Recommendations for Nutritional Management of Children with Neurological Impairment (NI)

NI relates to disorders of the central nervous system, affecting: speech, motor skills, vision, memory, muscle actions, learning abilities. Cerebral palsy is also considered within this guide as a major subgroup of NI.

NI frequently causes GI problems in children, most notably those with oral motor function and motility conditions (in children with cerebral palsy, for example, as many as 92% suffer from serious GI symptoms) and can be extremely complex to manage. Such conditions can lead to insufficient caloric intake, a broad spectrum of GI and nutritional complications and associated clinical conditions, including respiratory infections and chronic aspiration, as well as a significant impact on quality of life for the patient and carer.

**PATIENT MANAGEMENT GOALS**

- Regular nutritional assessment
- Optimise oral intake but where this is not possible prompt nutritional intervention with non-oral methods
- Multidisciplinary approach and follow-up
- Parents and/or caregivers to be involved in decision making – particularly concerning gastrostomy feeding
- Primary focus on improving quality of life for both the child and their family
- Professional ethicist to assist decision making concerning invasive procedures which pose ethical dilemmas

**UNDERNUTRITION WARNING SIGNS**

In the absence of strict criteria to identify undernutrition, ESPGHAN recommend 1 or more of the following warning signs to aid identification:

- Physical signs of undernutrition, e.g. decubitus ulcers, skin problems and poor peripheral circulation
- Weight for age z score <-2
- Triceps skinfold thickness <10th centile for age and sex
- Mid-upper arm fat or muscle area <10th centile
- Faltering weight and/or failure to thrive
**Assessing Nutritional Status and Requirements**

Laboratory assessments can be performed to identify undernutrition, although there is no single marker representing good or poor nutritional status in children with NI. These children often have lower mineral intakes than healthy children, predisposing them to having poor micronutrient status. Typically, deficiencies for iron, zinc, copper, vitamin D, carnitine, folic acid and vitamin B12 are common and lower values of serum albumin, prealbumin and retinol binding protein can be found.

Tube feeding and the use of nutrition supplements, however, were associated with higher concentrations of micronutrients in blood and serum.

Identification of children with NI as being undernourished should therefore be based on the interpretation of anthropometric data as well as on the assessment of their micronutrient status.

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<tr>
<th>ANTROPOMETRIC MEASUREMENT</th>
<th>METHOD</th>
<th>NI CHALLENGE</th>
<th>ESPGHAN RECOMMENDATION</th>
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</table>
| Weight                    | Wheelchair scales  
Sitting scales  
Hoist scales          | Weight for height (WFH) is a poor indicator of fat stores in children with cerebral palsy. Low body mass index can also imply a low muscle mass but high fat mass | Assessment of nutritional status in children with NI should not be based solely on weight and height measurements |
| Height                    | Stadiometers – for those who can stand  
Supine length – good alternative for children able to lie straight  
Segmental length, such as knee-heel, tibia and ulnar using sliding calipers – reliable for monitoring growth for those unable to stand or lie straight | Many children with NI are not able to stand and have joint contractions, spasticity and/or scoliosis | Measurements of knee height or tibial length in children with NI should be performed routinely to assess linear growth, when height cannot be measured |
| Skinfolds and limb circumferences | Body fat estimated by using skinfold measurement usually at biceps and triceps region using a caliper | Interpretation challenging as children with NI tend to store fat around their abdomen rather than in skinfolds | Measurement of fat mass by skinfold thickness should be a routine component of the nutritional assessment in children with NI |
| Body composition          | Whole-body dual-energy x-ray absorptiometry (DXA) is the best way to assess a child’s fat stores | Nutritional status of children with NI more accurate using measures of body composition, including fat, water, protein and bone | Whole-body dual-energy x-ray absorptiometry (DXA) is the ‘criterion standard’ for body composition measurement |
| Bone status               | Bone mineral density (BMD) assessment by DXA is limited to lumbar spine and hip | Due to hip flexion contractures, in children with severe NI, only lumbar DXA measurements are mostly performed | DXA scans should be used to measure bone mineral density |

**Monitoring Undernutrition**

Micronutrients should be checked annually

Growth should be assessed in infants every 1 to 3 months

Follow-up anthropometry to be carried out at least every 6 months

Regular monitoring of body weight and fat mass recommended to assess energy requirements
Growth Charts
Standard or cerebral palsy specific growth charts are not reliable as growth patterns vary significantly from the general paediatric population.

ESPGHAN recommends:
WHO charts
For children whom reliable height can be calculated up to 5 years old and a relevant national growth chart for older children.

