16
Clinical applications of 20% fat emulsions

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In 1976 fat emulsion for intravenous therapy was reintroduced in the United States. This new formulation, based on soybean oil, emulsified with egg yolk phospholipid and glycerol had a long history of safety in the European market. Although only the 10% emulsion was initially released in the United States, 20% emulsions were the preparation used predominantly in both Europe and Canada. During the late 1960s and early 1970s parenteral nutrition was developing in the United States based on hypertonic dextrose/amino acid solutions. The initial use of fat emulsions was for the treatment and prevention of essential fatty acid deficiencies. The need for a fat emulsion in a total parenteral nutrition regime had been demonstrated by the occurrence of essential fatty acid deficiency. This was expressed clinically by dermatitis, increased capillary permeability, alopecia, liver and kidney damage and thrombocytopenia. Biochemically it was manifested by depressed levels of linoleic and arachidonic acid in the phospholipid fraction along with increased levels of \( \Delta 5, 8, 11 \) eicosatrienoic acid. Although reports varied it appeared that between 2.5 and 20 g of linoleic acid per day are necessary to prevent an essential fatty acid deficiency. Prevention required the administration of between 4 and 8% of the total weekly calories as fat emulsions. Although a relatively large volume of literature exists to document the safety and efficacy of 10% fat emulsion, scant information is available on the utilization of 20% fat emulsion in the American literature. Both 10% and 20% fat emulsion are equally effective in treating or preventing essential fatty acid deficiency.

The use of lipids as an energy source has continued to expand in this country. It is in this area that a choice between 10% and 20% fat emulsion may be significant. Dextrose calories are significantly cheaper than lipid calories. Furthermore, the lack of substantial evidence that fat as a caloric source is significantly better than dextrose has reinforced this prejudice. Other problems have plagued the utilization of fat emulsions. Information
regarding exogenous energy utilization is at best incomplete. Hypertriglyceridaemia is frequently seen in stressed and septic patients as is hyperglycaemia. Holliday et al.\textsuperscript{2} suggested that fat emulsions may be detrimental in the septic patient. Furthermore, the appropriate ratio of dextrose/lipid calories in a dual energy system is unclear and the formulation of such a system is most difficult based on the present method of supplying fat emulsions. Few would consider discarding a portion of the product because of the expense nor would they ‘share’ portions of solutions among patients. There appears to be an increasing interest in many centres in basing protein and non-protein calories on metabolic need with solutions tailored to meet each patient’s requirement. Some modification in the method of supplying fat emulsions would be a significant benefit in this area.

In spite of potential problems, lipids offer significant advantages in a nutritional support system. Fat emulsions’ principal advantages are:

(1) High caloric content, from 1.1 to 2.0 kcal/ml based on the emulsion used.

(2) Isotonicity – osmolalities from 280 to 330 mOsmol based on the preparation supplied.

(3) The availability of essential fatty acids necessary for the treatment and prevention of essential fatty acid deficiency.

20% fat emulsion’s principal value is that it remains isotonic while delivering a richer caloric load per ml than 10% fat emulsions. 20% fat emulsion should allow the prescribing physician greater flexibility in formulating a dual energy nutrition support system while maintaining isotonicity and essential fatty acid requirements. The main chemical difference between the solutions is in the amount of emulsifying agent, egg yolk phospholipid. Essentially, per unit dose, 20% has twice the concentration of triglycerides and half the concentration of phospholipid as compared to 10%. The clearance and metabolism of the 20% solution is essentially the same as with the 10% solution. In adults, the methods for administration are similar with the same initial precautions. Adverse reactions are rare and are no different than the reported side-effects from the 10% solution. This difference is most apparent in the fluid-restricted patient, where fluid volume is critical. The paediatric or neonatal patient, the patient with either renal or cardiovascular compromise, or the critically ill patient with multiple system failure are the most obvious examples. In each of these areas successful therapy with fat emulsion has been reported. However, for any given nutritional support service to switch to 20% fat emulsions as the primary fat emulsion must involve cost comparison. It would be difficult to justify, in this time of cost containment, the substitution of 1 unit of 20% lipid for 2 units of 10% lipid unless the price of the 20% emulsion was equal to or less than 2 units of 10% emulsion.