Nutrition Support in Children

Lyon
21 sept 2013
Malnutrition: why detecting it in children?

- Alters cognitive development (observational or interventional studies)
- Responsible for prolongation of hospitalisation (45%), aggravates causal disease, increases the rate of complication and increases the cost of hospitalisation
- In France, taken care of in only 1/3 of cases.

Hankard et al, 2013
Malnutrition:
what impact on children diseases?

• No current data on the impact of malnutrition on children diseases
• No widely acknowledged criteria of malnutrition in children

Hankard et al, 2013
Physiopathology

**MARASMUS**

Balanced proteino-energetic malnutrition
Physiologic adaptation

**KWASHIORKOR**

Protein deficiency
Metabolic stress

Notice Edema®
### Mechanisms

<table>
<thead>
<tr>
<th>Insufficient intake</th>
<th>Excessive Losses</th>
<th>Hypermetabolism &amp; Hypercatabolism</th>
<th>Insufficient intake + Hypermetabolism + Hypercatabolism</th>
</tr>
</thead>
<tbody>
<tr>
<td>famine</td>
<td>IBD</td>
<td>severe infections</td>
<td>agression</td>
</tr>
<tr>
<td>anorexia</td>
<td>intestinal resection</td>
<td>inflammation</td>
<td>infectious diseases</td>
</tr>
<tr>
<td>hunger strike</td>
<td>digestive fistula</td>
<td>polytraumatism</td>
<td>organ failure</td>
</tr>
<tr>
<td>depression</td>
<td>chronic diarrhea</td>
<td>head trauma</td>
<td>(cirrhosis, chronic bronchopathy ...)</td>
</tr>
<tr>
<td>handicap (no help for taking food)</td>
<td>nephrotic syndrome</td>
<td>major surgery</td>
<td>&amp; food insufficiency</td>
</tr>
<tr>
<td></td>
<td>unbalanced diabetes</td>
<td>neoplasia</td>
<td>(energy and/or proteins)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>acute pancreatitis</td>
<td></td>
</tr>
</tbody>
</table>
Measuring the nutritional status: BMI

- Recommended parameter.
- Identifies weight insufficiency when <3rd percentile for age and gender.
- Good correlation from 2 to 18 years with other indexes, such as Waterlow’s

Notice
- BMI < 3rd percentile: # weight insufficiency (occurs in 3% of the population and thus is not always a pathological situation)
- In contrast, decrease in BMI and weight may be abnormal even with BMI >3rd percentile
Waterlow index

• Historic index
• Ratio between actual weight and weight expected for height (W/WEH).
• Malnutrition: moderate when <80% and severe when <70%
• Must be interpreted according to growth
  –Acute malnutrition when Waterlow <80% and stunting
  –Chronic malnutrition when stunting
## Waterlow index

<table>
<thead>
<tr>
<th>Degree of PEM</th>
<th>Stunting (%) Height for age</th>
<th>Wasting (%) Weight for height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal: Grade 0</td>
<td>&gt;95%</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>Mild: Grade I</td>
<td>87.5-95%</td>
<td>80-90%</td>
</tr>
<tr>
<td>Moderate: Grade II</td>
<td>80-87.5%</td>
<td>70-80%</td>
</tr>
<tr>
<td>Severe: Grade III</td>
<td>&lt;80%</td>
<td>&lt;70%</td>
</tr>
</tbody>
</table>

SOURCE: "Classification and definition of protein-calorie malnutrition." by Waterlow, 1972
Quel est le rapport poids sur taille d’un garçon de 100 cm pesant 11 kg ?

1. 100 cm correspond à la taille moyenne d’un garçon de 4 ans

2. 16 kg est le poids moyen d’un garçon de 4 ans

3. \[
\frac{11}{16} = 69\% \text{ dénutrition avérée}
\]
Which growth curves to use?

- WHO reference curves (Brasil, USA, Ghana, India, Norway, Oman)

- Frequently, important discrepancies between WHO standards and national reference curves

- 4 - 6 months, WHO weight & height: higher
- 6 mo - 2 yr, WHO weight: lower
There is a frequent need for nutrition support
Nutrition Support

Oral
Enteral
Parenteral
Nutrition Support

Oral
Enteral
Parenteral
Oral Supplements

- Between meals
- Added to foods
- Added into liquids for medication

- Enhances otherwise poor intake
- May be needed by children or teens to support growth
Conditions that require Enteral and Parenteral nutrition support

• Enteral
  - Impaired ingestion
  - Inability to consume adequate nutrition orally
  - Impaired digestion, absorption, metabolism
  - Severe wasting or depressed growth

• Parenteral
  - Gastrointestinal incompetency
  - Hypermetabolic state with poor enteral tolerance or accessibility
# Conditions That Often Require Other Nutrition Support

