L. and Greenbaum, D.M.: Effectiveness of intensive nutritional regimens in patients who fail to wean from mechanical ventilation. Care Med, 10:297, 1982.
10. Bassili, H.R. and Deitel, M.: Effects of nutritional support on weaning patients off mechanical ventilation. JPEN, 5:161, 1981.
11. Klein, S., Kinney, J., Jeejebhoy, K., et al: Nutrition support in clinical practice; Review of published data and recommendations for future research directions. JPEN, 21:133, 1997.

Nutrition Support for the Surgical Patient

Dr Karanvir Singh
MS,FRCS
Department of Surgery Sri Ganga Ram Hospital
Rajinder Nagar New Delhi 110 060

The presence of malnutrition in a surgical patient has a direct bearing on the overall outcome during hospitalisation. A multi-centric, prospective trial found a strong correlation between the serum albumin at admission and subsequent morbidity and mortality. This correlation was not restricted to surgical patients alone but spread across all specialities. This is logical considering that malnutrition has an adverse effect on immune function and tissue repair capacity.
Most patients admitted to a surgical ward are not malnourished. However, patients who have undergone a prolonged pre-admission illness are likely to have some element of malnutrition. This is compounded by surgical procedures (and subsequent fasting) after admission. These patients can go into severe malnutrition quickly, often before the treating team realises it. It is important to remember that it is easy to prevent a patient from slipping into the category of severe malnutrition but very difficult to bring him out of it again.

In patients who are severely catabolic, intensive nutritional support often fails to improve their serum albumin. All the calories provided are used up in the catabolic process. Nutritional support, in such a scenario, is aimed at preventing further deterioration in the nutritional status.

Improving the nutritional status of a malnourished patient always improves the overall prognosis. The stress should always be on enteral nutrition. Total Parenteral Nutrition (TPN) should be used judiciously because of its potential complications.

In studies on patients admitted for surgery1,2, patients were divided into three groups: well nourished; mild to moderately malnourished; and severely malnourished. They were all given pre-operative TPN to improve their nutritional status. Compared to the control group of patients, patients with severe malnutrition did better with such a preparatory nutritional support. However, patients with mild or moderate pre-operative malnutrition did worse when they received pre-operative TPN. This paradoxical finding is due to the complications of TPN (TPN-induced immunosuppression, central catheter-related complications, etc) outweighing the advantages of improvement in nutritional status. It is generally recommended that TPN should not be given to borderline malnourished patients who are likely to start feeding soon.

The above does not hold true for enteral nutrition, which always helps, even in patients with mild malnutrition.

INDICATIONS

Every patient must have a quick nutritional assessment at the time of admission. Severely malnourished patients should be given pre-operative nutritional support, preferably via enteral nutrition. TPN should be reserved for those who cannot be fed enterally. Moderately malnourished patients would do better with pre-operative enteral nutrition, time permitting. They should not be given TPN unless they are unlikely to start enteral or oral feeding fairly soon after operation and are, hence, likely to slip into the severe malnourished category.

CLINICAL ASSESSMENT

The amount of weight loss in the previous few months is a very useful parameter. A prolonged history of vomiting, anorexia or diarrhoea is significant. A quick inquiry is made by checking the oral intake over the past few weeks. A dietary history needs to be taken accurately, else it tends to be an insensitive parameter.

Visual assessment of muscle and fat mass is useful. Hair and nail changes may be present in chronic malnutrition. Simple clinical evaluation of nutritional status had been found to be as accurate as objective assessment such as body fat measurements and biochemical tests3.

BIOCHEMICAL ASSESSMENT

Serum albumin is the easiest available test. A serum albumin of less than 3.5 g per cent indicates moderate malnutrition, while a value of less than 3.0 g per cent indicates severe malnutrition, provided liver and kidney function tests are not grossly abnormal. Serum albumin has a half life of a few days and, hence, it does not change rapidly enough to reflect the current nutritional status. Serum prealbumin and retinol binding protein change faster and are more likely to reflect current changes in the nutritional status. These tests are relatively expensive and are not widely available.

TYPES OF NUTRITIONAL SUPPORT

Enteral

Feeding via the gut is superior to parenteral feeding. The reduction in complications due to the parenteral line is not the only reason for this; the main reason is the reduction in general sepsis-related morbidity and mortality in enterally fed patients. The presence of food in the gut improves intestinal mucosal integrity and reduces transmigration of bacteria and seeding into possible sites of sepsis such as pancreatic phelgmon, hematoma, lungs, etc.

