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Citation

Abstract
Patients with neurological disorders often require non-oral nutrition support because of intubation, altered mental status or dysphagia, irrespective of surgical intervention. To maximize patient outcome, nutrition support must be initiated within a 48- to 72-hour window immediately post-injury or surgical insult. In an attempt to provide nutrition support in an uniform manner without unnecessary delays, a multidisciplinary team of physicians, nurses, speech pathologists and the unit dietitian developed a set of nutrition support protocols for use in the neuro intensive care unit at our institution. Although new residents receive a handbook with extensive references on nutrition support, a brief orientation on the protocols and a one hour nutrition support lecture, a need was identified for a concise, pocket-sized reference outlining the fundamentals of nutrition support and the unit's nutrition protocols step-by-step. Towards this end, the unit dietitian developed a six-page nutrition support reference in outline form that is reproduced here. Although the material is geared towards the neurosurgical patient, it provides nutrition support basics appropriate for nearly any intensive care patient population. The material covers selection of an appropriate feeding route, assessment of nutritional status and nutrient requirements, calculation of parenteral and enteral feeding regimens, monitoring of nutrition support patients, and weaning patients off of nutrition support onto oral diets.

Glossary of Medical Terms and Abbreviations

- A (vitamin): retinol
- ARDS: adult respiratory distress syndrome
- BEE: basal energy expenditure
- BM: bowel movement
- B12 (vitamin): cobalamin
- C. Diff: Clostridium difficile
- CHF: congestive heart failure
- CHI: closed head injury
- C V V H: continuous veno-venous hemofiltration
- CAVHD: continuous arterio-venous hemodialysis
- d: day
- dl: deciliter
- DHT: Dobhoff tube (brand name for nasoenteral feeding tube)
- E (vitamin): tocopherol
- FIO2: forced inspiratory oxygen
- FSBG: fingerstick blood glucose
- GI: gastrointestinal
- H2 blocker: histamine-2 blocker
- I & O: intake and output
- IBW: Ideal Body Weight
INTRODUCTION

Neurologically impaired patients often require non-oral nutrition support because of intubation, altered mental status or dysphagia. Common diagnoses of patients admitted to a neuro intensive care unit (NICU) include traumatic head injury, stroke, brain tumor, spinal cord injury, degenerative disease (multiple sclerosis, amyotrophic lateral sclerosis, Alzheimer’s, Parkinson’s) or a mobility disorder (myasthenia gravis, Guillain-Barre syndrome). All of these conditions have the potential to promote visceral protein depletion and wasting of skeletal musculature through dysmobility, inadequate oral intake or hypercatabolism secondary to the disease process. Even non-surgical patients may be in a hypermetabolic, hypercatabolic state due to the nature of their disease and the invasive interventions required to support them during treatment and recovery. 1

Early nutrition support through the enteral route has been shown to blunt catabolism, reduce complications and reduce length of stay in a number of patient populations, including both surgical and non-surgical neuro patients. 2,3 However, nutrition support must be initiated within the 48- to 72-hour period immediately following injury or surgical insult to achieve these benefits. 2 Clinicians are often hesitant to feed critically ill neuro patients too soon. However, studies indicate patients with severe neurological deficits and clinically silent abdomens can tolerate low-rate jejunal feedings within 36 hours of injury 4 with a gradual increase in feeding rate to meet initial caloric goals within two to four days. 4,5 If jejunal feedings are initiated prior to induction of pentobarbital infusion, even patients in pentobarbital coma can be fed enterally. 6

In an attempt to provide nutrition support in an uniform manner without unnecessary delays, a multidisciplinary team of physicians, nurses, speech pathologists and the unit dietitian developed a set of nutrition support protocols for use in the neuro intensive care unit at our institution. The team also developed pre-printed orders to be used in conjunction with the protocols. The primary responsibility for initiating and monitoring nutrition support lies with a team of NICU residents in collaboration with the attending physician, nursing staff and the unit dietitian.

New residents receive a brief orientation on the protocols and an ICU handbook with extensive references on nutrition support on their first day of rotation. Later in the month, the residents attend a one-hour lecture on nutrition support. Nevertheless, a lack of nutrition support knowledge was
identified among NICU residents that the orientation, handbook and lecture did not adequately address. As a result, nutrition support was often delayed or inappropriate. A need was identified for a concise, pocket-sized reference outlining the fundamentals of nutrition support as per the unit protocols in a step-by-step fashion to assist the residents in writing nutrition support orders.

Towards this end, the unit dietitian developed a six-page nutrition support reference in outline form that is reproduced here. Although the material is geared towards the NICU patient, the basic information it provides is appropriate for nearly any intensive care patient population. The material covers selection of an appropriate feeding route, assessment of nutritional status and nutrient requirements, calculation of parenteral and enteral feeding regimens, monitoring of nutrition support patients, and weaning patients off of nutrition support onto oral diets. The reference is not designed to be all-inclusive, adding to its ease of use by residents in a busy intensive care unit where many nutrition support regimens must be initiated, adjusted and monitored daily.

