Nutritional Support outside the Hospital: Home Parenteral Nutrition (HPN) in Adult Patients

Module 19.6

Metabolic Complications of Home Parenteral Nutrition in Chronic Intestinal Failure

Bernard Messing
Francisca Joly

Learning Objectives

• Learn about identifying the main metabolic HPN complications in adult patients;
• Learn how to prevent and cure these complications.

Contents

1. Introduction
2. Fluid and electrolytes
3. Overall complications and hyperglycemia
4. Intestinal consequences of HPN
5. Micronutrient deficiencies
6. Trace element excess
7. HPN associated liver disease (HPNALD)
8. Gallbladder sludge and lithiasis
9. Renal function impairment
10. Metabolic bone disease
11. Summary

Key Messages

• HPN metabolic complications are still frequent but they can be significantly decreased through present knowledge, expertise and continued attention;
• Most of metabolic complications are multifactoral and interrelated;
• Nutrition support team, education and a Complete, but non exclusive, HPN adapted to the type of CIF is able to lower the rate of metabolic complications;
• Further understanding is needed especially in renal, bone and liver HPN associated complications to ameliorate preventive and curative treatments.
1. Introduction

Long-term HPN metabolic complications will be identified in order to assure prevention and curative treatments. Will be reviewed, liver, gallbladder, bone, renal associated HPN complications as well as vitamin deficiencies and trace metals deficiencies or toxicity (Fig. 1). Psychosocial issues will not be reviewed. Hyperglycemia, fluid and electrolytes disturbances and gastrointestinal HPN effects will be briefly quoted: readers will be informed with these matters on recent reviews (1 - 5). Monitoring for complications is indicated on table according to the A.S.P.E.N. (1).

<table>
<thead>
<tr>
<th>Metabolic complications of HPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver abnormalities</td>
</tr>
<tr>
<td>Gallbladder sludge &amp; stones</td>
</tr>
<tr>
<td>Metabolic bone disease</td>
</tr>
<tr>
<td>Trace element deficiencies</td>
</tr>
<tr>
<td>Vitamin deficiencies</td>
</tr>
<tr>
<td>Manganese toxicity</td>
</tr>
<tr>
<td>Renal function impairment</td>
</tr>
</tbody>
</table>

Fig. 1  B Messing. Approved centre for intestinal failure. Paris
1 title, 6 sub titles, 25 materials + 4 additional

Table 1 Practice Guidelines (A.S.P.E.N.): Monitoring for Complications

<table>
<thead>
<tr>
<th>Statement</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malnourished patients at risk for refeeding syndrome should have serum phosphorus, magnesium, potassium and glucose levels monitored closely at initiation of SNS</td>
<td>B</td>
</tr>
<tr>
<td>In patients with diabetes or risk factors for glucose intolerance, SNS should be initiated with a low dextrose infusion rate and blood and urine glucose monitored closely</td>
<td>C</td>
</tr>
<tr>
<td>Blood glucose should be monitored frequently upon initiation of SNS, after any change in insulin dose, and until measurements are stable</td>
<td>B</td>
</tr>
<tr>
<td>Serum electrolytes (sodium, potassium, chloride, and bicarbonate) should be monitored frequently upon initiation of SNS until measurements are stable</td>
<td>B</td>
</tr>
<tr>
<td>Patients receiving intravenous fat emulsion should have serum triglyceride levels monitored until stable and when changes are made in the amount of fat administered</td>
<td>C</td>
</tr>
<tr>
<td>Liver function tests should be monitored periodically in patients receiving PN</td>
<td>A</td>
</tr>
<tr>
<td>Bone densitometry should be performed upon initiation of long-term SNS and periodically thereafter</td>
<td>C</td>
</tr>
</tbody>
</table>

The authors used the AHRQ criteria to classify the strength of the evidence supporting each guideline statement.

