

## Review Article

# Long-term parenteral nutrition in pediatrics

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**ABSTRACT:** *In the last 3 decades, parenteral nutrition in pediatric patients has been used increasingly in specialized centers as the treatment for intestinal failure, which is common to a wide spectrum of intestinal diseases. Home parenteral nutrition is now recognized as the best option to improve the quality of life of children with intestinal failure who depend on long-term parenteral nutrition, as well as that of their families. A major advance in the area of pediatric home parenteral nutrition in Europe has been the recent publication of guidelines on pediatric parenteral nutrition (including home parenteral nutrition) by a group of expert pediatricians.*

*Another progress in the area of home parenteral nutrition in children is our improved knowledge of the prognosis of these children according to the indication for parenteral nutrition, i.e., according to the underlying digestive disease.*

*Studies performed in expert centers have shown that the outcome and survival of children on home parenteral nutrition are largely dependent on the underlying diagnosis. Children who depend on long-term parenteral nutrition should therefore be referred to comprehensive centers involved in all stages of intestinal failure management. (Nutritional Therapy & Metabolism 2007; 25: 12-5)*

**KEY WORDS:** *Guidelines on pediatric parenteral nutrition, Intestinal failure, Short bowel syndrome*

Over the last 3 decades, pediatric parenteral nutrition (PN) has developed rapidly in specialized centers (1-4) as the treatment of choice for intestinal failure, which is common to a wide spectrum of intestinal diseases (5).

Home PN (HPN) is now recognized as the best option to improve the quality of life of children with intestinal failure who depend on long-term PN, as well as that of their families (6). In addition, HPN reduces the cost of such long-term management (7). Advances in vascular access and nutrient formulas have allowed to decrease the morbidity and mortality associated with long-term PN and have extended the indications in which HPN is considered beneficial.

A major advance in the area of pediatric HPN in Europe has been the recent definition and publication of guidelines on pediatric PN including HPN by a group of expert pediatricians under the auspices of the European Society of Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the European Society for Clinical Nutrition and Metabolism (ESPEN) (8). The

main conclusions and recommendations concerning HPN are the following:

- All children who depend on long-term PN should be discharged on HPN, if familial criteria are fulfilled;
- Parents should undergo a structured teaching and training program, conducted by a nurse from the HPN center's nutrition support team;
- Parents' skills and knowledge should be checked prior to home discharge;
- Community health professionals and staff from the local hospital should be involved in all aspects of discharge planning and subsequent shared care;
- Single-lumen catheters should not routinely be used for blood sampling. However, to reduce stress and trauma to the child, blood sampling from single-lumen catheters may be considered when connecting or disconnecting PN on an individual basis;
- Flow control should be provided by a pump with free flow prevention, air alarm, occlusion alarm and lockable settings;
- HPN delivery should be cyclic. A progressive increase

and decrease in the infusion rate should be considered to avoid hypo- and hyperglycemia;

- Filters should be used to avoid the risk of precipitates and particulates;
- The patient should be on a stable regime before starting HPN;
- Standard PN mixtures are usually not suitable for long-term PN in infants and children. Therefore, PN solutions providing macro- and micronutrients for pediatric HPN should be compounded according to individual patients' needs;
- Centers caring for infants and children on HPN must have adequate expertise and resources, including multidisciplinary nutrition support teams trained and qualified to be responsible for use and prescription of HPN in children, and a 24-hour telephone hotline;
- Pediatric HPN patients must be followed up by an experienced team on a regular basis;
- The nutrition support team should provide nursing assistance and psychological assistance for children on HPN and their families.

The implementation of a nutrition support team (NST) which should include pediatricians and pediatric surgeons trained in nutrition and gastroenterology, a specialized nurse, a pharmacist, a dietician and a social worker, is a prerequisite for running an HPN program (9). The NST should propose a standardized method for ordering and monitoring HPN support. The use of "disease-specific pathways" is also recommended to organize the patient's clinical and biological follow-up and formal communication between the NST and the general practitioner (10).

Another advance in the area of pediatric HPN is our improved knowledge of prognosis according to the indication for HPN, i.e., according to the underlying digestive disease.