<table>
<thead>
<tr>
<th>RECOMMENDED ROUTE OF FEEDING</th>
<th>CONDITION</th>
<th>TYPICAL DISORDERS</th>
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<tr>
<td>Enteral nutrition</td>
<td>Impaired nutrient ingestion</td>
<td>Neurologic disorders, HIV/AIDS, Facial trauma, Oral or esophageal trauma, Congenital anomalies, Respiratory failure, Cystic fibrosis, Traumatic brain injury, Hyperemesis of pregnancy, Hypermetabolic states such as with burns, Comatose states, Anorexia in congestive heart failure, cancer, COPD, ED, Congenital heart disease, Impaired intake after orofacial surgery or injury, Spinal cord injury</td>
</tr>
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*AIDS, acquired immunodeficiency syndrome; COPD, chronic obstructive pulmonary disease; ED, eating disorder; HIV, human immunodeficiency virus.*
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<td>Enteral nutrition</td>
<td>Impaired digestion, absorption, metabolism</td>
<td>Severe gastroparesis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inborn errors of metabolism</td>
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<tr>
<td></td>
<td></td>
<td>Crohn’s disease</td>
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<tr>
<td></td>
<td></td>
<td>Short bowel syndrome with minimal resection</td>
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<tr>
<td></td>
<td></td>
<td>Cystic fibrosis</td>
</tr>
<tr>
<td></td>
<td>Severe wasting or depressed growth</td>
<td>Failure to thrive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cancer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sepsis</td>
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<td></td>
<td></td>
<td>Cerebral palsy</td>
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<tr>
<td></td>
<td></td>
<td>Myasthenia gravis</td>
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<td>Parenteral nutrition</td>
<td>Gastrointestinal incompetency</td>
<td>Short bowel syndrome—major resection, Severe acute pancreatitis, Severe inflammatory bowel disease, Small bowel ischemia, Intestinal atresia, Severe liver failure, Major gastrointestinal surgery, Multiorgan system failure, Major trauma or burns, Bone marrow transplantation, Acute respiratory failure with ventilator dependency and gastrointestinal malfunction, Severe wasting in renal failure with dialysis, Small bowel transplantation, immediate postoperatively</td>
</tr>
<tr>
<td></td>
<td>Critical illness with poor enteral tolerance or accessibility</td>
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Nutrition Support

Oral
Enteral
Parenteral
Enteral Nutrition : definition

- Nutritional support via tube feeding through nose, esophagus, stomach, or intestine (duodenum or jejunum)
  - Needs functioning GI tract
  - Exhaust all oral diet methods first.

- USE THE GUT, IF IT WORKS
Enteral nutrition: advantages

- Provides nutrition when oral is not possible or adequate
- Intake easily/accurately monitored
- Costs less than parenteral nutrition, supplies readily available
- Preserves gut integrity and immunologic function
- Decreases likelihood of bacterial translocation
- Increases compliance with intake
Enteral nutrition: disadvantages

- Costs >> oral diets
- Less “palatable/normal”
- Assessment, administration, monitoring
- Tube patency, site care
Enteral nutrition

- Placement of tube
  - Gastric
  - Small bowel
- Duration of tube feeding
  - Nasogastric or naso-enteric tube for short term
  - Gastrostomy and jejunostomy tubes for long term
Enteral nutrition: tube placement

Location in accordance with
- Duration
- Adequacy of GI functioning access (medical status)

Check
- Tube measurements and durability
- Placement through radiographic confirmation
Enteral nutrition: questions

- Applicability?
- Site placement?
- Formula selection?
- Nutritional/medical requirements?
- Rate and method of delivery?
- Tolerance?
Enteral Nutrition: formula selection

Suitability of a feeding formula based on:

- Functional status of GI tract
- Digestion and absorption capability of patient
- Contribution of the feeding to fluid and electrolyte needs or restriction
- Specific metabolic needs

- Physical characteristics of formula (osmolality, fiber content, caloric density, viscosity)
- Macronutrient ratios
- Cost effectiveness
Enteral nutrition: physical properties of formulas

• Residue
• Viscosity
  - Size of tube is important
• Osmolality: consider protein source
  - Intact (do not affect osmolality) : soy isolates; sodium or calcium casein; lactalbumin
  - Hydrolyzed (more particles) : peptides or free amino acids
## Enteral Formula Categories