The evidence supporting each statement is classified as follows:
A - There is good research-based evidence to support the guideline (prospective, randomized trials)
B - There is fair research-based evidence to support the guideline (well-designed studies without randomization)
C - The guideline is based on expert opinion and editorial consensus

Nutrition Support Team is required for HPN (see chapter on HPN nutrition support): it is important that patient, family and care giver as well as the general practitioner have had a good understanding of the “disease specific pathways” used in each case (1, 4). Monitoring has also to be adapted in timing for each patient. Using booklets and/or video tapes for educational purposes has the aim to get the patient’s participation to all aspects of care, and obtaining this goal reduces rate of complications (especially but not only catheter related) and improves quality of care, quality of life and economic outcomes (6, 10).
2. Fluid and electrolytes

Digestive balances of water/Na, especially for short bowel patients (SBS) type I with a high output stoma output, had to be carried on to evaluate needs (see corresponding chapter in Leonardo). Hydration should be enough to produce a urine output of more than 1L/d. Input, output records should be look at by patients during establishing initial balance and during attempt of weaning off HPN (3). Chronic fatigue can be caused by chronic dehydration, hypokalemia, hypomagnesemia, the latter inducing refractory hypokaliemia. Hypernatremia can be caused by poor control of oral fluid intake with dehydration, excess loss of hypoosmotic water through post duodenal remnant shorter than 1m (see the ESPEN chapter on SBS).

It is also important to measure enterostomy - or high output fistulae - to know if there is discrepancy between expected output and observed output because such a gap should prompt to search for causes of excessive enteric losses well described in a recent review (3). Refeeding syndrome (pseudo hyperthyroidism with hypophosphatemia and cardio pulmonary insufficiency) is beyond the scope of this review (1, 11, 12) mainly because HPN is usually conducted in “stable” patients after adjustment of PN requirements and when cyclic PN is feasible. Indeed cyclic PN is contraindicated in severely malnourished patients as well as in non controlled cardiac patients.

3. Overall complications and hyperglycemia

In a recent meta analysis, it has been shown that infectious complications, in clinical practice, are more frequent during PN than during enteral tube feeding nutrition (EN) (0.66; 95 confidence interval (CI) = 0.56, 0.79) independently of whether catheter sepsis was included in the analysis, (13) Interestingly, the non infectious complications were found higher in EN (RR = 1.36; 95CI: 0.96, 1.83) than in PN. The higher risk of infection (Catheter and non catheter related) during PN may be partially explained by a higher incidence of hyperglycemia (4).

Then tight glucose control (14) might be a goal to achieve to decrease overall infectious complications during HPN, as demonstrated in the ICU setting (15). In our experience (personal unpublished data), glycemic control is easier to achieve in our HPN diabetes patients with fast insulin into the nutritive mixture (1 U/10 g of dextrose) than with usual SC insulin injections.

In any case, do not forget to use programmable pumps for appropriate down rates at the end of the cyclic nocturnal PN infusion to avoid rebound hypoglycemia. (6) The latter complication can be observed, even with down rates of infusions, when cyclic follows several weeks of continuous PN infusions. To avoid this problem, transition between continuous and cyclic should be made in one week; i.e., minus 2 h infusion per day from 24 h to 10 h of PN infusion.

4. Intestinal consequences of HPN

They are more related to CIF causes than to HPN perse. Changes following SBS had been reviewed elsewhere (see ESPEN Book to be published 2005). Bacterial translocation in humans has not been related to bowel rest only but to either gut occlusion or pseudo obstruction (4, 16). These patients benefit from sequential antibiotic treatment to decrease intestinal bacterial overgrowth. Contrary to most animal models, exclusive TPN, i.e., bowel rest, is associated neither with mucosal atrophy nor with intestinal immune dysfunction assessed through intestinal immunoglobulins (4).
5. Micronutrient deficiencies

They were recognised in the early years of long term HPN. Regular provision through commercial parenteral vitamin and trace metal preparations avoid these deficiencies (Zn, Cu, B1, B6, B12…) (Fig. 2), since these preparations brings 1.5 to 2 fold AMA IV allowances (3). Danger exists if there is a shortage of provision (check list of complete PN) or when patients went off HPN. When less than 5 cycles per week are used it is advisable to double vitamin preparation in each cycle.

Important fat malabsorption is almost constantly associated with ADEK deficiencies (3) (Fig. 3) and then appropriate oral supplements should be used. Fe deficiency developed in 36% of patients due to occult blood loss (18). In specific diseases leading to CIF, oral supplements are insufficient and parenteral supplements should be used, e.g. Vitamin E in chronic pseudo obstruction syndrome, especially with significant fat calorie intake (19).

In our experience, Cu deficiency may follow severe protein loosing enteropathy (extensive villous atrophy diseases or Waldman disease).