Over the past 15 years, intestinal transplantation (ITx) has also developed and ITx has become a viable alternative for about one third of HPN children in Europe (11). While combined ITx and liver transplantation is required for patients with end-stage liver failure, children with mild to moderate liver disease may recover normal liver function after an isolated ITx (11, 12). The timing of ITx and criteria for isolated ITx or combined intestinal and liver transplantation remain controversial (5, 11-13). Survival and quality of life after ITx should be compared to survival and quality of life of well-managed chronic patients on HPN (6, 14). Therefore, to help specialized pediatricians with proper patient referral, the morbidity and mortality risks of long-term (H)PN according to the underlying disease need to be assessed.

In the past years there have been several studies of children on HPN (1-4, 15-17), some of which focused

on the comparison of outcomes between subgroups of children with different diagnoses (16, 17). All studies show that short bowel syndrome (SBS) due to neonatal causes accounts for almost half of all indications for HPN, the other main causes of intestinal failure being motility disorders and intractable diarrhea due to congenital enteropathy (16, 17).

The 89% probability of survival after 5 years described in a recent French study on 302 children enrolled in a HPN program was high, despite the enrollment of children with primary nondigestive diseases including immune deficiency syndrome and cancer (17). Although the mortality rate was as high as 16% in the whole cohort, it was only 9% in children with primary digestive diseases and 7% in children with SBS (17), very close to the data provided by a recent Italian multicenter study (16). In both studies, the highest mortality rate was in children with intractable diarrhea due to congenital enteropathy. In the French study, patients with immune deficiency syndrome and other forms of primary nondigestive diseases had a 38% mortality rate with a much lower probability of survival as compared to patients with primary digestive diseases (17).

Likewise, the duration of HPN varied according to the primary diagnosis. Weaning off HPN and resuming full enteral autonomy is most likely in children who survive primary nondigestive disease and those with inflammatory bowel disease. As many as 54% of the French patients were weaned off HPN; this recovery rate was 25% higher than that reported by the same team 16 years previously (2), and 65% of SBS children who survived were weaned off HPN. In the Italian study, 42% of the patients were weaned off HPN and only 40% of SBS children adapted, but this lower rate might be attributed to the shorter study period, 5 years (16). In SBS patients, PN weaning was shown to depend on remnant small bowel length and on the presence of an intact ileocecal valve (15, 17, 18).

Complications have a serious impact on the quality of the children's and their families' lives and on health-care costs. A recent Italian study calculated an overall rate of HPN complications of 0.8/patient-year, of which 78% were catheter-related complications (19). About 20% of the complications leading to rehospitalization in HPN children are due to catheter-related bloodstream infections (CRBSI) (17, 19), but the incidence of CRBSI varies from one study to another (20). In the French series (17), the mean annual number of hospitalizations per patient, fewer than 3 per year, was similar to that reported in the United States (21). PN-associated liver failure is another potentially life-threatening complication frequently described in children, with risk factors related to both digestive disease and PN itself (22). In 2

recent studies using biological criteria to define hepatocellular injury and cholestasis, "liver disease" was described in about 15% to 20% of HPN children with primary digestive diseases (17, 19). The so-called prevalence of PN-associated liver disease depends in part on the criteria used, since doctors are reluctant to perform serial liver biopsies in pediatric patients. In the French series, the highest rate of liver dysfunction was in children with intractable diarrhea of infancy (48%); PN-associated liver disease appeared to be a significant risk factor for mortality, while the mortality due to liver dysfunction (2% in children with primary digestive disease, 2% in SBS children) and the rate of liver transplantation (2%) were low (17).

Amongst 68 French children on HPN on January 1, 2000, 60% had been on HPN for more than 4 years, and 40% for more than 8 years. As many as 28% of these children seemed likely to require lifelong HPN because of severe and irreversible intestinal failure and are therefore potential candidates for ITx. This rate is very close to the 34% pediatric candidacy for ITx recently reported by Pironi et al in an European multicenter survey (11).

In conclusion, major progress has been made recent-

ly in the area of pediatric HPN. Expert teams have provided evidence-based guidelines which help to upgrade the management of children on HPN. Studies performed by expert centers have shown that the outcome and survival of children on HPN depend mainly on the underlying diagnosis. They also suggest that life-threatening complications of long-term PN and thus the number of intestinal and liver transplantations which result directly from these complications can be dramatically decreased with early appropriate management. Therefore, children who depend on long-term PN should be referred to integrated centers involved in all stages of intestinal failure management, from non-transplant neonatal digestive surgery to intestinal transplantation in some cases.

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