Oral Feeding

This remains the best form of nutrition. In malnourished patients, however, relying solely on oral feeding is fraught with danger unless one is very sure of the actual intake. It is very easy for a patient to slip insidiously into malnutrition. If there is the slightest doubt about the amount of oral intake, it is advisable to pass a nasogastric tube for feeding.

Nasoenteral Tube Feeding

A nasogastric feeding tube is indicated in patients whose intestine can tolerate food and there is no contraindication to the entry of food in the gut, but who do not, or cannot, take food orally. Although it is common and quite acceptable to use a 10-14 Fr nasogastric tube for this purpose, there are special fine bore tubes (6-8 Fr) available which are more tolerated by patients but are much more difficult to pass. They also clog easily.

Where feeding into the stomach is contraindicated (pancreatitis, severe gastro-oesophageal reflux), a naso-jejunal tube can be inserted for feeding. This may be positioned endoscopically or under fluoroscopic guidance. Easier still is to pass such a tube into the stomach and give an intravenous injection of metaclopramide, when most tubes will pass spontaneously into the jejunum. Multilumen tubes are also available. They allow feeding into the jejunum while simultaneously allowing aspiration from the stomach.

Invasive Tube Feeding

Patients who cannot have a nasogastric or naso-jejunal tube passed (inoperable carcinoma of the pharynx or oesophagus, etc) or those who need long-term feeding for months or years, should have a percutaneous feeding tube positioned. A gastrostomy can be performed endoscopically (PEG: percutaneous endoscopic gastrostomy) or at laparotomy (Stamm gastrostomy).

Bypassing the stomach, for the indications mentioned above, can be done by performing a feeding jejunostomy.

PARENTERAL

Central Venous Access

Infusion of a TPN solution is almost always done via a central venous line. This is because TPN solutions are very hypertonic and need a vein with a rapid blood flow to dilute the solution as soon as it enters the body.

Peripheral Venous Access

Peripheral TPN is being increasingly used. It involves infusion of TPN solutions via an ordinary cannula or via a peripheral long cannula where the tip lies in the upper arm with a relatively higher blood flow. Peripheral TPN obviates the use of a central line and its attendant complications. Obviously, a standard TPN solution cannot be used via the peripheral route because of its hyperosmolarity. The osmolarity of blood is close to 300 mOsm.

Solutions meant for peripheral use should have a maximum osmolarity of about 700-800 mOsm. Even this osmolarity limits use of a particular vein to a maximum of seven to 14 days before thrombophlebitis sets in and the infusion site has to be changed. The total duration of administration of peripheral TPN is limited by the number of veins available in the upper limbs. Solutions meant for peripheral use are always three-in-one solutions. This is because such mixtures allow a lower concentration to deliver a larger amount of the same substance (see explanation below in the section on all-in-one solutions). Even then, the number of calories that can be delivered peripherally are limited to about 1,500 cals/day.

FEEDING SOLUTIONS

Enteral Kitchen feeds:

Provided the feeds are liquidised properly in a kitchen mixer and are well designed, kitchen feeds are the most economical tube feeds available. Caloric information per feed is usually not accurately known and, hence, it is difficult to determine the exact calories being provided. Moreover, residual solid material blocks fine bore feeding tubes. Milk-based feeds contain lactose and kitchen feeds can be made lactose-free by using only pulses, starches and cereals.

General proprietary formulae:
Commercially available powdered, flavoured feeds derived from milk or soya bean with various additives are complete feeds containing a balance of carbohydrates, proteins, fats, vitamins, minerals and trace elements. These can be used for oral as well as tube feeding. Most formulae are lactose free. During periods of malnutrition, lactase enzyme deficiency commonly develops. If lactose derived from milk is ingested, diarrhoea results. Logically, lactose-free formulae should be reconstituted with water and not with milk. Special formulae: Certain formulae contain special nutrients:

Polypeptide formulae: These formulae are designed for initial feeding in acute pancreatitis. The risk of early feeding in pancreatitis is because certain components of food can stimulate the pancreas by stimulating the release of gastro-duodenal hormones, mainly Cholecystokinin/Pancreozymin (CCK/PZ). The two food components responsible for this are proteins and fats. The short chain length polypeptides and the lower quantities of fat contained in these formulae cause much less gastric hormone stimulation than normal proteins and fats.