Vitamins C, PP, B and other (Fig. 3, Fig. 4) may not be optimal with current allowances if HPN dependence is at its highest level, i.e., during periods of exclusive HPN. EFA deficiency on the n-6 series is frequently seen even with sufficient intake of usual fat emulsions (19, 20) implying perhaps larger use of fat emulsions enriched in the n-6 series at least in diseases having a propensity to inflammation. Blood testing of micronutrients should be limited to 2 to 3 times/year in stable long term patients (3).

The following rule should be kept in mind: a deficit in micronutrient is rarely single and excess(s) can be present with deficiencies masking each other.

---

**TRACE-METAL DEFICIENCIES during (H)PN**

<table>
<thead>
<tr>
<th>Element</th>
<th>Deficiency / Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Se</td>
<td>Cardiomyopathy / Heart Failure</td>
</tr>
<tr>
<td>Cr</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Mo</td>
<td>Coma, ? Met, Uric acid Neuromyelopathy</td>
</tr>
<tr>
<td>Cu</td>
<td>Aplastic anemia ± mild leucopenia</td>
</tr>
<tr>
<td>Zn</td>
<td>Acrodermatitis, diabetes, hair loss, - NB</td>
</tr>
<tr>
<td>I</td>
<td>Goitre (nil po)</td>
</tr>
<tr>
<td>Fe</td>
<td>Liver thesaurismosis, perls Perls, ferritine</td>
</tr>
<tr>
<td>Al*</td>
<td>Porotic ±painful osteopathy blood, Ur</td>
</tr>
<tr>
<td>Mn*</td>
<td>Extrapyramidal syndrome Blood &amp; MRI</td>
</tr>
</tbody>
</table>

---

**Vitamin deficiencies during (H)PN**

<table>
<thead>
<tr>
<th>Deficiency</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Night blindness, xerophamma, dark field adaptation, defective bone mineralization</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>In vitro plated hyper-aggregation and H2O2 - induced RBC hemolysis. Signs and symptoms suggestive of subacute combined degeneration (postero-lateral columns) in the presence of normal B12, ophthalmoplegia</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Osteomalacia</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Bleeding tendencies, defective II, VII, IX, XII Bone mineralization (Gla proteins)</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Scurvy, bleeding sore gums, peri joint and bone hemorrhages</td>
</tr>
</tbody>
</table>

---

**Vitamin deficiencies during (H)PN**

<table>
<thead>
<tr>
<th>Deficiency</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1, Thiamine</td>
<td>Wermicke's encephalopathy, Cardiomyopathy, Refractory lactic acidosis</td>
</tr>
<tr>
<td>Folique (B9)</td>
<td>Megaloblastic anemia ± cytopenia</td>
</tr>
<tr>
<td>B12</td>
<td>Irritability, megaloblastic anemia, Cordonal posterior syndrome</td>
</tr>
<tr>
<td>PP, Niacin,</td>
<td>Dermatosis (pellagra), Diarrhea, Dementia</td>
</tr>
<tr>
<td>B6</td>
<td>Sideroblastic anemia, Convulsions</td>
</tr>
<tr>
<td>B2</td>
<td>Cheilosis, red swollen tongue, folliculitis</td>
</tr>
<tr>
<td>Biotin</td>
<td>Dermatitis, alopecia, hypotonia in 1 child</td>
</tr>
</tbody>
</table>

---

*Fig. 2* Excess and toxicity (chronic dehydration, renal insufficiency, cholestasis). (Chonic Zn deficit : altered growth in children with nanism) BM 0095

*Fig. 3* BM 0096

*Fig. 4* BM 0097
6. Trace element excess

Greater than needed micronutrients have a harmful effect, meaning apparent paradoxical propensity to increased peroxydation (21, 22). Thus, large doses of micronutrients should not be used routinely. Zn and Fe had been demonstrated to increase acute phase reaction response and should not be given during period of sepsis or inflammation, having the capability to aggravate both (22, 23). In chronic cholestasis, trace metals (Cu and Mg) may accumulate in the liver due to decreased choleresis: then decreasing or stopping that input is recommended (3).

Excess Mn accumulates in basal ganglia and can be responsible for parkinsonian-like symptoms in HPN patients (3, 24, 25). Reduction of Mn supply is followed by lengthy disappearance of abnormal (Hyper signal in weighed T1) magnetic resonance brain imaging (3). (Fig. 5)

Al IV load was, in the past, higher than safe IV input (26): quality of glasses and interaction between glasses and trace metals, phosphorus or amino acids solutions to store these IV nutrients had been implicated in this thesaurismose (27). It is rarely seen at present times but patients with renal insufficiency are at risk. Al accumulates in brain, bone and liver where harmful effects had been demonstrated (26) especially in children (28) in which impairment of cognitive function had been reported (29).