Alternative growth measurements for children with cerebral palsy
Segmental lengths including; upper-arm length, tibial length, and knee height are all reliable and valid proxies for stature in children with cerebral palsy up to 12 years of age. We recommend that either knee height or tibial length be measured in the routine anthropometry of children with cerebral palsy who cannot be measured by standard techniques. Estimates of stature can then be calculated and plotted on standard growth charts.1

Ulna growth charts
The ulna measurement has been found to precisely predict height in school-age children and is more reliable than arm span measurement when neuromuscular weakness, joint, or spinal deformity exists.3

The following equations for height based on ulna length (U) and age in years (A) were developed using linear regression and the LMS Method.

Males: height (cm)=4.605U+1.308A+28.003 (R²=0.96)
Females: height (cm)=4.459U+1.315A+31.485 (R²=0.94)

Requirements for Energy Intake in Children with Neurological Impairment
There are no appropriate specific recommendations for assessing the energy needs of children with NI. Their requirements must be assessed individually, as their needs differ considerably, depending on mobility, muscle tone, activity level, altered metabolism and growth.

ESPGHAN recommends the use of dietary reference standards (DRI) for typically developing children in order to estimate the caloric needs of children with NI.

Note of caution: DRI may overestimate energy needs due to the severe growth delay and decreased physical activity of children with NI and, generally, patients with NI have lower body fat, muscle mass and protein.

General energy needs predictors
- Patients with NI require more energy for walking
- Patients dependent on a wheelchair require 60% to 70% energy, compared to healthy children
- Enterally fed children with NI show lower energy expenditure and high body fat content
- Children with spastic quadriplegia have lower energy expenditure than unaffected children; spasticity contributes 10% of total energy expenditure
- Increased feeding difficulties correlates with decreased nutritional status, relating to weight, body fat and arm muscle mass measurements
- Greatest predictor of energy needs is fat-free mass, followed by ambulatory status
- Total energy expenditure to resting expenditure ratio is estimated to be 1.5 or 1.6 for normal activity but can be as low as 1.1 in children with cerebral palsy quadriplegia

Energy Equations for Estimating Energy Requirements
Published equations have been found to underestimate energy needs in non-ambulant children by approximately 22%, yet overestimation of energy needs can lead to overweightedness, currently seen in up to 15% of children. However, ESPGHAN recommend the Schofield equation – for estimating calorie needs4 and the Andrew et al. equation – for estimating energy requirements5 as a starting point, but the effect of dietary intervention must also be continually reassessed.

Requirements and Recommendations for Protein and Fluids
Protein requirements for children with NI are similar to the protein requirements of unaffected children, except for tube-fed children. However, as body composition is altered in these children, their hydration status is impaired and requires close attention.

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<tr>
<th>ENERGY</th>
<th>NI REQUIREMENTS</th>
<th>ESPGHAN RECOMMENDATION</th>
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<tbody>
<tr>
<td>Protein</td>
<td>Problems with protein intake arise when calorie needs are low, particularly in tube-fed children</td>
<td>Use dietary reference intake for protein in typically developing children to estimate the appropriate protein intake for children with NI</td>
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<td>Tube-fed, non-ambulant pre-school aged children have lower protein intakes compared with orally fed children</td>
<td>Supplementary protein should be taken in specific clinical situations such as decubitus ulcers or in children with low calorie requirement</td>
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<td>Fluids</td>
<td>Children with NI may have impaired hydration status</td>
<td>Careful attention should be paid to hydration status, as dehydration is a risk due to inability to communicate thirst, drooling and unsafe swallowing</td>
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Requirements and Recommendations for Micronutrients

Micronutrient deficiencies, specifically; calcium, iron, zinc, vitamins C, D and E and selenium, are common, especially in children who are exclusively tube-fed. Many children with NI also require less energy to avoid being overweight and, as a consequence of a reduced energy intake, their micronutrient intake can be less than their daily requirements.

**ESPGHAN MICRONUTRIENT RECOMMENDATION**

DRI for micronutrients in typically developing children to be used to estimate the appropriate micronutrients intake for children with NI

Iron supplementation to be used as first and diagnostic measure to treat children with iron deficiency

RDA of iron is:
- 10mg/day in children (7-10 years)
- 12mg/day adolescent boys (15-19 years)
- 15 mg/day in adolescent girls (15-19 years)

Recommendations for Nutritional Assessment

Multidisciplinary nutritional assessment of the neurologically impaired child:
- weight, length, triceps skinfold
- dietary history (e.g. meal duration)
- evaluation of oral motor function

### Adequate nutrition

- Safe
- Systematic reevaluation (yearly or on indication)
- Ensure consistency, positioning

### Inadequate nutrition

- Unsafe
- Tube feeding (supplementary vs. exclusive)
- GORD

#### Gastrostomy

- Controlled (PPI, diet)
- Not controlled (PPI, diet)

- Gastrostomy with fundoplication
- Jejunostomy

#### Unsafe*

* unsafe – Careful attention needs to be given to any swallowing, dental or orthopaedic issues that may make oral feeding unsafe. Partial or full enteral feeding should be considered if any concern over safety.

### References