An alternative method of feeding in patients with ongoing low-grade pancreatitis is to pass the feeds directly into the jejunum, either via a naso-jejunal tube or via a feeding jejunostomy. In such a situation even normal feeds can be used because the stomach and duodenum have been bypassed.

- MCT-containing formulae: Medium chain triglycerides (MCT) have shorter chain lengths than the long chain triglycerides (LCT) normally found in nature. MCTs have the advantage of faster absorption and faster oxidation for calorie production because they bypass the normal regulatory controls the body has for limiting fat utilisation. Bypassing these controls is not always advantageous but in patients who are malnourished and cannot metabolise glucose (glucose metabolism is always suppressed in acute stress conditions), MCTs are a good calorie source. Enteral feeds containing MCTs along with the standard feed components are being introduced in the Indian market.
- Immunonutrients: Certain dietary substances have been found to improve the immune response of stressed, ill patients. These are glutamine, argenine, v-3 fatty acids and nucleotides. Enteral feeds containing higher concentrations of these immunonutrients are also available. Glutamine, additionally, has a role in maintaining the gut mucosal barrier and in reducing bacterial translocation with a reduction in the overall sepsis rate.

Parenteral Hypertonic dextrose solutions:

Hypertonic dextrose solutions (20 per cent to 50 per cent) were the first solutions used for TPN. They have to be infused via a central line into a major, high-flow vein to avoid thrombophlebitis.

It was soon realised that providing all the calories via glucose alone has disadvantages:

- Patients develop essential fatty acid deficiency within a few weeks in the absence of lipid infusions.
- Fatty changes occur in the liver due to reduced mobilisation and export of locally synthesised lipids. One of the factors responsible for this is a deficiency of essential fatty acids.
- In patients under severe stress (polytrauma, sepsis, burns, etc), the body switches from glucose metabolism to fat metabolism. It fails to utilise dextrose even when blood glucose levels are high but uses ketone bodies instead for calorie production. This switch occurs within 24 hours of the onset of the stress condition.

Lipid solutions:

Lipids provide about 9 cals per g (as opposed to about 4 cals per g from dextrose). An additional advantage of lipid solutions is that they are completely isotonic, allowing peripheral infusion.

Lipids are essential in stressed patients who metabolise lipids preferentially over glucose. Additionally, they provide the essential fatty acids - arachidonic acid, linolenic acid and linoleic acid - although the amount of lipid required for this is very small. As explained above, infusion of lipids also reduces the incidence of fatty changes in the liver.

Lipids cause immunosuppression. A high concentration of unmetabolised fatty acids increases the production of immunosupressive (E2 series) prostaglandins. This problem is less with medium chain triglycerides. Higher concentrations of dextrose (beyond therapeutic doses) are directly hepatotoxic, but such toxicity is rarely observed these days. Some patients with egg allergy may react to the egg lecithin component and even develop anaphylaxis.

Lipid solutions for TPN are made by emulsifying triglycerides using egg lecithin as an emulsifier. The resulting emulsion (oil-in-water) is stable by itself but does not tolerate many additives. For instance, addition of high concentrations of dextrose or acidic solutions/drugs can 'break' the emulsion, allowing the fats to form a separate layer. Infusion of such a 'broken' solution can be fatal. Fortunately, such problems are quite rare but utmost caution is required while mixing lipid emulsions with other solutions.

Amino acid solutions:

These must be distinguished from other protein-providing solutions such as albumin or plasma. Both these latter solutions contain large protein molecules which have to be broken down to amino acids before they can be used for protein manufacture.

Simple amino acids in solution can, on the other hand, be directly used for protein manufacture. Amino acid solutions cost only a fraction of the cost of albumin solutions. They do not carry the risk of transmitting infection as do albumin and plasma. Hence, albumin and plasma have no role in nutrition; only pure amino acid solutions are used.

Amino acids provide 4 cals per g if they are oxidised. They should, however, be protected from such wasteful oxidation and should be used purely for protein manufacture. Such protection is provided by the presence of adequate amounts of energy-providing substrates (dextrose, lipids) on board. Thus, before amino acid infusions are given, it is essential to ensure that adequate calories are provided. The calories provided by amino acids should never be counted while calculating the calories in a feed provided to a patient. It is hence common to find solution labels mentioning 'non-protein' calories.

Amino acids are usually provided as a 10 per cent solution. This is too hyperosmolar for peripheral use. A 5 per cent solution is available which can be used peripherally for a few days.