7. HPN associated liver disease (HPNALD)

Comprehensive reviews had been recently published (2, 5, 30) including the one in the ESPEN HPN Book (to be published 2005). HPNALD led in the past two decades to liver failure in one every 5 adult patients on long-term HPN (31) being then responsible for either death or being put on a waiting list for combined liver-intestine transplantation (32). Prevention of HPNALD is therefore of crucial importance from the first PN days, and the first PN regimen months have to be managed carefully in order to avoid chronic cholestasis; i.e., ≥ to 6-month duration. These facts plaid for management of these patients in centres expert in the whole spectrum of Intestinal failure therapy (32).

Elemental liver lesions during HPN

Macrovacuolar steatosis
Portal inflammation
Ductular proliferation
Hepatocyte necrosis
Microvacuolar steatosis
Macrophage proliferation

Extensive fibrosis

25% Cirrhosis 50%
Glucose based Lipid based

Fig. 6
After 2 years of HPN, glucose based-HPN was associated with macrovacuolar steato-hepatitis and severe liver disease in less than 25% of patients (34) whereas lipid based-HPN, i.e., ternary mixtures including standard LCT emulsions of more than 1 g/Kg/d, was associated with portal inflammation, ductular abnormalities, microvacuolar steatosis and cholestatic severe liver disease in 50% of patients (33) (Fig. 6). When liver function tests became abnormal, timing of occurrence of extensive fibrosis and liver failure can be accelerated within several months if high degree of PN dependence is maintained, i.e., poor oral intake and ongoing IV hyperalimentation (35, 36).

In HPN patients, jaundice with increased conjugated and unconjugated bilirubin, splenomegaly and thrombocytopenia, can be significantly associated with noticeable sea-blue histiocytes (activated macrophages CD 68+) infiltration of bone marrow without hemophagocytosis (37). This latter fate traduces accumulation of polyunsatured-fat (PUFA), coming from too high long term standard lipid delivery through ternary mixtures, in the reticulo-endothelial cells (35, 37). Microvacuolar steatosis, phospholipidosis (38), accumulation of phospholipids, polyunsaturated triacyl glycerol within hepatocytes and hyperplasia of macrophages, i.e., Kupffer cells in and around sinusoids or in or around portal areas (38, 39) need special staining to be revealed (Oil red O and Otan Baker+), and are especially seen when ternary nutritive mixtures are used. This fate explained why microsteatosis was not described with the use of IV fat infusions whereas hepatocyte macrosteatosis was easily demonstrated, e.g. with high glucose infusions.

### (Long-term) HPN Associated liver disease: Main physiopathological components*

<table>
<thead>
<tr>
<th>Chronic Cholestasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN-dependent</td>
</tr>
<tr>
<td>LCT (w6) emulsion:</td>
</tr>
<tr>
<td>hepatocytes/ macrophages</td>
</tr>
<tr>
<td>Macrophages (Kupffer):</td>
</tr>
<tr>
<td>decreased bacterial clearance</td>
</tr>
<tr>
<td>Deficit in tauro-Conjugates BS</td>
</tr>
<tr>
<td>Patient-dependent</td>
</tr>
<tr>
<td>Excluded segment(s),</td>
</tr>
<tr>
<td>bacterial translocation</td>
</tr>
<tr>
<td>sepsis</td>
</tr>
<tr>
<td>Very short bowel/no ileum</td>
</tr>
</tbody>
</table>

**extensive fibrosis, cirrhosis**

Fig. 7  
*Hypernutrition per se and through imbalance between pro & antioxidants promoting peroxidation of various substrates, notably IV lipids. * BS = Biliary salts

### PN « TOXICITY » AND HEPATOPATHY

<table>
<thead>
<tr>
<th>? EXCESS OF</th>
<th>? DEFICIENCY IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Vit. A*</td>
<td>• Selenium</td>
</tr>
<tr>
<td>• Cu.</td>
<td>• Vit. E*</td>
</tr>
<tr>
<td>• Fe*</td>
<td>• Sulfur AA (glutathion).</td>
</tr>
<tr>
<td>• Mn.</td>
<td>• Carnitine</td>
</tr>
<tr>
<td>• Alu*</td>
<td>• Choline*</td>
</tr>
</tbody>
</table>

- Phospholipids*
- P.U.F.A (soya)*
- Other micronutrients...