<table>
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<tr>
<th>Category</th>
<th>Description</th>
</tr>
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<tr>
<td>General purpose/intact</td>
<td>For use in patients with normal or minimally impaired digestion; absorption required; contains intact protein; can be instituted at full strength; low viscosity; 300-500 mOsm/kg; 1-1.2 kcal/ml; lactose free; 30-40 protein/L; inexpensive; also known as “house,” general, meal replacement.</td>
</tr>
<tr>
<td>Defined/hydrolyzed (monomeric)</td>
<td>For patients with GI compromise who require hydrolyzed nutrients for improved digestion; osmolality depends on hydrolysis; 1-1.2 kcal/ml; lactose free; 30-45 g protein/L; is more expensive than general purpose formula; also known as chemically defined, peptide-based, elemental formula.</td>
</tr>
<tr>
<td>Semielemental</td>
<td>For use in patients with limited GI function; contains free amino acids, minimal fat, and minimal residue; hyperosmolar; low viscosity; 1 kcal/ml, 40 g protein/L; expensive; also known as free amino acid formula.</td>
</tr>
<tr>
<td>Disease-specific</td>
<td>Designed for specific organ dysfunction or metabolic abnormality; may not be nutritionally complete; most are hyperosmolar; products specific for hepatic, renal, and pulmonary diseases, glucose intolerance, impaired immune function, and trauma (BCAA); expensive; available data should be evaluated carefully for efficacy and benefits.</td>
</tr>
<tr>
<td>Rehydration</td>
<td>For patients requiring an optimal ratio of simple carbohydrates to electrolytes for the purpose of maximizing fluid and electrolyte absorption and rehydration.</td>
</tr>
<tr>
<td>Modular</td>
<td>Formula providing protein, fat, or carbohydrate as single nutrients to alter the nutrient composition of commercial formulas or food; may also contribute electrolytes and increase osmotic or renal solute load; increase cost, require labor and safe mixing technique; also known as modular formula.</td>
</tr>
</tbody>
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Enteral Nutrition
Rate and method of delivery

Determined by medical status, feeding route and volume, and nutritional goals

- Bolus, rapidly delivered via syringe, several times daily
- Intermittent, 20 to 30 minutes, several times/day via gravity drip or syringe
- Cyclic, via pump usually at night
- Continuous, via gravity drip or infusion pump
Enteral nutrition: complications

- Access problems (tube migration, tube obstruction, increased risk of bacterial contamination, pneumothorax)
- Gastrointestinal (diarrhea)
- Metabolic (overhydration)
- Respiratory (aspiration): High-risk patients
  - Poor gag reflex
  - Depressed mental status
Enteral nutrition: bad tolerance

• Consciousness
• Hydration
• Nausea, gastro-esophageal reflux vomiting, diarrhea, abdominal distention, constipation, cramps
• Respiratory distress: aspiration
• Weight change
• Lactose/gluten intolerances
• Labs: Glucose fluctuations
Enteral nutrition
Reducing risk of aspiration

- Check gastric residuals if receiving gastric feeds
- Older children: Elevate head of bed >30° during feedings
- Postpyloric feeding
  - Nasoenteric tube placement (may require fluoroscopic visualization or endoscopic guidance)
  - Transgastric jejunostomy tube
Nutrition Support

Oral
Enteral
Parenteral
Advantages

- Provides nutrients when <60 -70cm of small intestine remains
- Allows nutrition support when GI intolerance prevents oral or enteral support
Parenteral nutrition: Routes

• Central access
  - TPN both long- and short-term placement

• Peripheral or PPN
  - New catheters allow longer support via this method limited to 800 to 900 mOsm/kg due to thrombophlebitis
  - When <2000 kcal required or <10 days
PPN vs. TPN

- Lower duration
- Central line contra-indicated
- Less Kcal required
  (max. PPN concentration 10% dextrose)

- Needs fluid tolerance
- Needs lower osmolarity
Indications for TPN

- NPO (not by mouth) >10 days
- GI non functioning
- GI fistula
- Acute pancreatitis
- Short bowel syndrome
- Malnutrition with >10% - 15 % weight loss
- Nutritional needs not met; patient refuses food
TPN Preparation

- Preparation in hospital pharmacy
  - With/without automated processes

- Ready to use
  - 2/3 chamber bags
  - Lipid emulsions
  - Standard / special amino acids
  - Additives
Parenteral Components

- Carbohydrate
  glucose or dextrose monohydrate
- Amino acids
  3, 3.5, 5, 7, 8.5, 10% solutions
- Fat
  10% emulsions = 1.1 kcal/mL
  20% emulsions = 2 kcal/mL
- 3-in-1 solution: lipid, amino acids, glucose, additives
Calculating Osmolarity of a Parenteral Nutrition Solution

1. Multiply the grams of dextrose per liter by 5. Example: 50 g of dextrose x 5 = 250 mOsm/L
2. Multiply the grams of protein per liter by 10. Example: 30 g of protein x 10 = 300 mOsm/L
3. Fat is isotonic and does not contribute to osmolarity.
4. Electrolytes further add to osmolarity.