Branched-chain amino acids are possibly beneficial in patients with a liver disease. Glutamine-enriched amino acid solutions have been shown to improve survival in stressed, sick patients. Arginine probably improves immune function. Amino acid solutions enriched with essential amino acids have been found to be beneficial in patients with renal failure. Commercial solutions containing these components are also available.

Amino acids have no major side effects. High doses of amino acids should be avoided in hepatic encephalopathy.

OTHER COMPONENTS

Multivitamins (MVI) and Trace Elements

Most patients are likely to have vitamin and trace element deficiencies by the time they go onto TPN. They should be given supplements as soon as possible. Both MVI and trace element solutions are relatively unstable once mixed and are never provided as components of ready-mixed TPN solutions. They have to be added just prior to infusion. Currently, trace element solutions are not available in India. Oral trace elements can be used whenever feasible.

Other Additives

Insulin may be added to TPN solutions, provided one remembers that an unspecified amount of insulin will be adsorbed onto the surface of the TPN container and tubing. It is always better to administer insulin separately. Diabetic patients are likely to develop hyperglycaemia because of the large volumes of hypertonic solutions used. Even non-diabetic patients may require insulin if they develop glycosuria during hypertonic dextrose infusions (urine should always be checked for glycosuria regularly).

Calcium supplements deserve a special mention since they are highly incompatible with TPN solutions and should always be given via a separate vein. If mixed with TPN solutions they can precipitate inorganic phosphates present in the solution, infusion of which is dangerous. The presence of lipids in the final TPN solution masks detection of such precipitates.

Heparin is often added to all-in-one solutions in a bid to reduce the incidence of thrombophlebitis and venous thrombosis. It also facilitates lipid metabolism.

All-in-one Solutions

All-in-one solutions (also called three-in-one solutions) are the biggest recent advance in TPN therapy. Amino acid solutions, hypertonic dextrose solutions and lipid emulsions are mixed into a single container and infused. The advantages of this approach are:

- The infection risk is reduced. Each infusion change on the ward carries a risk of introducing infection. Adding all the solutions into a single bag under aseptic conditions reduces infusion changes to once a day, reducing the infection rate.
- It allows the solutions to be given in a more diluted form. The added amino acid and lipid solutions dilute the dextrose solution and vice versa. Thus, 250 g of glucose (an average daily requirement) can be given as either 1,000 ml of 25 per cent dextrose or as 2,500 ml of 10 per cent dextrose. The 2,500 ml solution would, in this example, be obtained by mixing 1,000 ml of 25 per cent dextrose with 500 ml of lipid solution, 500 ml of amino acid solution and 500 ml of normal saline. This would dilute the dextrose as well as the hypertonic amino acid solution. It is in fact possible, using such a three-in-one solution mixture, to infuse via a peripheral vein, provided the total calorie requirement does not exceed about 1,500 cals.

- Nursing time requirement is reduced because of less frequent TPN bag changes.
- Administration of 'Home TPN' is possible.

MISUSED COMPONENTS

Albumin

Although albumin solutions are not a component of TPN, patients requiring TPN often have hypoalbuminaemia. These patients may require albumin infusion if they develop clinical features of low oncotic pressure. Albumin infusions should be stopped once oncotic pressure has risen.

Plasma

Plasma has no role whatsoever in nutrition. Fresh Frozen Plasma (FFP) should be used only for the provision of clotting factors when required, this being their only role. Plasma is also commonly misused in patients with clinical features of low oncotic pressure. Albumin solutions (20 per cent) should be used here instead. However, in India, FFP is often used because albumin solutions are expensive.

COMPLICATIONS

General Complications

Gallstones

: Gallstones are likely to develop in patients on long-term TPN. This is not a direct complication of TPN but is because of the absence of gut stimulation which allows gallbladder stasis and stones to form. It can be prevented by small quantities of enteral feeding or by regular injections of CCK/PZ.

Excess calorie provision

: It was common to give patients 3,000-5,000 calories some years ago under the impression that provision of a larger number of calories would allow them to recover faster. This was called 'hyperalimentation'. It was soon realised that provision of excess calories has its own complications:

- Excess carbon dioxide is produced in these patients leading to difficulty in weaning patients off ventilators.
- An extreme hyperosmolar environment is created leading to osmotic diuresis and water and electrolyte imbalance.
- It is now acceptable to provide 25-30 cals/kg/day as basal calories for adults. Of these, 25-40 per cent (but never more than 60 per cent) should come from lipid sources.