Fig. 8  
* Strong arguments for implication

### (Long-term) HPN Associated liver disease

- **Best treatment**: prevention through adapted IV
  - « no hyperalimentation » with sufficient micronutrients
  - if « normonutrition », no more than 33% of energy as lipids
  - IV soya lipids: Less than 1g / Kg /d (20 or 30%)
  - IV Soya lipids = MCT/LCT. Structured : ? Olive oil : =
  - supplement PUFA with α-tocopherol (oral + IV)

- **Treat « contributive » patient’s covariables**
  - encourage enteral feeding as much as possible
  - avoid or treat sepsis
  - treat bacterial overgrowth
  - nourish excluded segments especially colon (SCFA)
  - decrease or stop some of the trace metals if cholestasis

- **Curative**: Ursodeoxycholate; hope with methyl donors / taurine enriched AA

Fig. 9
Pathogenesis of HPNALD, yet not fully understood, is intricate and multifactorial (see HPN ESPEN book, to be published 2005).

Are involved:
(a) patient-dependent factors, especially very short-bowel syndrome and an excluded colon and
(b) nutrition factors, especially “intravenous hyperalimentation” or high soya rich PUFA triglycerides emulsion (more than 1 g/Kg/d) even without hyperalimentation (33). New lipids emulsions might be better tolerated (40) (Fig. 7).

Deficiency (Se, Vitamin E & C, choline, taurine...) and or excess (amino acids, Fe, Mn, Al, Vitamin A, phytosterols...) of nutrients may also contribute to liver disease during HPN (Fig. 8).

It is clear from clinical observation that more than one factor is, most of the time, needed to provoke this complication, suggesting a second hit physiopathology notably through sepsis – whatever the origin- or intestinal bacterial translocation.

A schematic view of physiopathology is presented on (Fig. 7). Based upon this knowledge, preventive and curative treatments are summarised on (Fig. 9).

8. Gallbladder sludge and lithiasis

A schematic view of physiopathology is presented on. (Fig. 10) Comprehensive reviews had been recently published (3, 41).

Lack of enteral intake during exclusive HPN induces gallbladder stasis which is the main factor inducing gallbladder sludge (calcium bilirubinate and cholesterol crystals). The latter can disappear upon enteral CCK stimulation, or - if the causative factor persists - evolve to lithiasis in weeks to months (42) (Fig. 11). Too long bowel rest with surgery is similarly a sludge provocation factor (3, 41).

In large series of long-term HPN patients, biliary lithiasis and/or sludge is observed during HPN in one third of patients and biliary complication rate (acute cholecystitis, angiocholitis, acute
pancreatitis) occurred in 50% to 12% of positive patients (43, 44) (Fig. 12).

In early days, because high rate of morbidity / mortality was associated with biliary complications, a prophylactic cholecystectomy was recommended (43). Today, complications and their morbidity implicating that cholecystectomy, at the time of the initial surgery, is not warranted if the gallbladder is healthy (3, 44).

9. Renal function impairment

Serious progressive renal impairment may occur on long years in HPN patients (2, 45). Largely unexplained decline in the creatinine clearance was greater than the one seen in controls (45) (Fig. 13). Nephrotoxic drugs, bacteriemia / fungemia, high load in amino acid solution(s) explained 50% of the yearly 3.5% creatinine clearance decline in 33 adult patients followed up during a median of 8 years (Fig. 14).

Mineral water imbalances, chronic dehydration (diuresis should be more than 1 L/d), trace metal depots, hyperoxaluria and or nephrolithisis (up to 25% in type II and III SBS patients; i.e., those with large steatorrhea and presence of at least part of the colon in continuity) may contribute to the problem (3, 46).

It is interesting to note that one experimental study has suggested that arginine deficiency was the cause of focal tubulointerstitial fibrosis in the kidney after massive small bowel resection in rats (47). The same group, reported a single case of a SBS boy, 3 yr old on HPN, who received GH supplementation between 11 and 17 years and who had, at 20 years old, hyperuricemia and renal focal tubulointerstitial fibrosis (48). Huge orotic aciduria and significant decreases in uric acid and urea excretion had been described after few days on arginine free diet in four SBS patients (49).