Total osmolarity = 250 + 300 = 500 mOsm/L
Conclusion
Recommendations of the Committee of Nutrition of the French Society of Pediatrics

- Weighing and measuring with adapted tools all children whatever the reason for hospitalisation;
- Compare with growth charts in the medical file or the carnet de santé
- Analyse growth based on these charts
- Calculate BMI, check whether it is or not < 3rd percentile for age and gender
- Integrate a nutrition strategy in the medical handling of the patient

Hankard et al, 2013
Recommendations of the SFP Committee of Nutrition (cont’d)

- Introduce detection of nutritional problems as an indicator of quality and safety of treatments in Pediatrics
- Promote codification of nutrition in healthcare system payments
- Create a register of children with malnutrition and a national committee in charge of nutrition problems, in relation with other professional bodies
- Promote research on determinants, diagnostic and prognostic criteria in hospitalized children
- Measure prevalence of malnutrition in low income families or family with a high risk of food insecurity

Hankard et al, 2013
Enteral nutrition
Recommended Water

• Normal tube feeding: 1 kcal/ml; 80% to 85% water

• Older child: 1 ml/kcal or 35 ml/kg
• Infant: 1.5 ml/kcal or 150 ml/kg
Energy and protein in formulas

Energy
• 1 - 1.2 kcal/mL = usual concentration
• 2 kcal/mL = highest concentration

Protein
• 4% - 26% of kcal = possible
• 14% - 16% of kcal = usual
• 18% - 26% of kcal = high-protein solution
Calculating Energy and Protein

Example: Patient drinks 200 mL of a 15.3% protein product with 1 kcal/mL

1 kcal/mL x 200 mL = 200 kcal
• 200 kcal x 15.3% (%protein) = 30.6 kcal as protein
• 30.6 kcal : 4 kcal (for 1g protein) = 7.65 g protein

cc = mL
Parenteral nutrition
Parenteral nutrition

• Energy
  Infant
    50 to 60 kcal/kg/day maintenance
    70 to 120 kcal/kg/day growth
  Child >1yr
    BEE
    1 - 8 yrs: 70 to 100 kcal/kg/day
    8 - 12 yrs: 60 to 75 kcal/kg/day
    12 - 18 yrs: 45 to 60 kcal/kg/day

Injury factors
  1.25 mild stress
  1.50 nutritional depletion
  2.00 high stress
Parenteral nutrition

Protein:

- **Infant**
  - 2.4 to 4 g/kg/day <1500 g weight
  - 2.0 to 2.5 g/kg/day 0 to 12 months normal weight

- **Child >1 year**
  - 1 to 8 years 1.5 to 2.0 g/kg/day
  - 8 to 15 years 1.0 to 1.5 g/kg/day
Pediatric - cont’d

- Carbohydrate
  Infant, preterm:
    4 to 6 mg/kg/minute begin rate
  Term infants:
    8 to 9 mg/kg/minute begin rate

- Fat
  Infants:
    0.5 to 1.0 g/kg/day min for EFA needs
    2 to 3 g/kg/day max

- Vitamins and minerals:
  See tables in textbook
Fight against malnutrition in hospital

• Nutrition specialists with transversal activity across medical departments

• Hospital clinical nutrition units
Administration

• Start slowly
  (1 L 1st day; 2 L 2nd day)
• Stop slowly
  (reduce rate by half every 1 to 2 hrs or switch to dextrose IV)
• Cyclic give 12 to 18 hours per day
Monitoring and Complications

- Infection
- Hemodynamic stability
- Catheter care
- Refeeding syndrome
Refeeding Syndrome

- Hypophosphatemia
- Hyperglycemia
- Fluid retention
- Cardiac arrest
Monitor

- Weight (daily)
- Blood Daily
  Electrolytes ($\text{Na}^+, \text{K}^+, \text{Cl}^-$)
  Glucose
  Acid-base status
  3 times/week
  BUN
  $\text{Ca}^+, \text{P}$
  Plasma transaminases
Monitor—cont’d

• Blood
  Twice/week
    Ammonia
    Mg
    Plasma transaminases

Weekly
  Hgb
  Prothrombin time
  Zn
  Cu
  Triglycerides
Monitor—cont’d

- Urine:
  - Glucose and ketones (4-6/day)
  - Specific gravity or osmolarity (2-4/day)
  - Urinary urea nitrogen (weekly)

- Other:
  - Volume infusate (daily)
  - Oral intake (daily) if applicable
  - Urinary output (daily)
  - Activity, temperature, respiration (daily)
  - WBC and differential (as needed)
  - Cultures (as needed)
Problems

• PPN
  Site irritation

• TPN
  1. Catheter sepsis
  2. Placement problems
  3. Metabolic
Document in Chart

• Type of feeding formula and tube
• Method (bolus, drip, pump)
• Rate and water flush
• Intake energy and protein
• Tolerance, complications, and corrective actions
• Patient education