Complications due to dextrose:

Dextrose by itself does not cause any complications other than due to hyperglycaemia and hyperosmolarity. Relying on dextrose alone as the caloric source however leads to problems:

- Oxidation of glucose produces more carbon dioxide than does the oxidation of a combination of glucose and lipid. Although this is not a problem in patients breathing normally, in patients with borderline hypercapnoea (weaning off ventilator, ARDS) it can tip the balance.
- Patients fed on dextrose alone are likely to develop a fatty liver, as has been explained earlier.

Complications due to lipids:

Though present-day lipid solutions are quite safe, some problems can still occur:

- Excessive lipid infusions can be hepatotoxic. It is recommended that not more than 40 per cent of the total daily calories should be of lipid origin. Acute overdosage is manifested by fever, nausea, vomiting, dyspnoea and hypercoagulibility.
- Serum triglyceride levels can rise rapidly if an individual's capacity to clear them is compromised. Blood levels should be checked regularly.
- Accumulation of unmetabolised free fatty acids (FFA) in the blood increases PGE2 production, causing immunosuppression.
- Pulmonary dysfunction may result from the release of vasoactive amines produced because of excessive PGE2 levels.

Medium chain triglycerides (MCT) are variants which can avoid some of these problems. They can be metabolised faster by the body, leading to less accumulation in the blood stream and lesser PGE2 production. Since all essential fatty acids have long chains, infusion of some long chain triglycerides (LCT) also is essential. The ideal mixture is a 50:50 ratio of LCT and MCT. Currently, only one company markets such a product worldwide (Lipofundin, Braun, Germany).

Complications Specific to Access Lines
Enteral feeding line related:

Nasogastric tubes increase the risk of gastric content aspiration, especially in an unconscious patient. Where such a risk is present, feeding into the jejunum via a naso-jejunal tube may help. Prolonged use of either of these tubes can lead to oesophageal ulceration. A feeding gastrostomy is the solution in such cases.

Central line related:

Currently, most TPN-related complications are related to the central venous line. Complications include injury to adjacent nerves and vessels, pneumothorax, air embolism, infusion of TPN into the pleural cavity via a misplaced line and infection of the central line. The position of all central venous lines should be confirmed by a chest x-ray prior to the commencement of the infusion. Central lines should be handled with aseptic precautions. A subcutaneously tunnelled infusion line with a Dacron cuff (Hickman line) is used for long-term or home TPN. Its use in routine TPN is not justified.

Peripheral line related:

Clinical thrombophlebitis remains the most common complication of peripheral TPN. The use of a glyceryl trinitrate patch just distal (towards the hand end) of the infusion site is claimed to dilate the vein, increase the blood flow and dilute the infused TPN solution more rapidly, leading to a lower incidence of thrombophlebitis. Peripheral TPN cannulae should be treated with the same aseptic precautions as central lines.

TAILORING NUTRITION FOR THE PATIENT

If possible, patients should be fed via the gut. This reduces overall septic complications. Although there are complicated equations for calculating calorie requirements, for most clinical purposes its daily requirement can be calculated as:

Baseline calorie requirements (cals) = 28 x body weight (in kg)

Adjustments for other factors:

Increase:

Situation	Percentage increase
Malnourished patient	+ 10 per cent
Age: 18-30 years	+ 10 per cent
Each oC rise in temperature	+ 10 per cent
Bedridden	No change
In bed but mobile	+ 5 per cent
Mobile	+ 10 per cent
Post-operative	+ 15 per cent
Sepsis/trauma	+ 25 per cent
Burns	+ 35 per cent

Decrease:

Situation	Percentage decrease
Obesity	10 per cent
Age > 70 years	10 per cent
Female sex	10 per cent

Nitrogen:
The daily protein requirement in adults is equal to body weight x p, where 'p' is

2.5	Highly increased requirements	Peritonitis, burns, building up the patient
2.0	Moderately increased requirements	Sepsis, multi-trauma
1.5	Slightly increased requirements	Post-operative status, cancer, inflammatory
1.0	Basic requirements	None of the above factors
0.6	Reduced requirements	Renal failure, hepatic encephalopathy

The nitrogen requirement is equal to protein requirement divided by 6.25. :

Fluids:

All-in-one solutions do not always meet all the fluid requirements of patients in hot weather or in patients with large additional fluid losses. Additional fluids can be added to the all-in-one bag itself prior to connecting the bag. The bag has a capacity to accommodate 1-3 litres of additional fluid within it depending upon the size. Trace elements, minerals and vitamins are added to the bag before the infusion is made.