These studies may have opened a window to a new metabolic complication. Indeed hypoargininemia can be seen in HPN SBS patients despite a normal oral diet including more with more than 5 g/d of oral arginine (50).
10. Metabolic bone disease

Recent reviews have addressed this problem (2, 3). Only recently was studied, in two large cross sectional studies, the prevalence of low bone mineral density, \textit{a priori} designed to make a diagnosis of osteoporosis (< to 2.5 DS in T score, with comparison to sex paired peak bone Ca) (51, 52) (Fig. 15). Osteoporosis was diagnosed in 41% and 67% of patients, bone pain in one third and fractures in 10% (51, 52). Same authors looked at the evolution of bone mineral density with DEXA during HPN of 1.5 and 5.5 years duration respectively, in more than 50 patients each, showing, with no specific treatment, a modest but significant increase in lumbar spine (trabecular bone) and no significant change in the femoral neck (cortical bone of lower rate of remodelling than trabecular bone) (52, 53).

Thus, it can be suggested that HPN, in expert centres is not a causative factor for osteoporosis, but that low bone mineral density may either predate HPN in chronic intestinal diseases or be aggravated during the stormy period of acute intestinal failure with associated sepsis, inflammation and immobilisation (5, 52, 55). Bone loss has not been addressed in this latter PN condition.

Another caveat is that osteomalacia, a frequent fate in chronic malabsorptive diseases, is a cofounder of the mere presence of osteoporosis because its low rate of Ca deposit in the increased osteoid.

Establishing a normal vitamin D status is therefore of primary importance and a prerequisite before discussing specific treatment for osteoporosis (56, 57). Indeed, treatment of osteomalacia may enhance abruptly and dramatically the bone mineral content (58), more than modern treatments of osteoporosis with biphosphonates, natural GLP2 or recombinant low doses of PTH (59-62).

In addition, IV biphosphonates bring a higher risk, in CIF malabsorptive patients, of hypophophatemia and hypocalcemia (61) meaning again optimal minerals and vitamin D status when prescribing such a treatment (Fig. 16).

Low BMI (51, 52) disease requiring corticosteroids (52) were found associated significantly with osteoporosis.
Younger age of CIF occurrence, before acquisition of the bone peak, brings higher risk for osteoporosis (52) (Fig. 17).

High HPN input in amino acids induced negative Ca balance through metabolic acidosis, a fact that can be negated with acetate infusion (2, 57). IV Ca should not be too important, given its negative feed back on PTH, a positive factor on bone remodelling. Hypocalcemia has a negative effect on bone through hyperparathyroidism (56).

Many other factors modulate bone remodeling including vitamin K through Gla proteins (63). Finally, low remodeling bone disease associated with HPN, is a poorly understood multifactorial metabolic disease (64). Based upon present knowledge, preventive and curative treatments are summarised on slide (Fig. 18).

11. Summary
- HPN metabolic complications are still frequent but they can be significantly decreased through present knowledge, expertise and continued attention.
- Most of metabolic complications are multifactorial and interrelated.
- Nutrition support team, education and a Complete, but non exclusive, HPN adapted to the type of CIF is able to lower the rate of metabolic complications.
- Further understanding is needed especially in renal, bone and liver HPN associated complications to ameliorate preventive and curative treatments.

Metabolic bone disease & LT-HPN

• Osteomalacia :
  - Check vit D metabolites & Ca, P and Mg balance
• Low remodeling bone :
  - ibid & reinforces Ca, Mg, Vit D metabolites orally
  - Avoid too much N & Ca IV (calciuria & lower PTH)
  - Check Al in Blood & in All-in-One (& in renal risk patients ++)
  - Check DEXA & BMD at PN start & annually
  - Check bone markers : osteocalcin & cross laps/deoxypyridinoline
• Specific treatments of osteoporosis :
  - Biphoshonates ° : positive moderate results at lumbar site, be careful with Ca & vit D status before treatment to avoid deficits
  - Near future : trophic factors (GLP2*) or rH-PTH**

To illustrate the results, we chose 3 ages equally spaced within the age-range of our patients, and we calculated the evolution, using the regression equation. As the duration of treatment decreased linearly with age, we did not extrapolate the evolution above the duration of follow-up. The negative evolution under HPN in young patients became positive with aging, and the change was reversed when the patients reached the age of 21. Similar evolutions were observed among patients with osteoporosis. However their Z-Scores were much lower (all values were reduced by 1.1 SD).

References
1. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. JPEN J Parenter Enteral Nutr 2002;26:1SA-138SA.