ADMINISTERING THE FEEDING SOLUTIONS

Enteral:

Most enteral feed solutions are available as dry powders to be reconstituted by mixing with water. Milk should not be used since the final solution is then no longer lactose free. Some powders are available as single feed sachets providing 225-250 calories per feed. Tins are available providing the total calories for the whole day for an average patient. They also contain the daily requirements of vitamins and all trace elements.

These proprietary enteral feed formulae cost only a fraction of the cost of TPN, in the range of Rs 150-300 per day, often being less than the cost of the antibiotics the patient may be receiving. Proprietary feeds allow the exact calculation of the calories being ingested by the patient and are less likely to block feeding tubes.

TPN:

Although TPN solutions are available as individual component bottles, the introduction of all-in-one TPN bags has made TPN administration very easy. These bags are available in different sizes with different caloric, nitrogen and electrolyte content to suit the requirement of individual patients. Lipid solutions, multivitamins and trace elements have to be added to the bag prior to the infusion. Once mixed, the infusion has to be started within 24 hours (three days if refrigerated).

If the osmolarity of the final solution is less than 700-800 mOsm, it can be infused via a peripheral cannula; else it has to be infused via a central line.

SAMPLE TPN PRESCRIPTION

A 28-year-old man weighing 60 kg is injured in a car accident and sustains injury to the duodenum which is repaired surgically. Post-operatively he is put on TPN. He is febrile till 38 oC.

His requirements are calculated as follows:

Calories

Basal calories	60 x 28	1680
Additional calorie requirements:		
For age between 18-30 years	+ 10 per cent	168
Temperature 1 degree above normal	+ 10 per cent	168
Post-operative status	+ 15 per cent	252
	Total calories	2,268

Proteins

Protein requirement	60 x 1.5	90
Nitrogen requirement	90 ÷ 6.25	14.4

Fluid requirements

Basal	60 x 40	2,400 ml
For 1oC rise in temperature	+ 10 per cent	240
Other extra losses	None	0
	Total fluids	2,640 ml

Electrolyte requirements

Final prescription:

Fluid	Volume	Calories	Nitrogen
20% lipid	500 ml	1,000	
10% amino acid	1,000 ml	Zero*	12.8
40% dextrose	1,000 ml	1,200	
Normal saline	500 ml		
KCI solution	30 ml		
Total	3,030 ml	2,200	12.8

* Although amino acids in solution do provide calories, they are not counted in the calculations because amino acids are not meant to be oxidised for calories. The above provides 78 mEq of sodium and 60 mEq of potassium.

In conclusion, the objective of this article has been to present a broad view of the practical difficulties encountered during nutrition supplementation in the hospitalised surgical patient. As the subject is very vast, no attempt has been made to go into the details of individual components used in the commercial preparations available - this is beyond the scope of this article.

REFERENCES

1. Buzby, G.P., Blouin, G., Colling, C.L., et al: Perioperative total parenteral nutrition in surgical patients. N Engl I Med, 325:525, 1991.
2. Detsky, A.S., Baker, J.P., O'Rourke, K., et al: Perioperative parenteral nutrition; a meta-analysis. Ann Inter Med, 107:195-203, 1987.
3. Baker, J.P., Detsky, A.S., Wesson, D.E., et al: Nutritional assessment: a comparison of clinical judgement and objective parameters. New Engl J Med, 306:969-977, 1982.

News And Notes

VI Annual ISPEN Conference
March 14-15, 2000, India Habitat Centre, New Delhi

The VI Annual Conference of the Indian Society for Parenteral and Enteral Nutrition (ISPEN) is being jointly organised by ISPEN Delhi Chapter and CRNSS. The Scientific Programme of the Conference will cover frontier areas in the field of clinical nutrition, especially parenteral and enteral nutrition, equipping us with the latest information to launch us into the next millennium. You are requested to register early to make this conference a grand success.

For a copy of the First Announcement and inquiries, contact:

Dr Sarath Gopalan or Ms Shailee Saran
Centre for Research on Nutrition Support Systems (CRNSS)
Nutrition Foundation of India
Building C-13,
Qutab Institutional Area,
New Delhi 110 016
Tel: 91-11-6857814, 6962615
Email crnss@hotmail.com, or nfi@ren02.nic.in