**PROTOCOLS**

**Figure 1**

<table>
<thead>
<tr>
<th>Oral</th>
<th>Parenteral central</th>
<th>Parenteral peripheral</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>for patients who are extubated, awake/alert, following commands</td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>for patients who are intubated, unable to swallow or eat adequate</td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>have adequate small bowel function</td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>for patients who have inadequate small bowel function</td>
<td></td>
</tr>
<tr>
<td>OR in whom all forms of enteral access or support are contraindicated AND who have central venous access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR in whom all forms of enteral access are contraindicated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLUS on whom central venous access is contraindicated</td>
<td></td>
<td></td>
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</tbody>
</table>

**Figure 2**

<table>
<thead>
<tr>
<th>A. Assess energy reserve based on pre-resuscitation weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calculate ideal body weight (IBW) by Harris method</td>
</tr>
<tr>
<td>Males: 165 pounds for the first 5 feet plus 5 pounds for each inch above 5 feet</td>
</tr>
<tr>
<td>Females: 100 pounds for the first 5 feet plus 5 pounds for each inch above 5 feet</td>
</tr>
<tr>
<td>2. Obtain admission weight and usual weight as a percentage of IBW</td>
</tr>
<tr>
<td>&gt; 100% IBW: morbidly obese</td>
</tr>
<tr>
<td>125% - 199% IBW: obese</td>
</tr>
<tr>
<td>110% - 125% IBW: overweight</td>
</tr>
<tr>
<td>90% - 110% IBW: adequate energy reserve</td>
</tr>
<tr>
<td>80% - 90% IBW: lean body habitus or mildly depleted energy stores</td>
</tr>
<tr>
<td>70% - 80% IBW: moderate depletion of energy reserve</td>
</tr>
<tr>
<td>≤ 65% IBW: severe depletion of energy reserve</td>
</tr>
</tbody>
</table>

| B. Assess visceral protein stores |
|---------------------------------
| Note that these parameters are unreliable if creatinine clearance is under 50 ml/minute or if patient is in fulminant renal or hepatic failure. Serum albumin is useful as an indicator of protein reserve after fluid resuscitation has been initiated and acute stress response has occurred. Laboratory values may differ slightly by institution and assay used |
| 1. Adequate stores: |
| Albumin 3.5 - 5.0 mg/dl |
| Transferrin 212 - 366 mg/dl |
| Prealbumin ≥ 45 mg/dl |
| 2. Mildly depleted stores: |
| Albumin 2.9 - 3.4 mg/dl |
| Transferrin 160 - 212 mg/dl |
| Prealbumin < 15 mg/dl |
| 3. Moderately depleted stores: |
| Albumin 2.1 - 2.7 mg/dl |
| Transferrin 100 - 149 mg/dl |
| Prealbumin ≤ 14 mg/dl |
Male: BEE = 66.47 + (13.75 x weight in kg) + (5.0 x height in cm) - (6.76 x age in years)
Female: BEE = 655.1 + (9.56 x weight in kg) + (1.85 x height in cm) - (4.68 x age in years)

III. Begin feeding through chosen access route as soon as patient is hemodynamically stable and oxygenating well. Benefits of early nutrition support as described in the literature occur when feedings are initiated within 48 to 72 hours following injury or surgical insult. Feeding a hemodynamically unstable patient may lead to undesirable complications, most notably bowel infarction in enterally fed patients.

NOTE: Bowel sounds are an unreliable indicator of small bowel function. Patients with altered GI function may be fed with elemental solutions via the small bowel in most instances. Continuous small bowel feedings are associated with a lower incidence of feeding-induced GI dysfunction and a higher incidence of achieving and maintaining feeding goals in the ICU setting than with gastric or bolus feedings.

Figure 6

1. Start bowel protocol with daily laxatives and electric bowel irrigation, giving premix laxatives if no BM after first dose of laxatives or if no BM over 3 days.
2. If enteral support anticipated for 6 weeks or more, consult Procedure Team for PEG placement.
3. If enteral support anticipated for less than 6 weeks, manually place nasoduodenal or nasogastric feeding tube, giving metoclopramide 10 mg IV x 1 prior to tube insertion.
4. Obtain KUB after placement of feeding tube.
5. If KUB indicates tip of nasointestinal tube to be in the stomach, reposition until tip is past the pylorus and repeat KUB. If unable to manually place tube post-pylorically after 2 attempts, consult Procedure Team for NGT placement.
7. Osmolite PN: polymeric, 1 calorie/cc, moderate protein/ electrolytes/fat.
8. Promin: polymeric, 1 calorie/cc, high protein/potassium/phosphate.
9. Total PN: polymeric, 2 calorie/cc, for simple fluid restriction.
10. Neopor: polymeric, 2 calorie/cc, restricted fluid in protein, fluid and electrolytes, high fat, moderate carbohydrate, for hemodialysis patients.
12. Advance tube feedings by 15 – 30 cc every 4 – 12 hours until at goal rate.
13. If diarrhea present long:
   1. Obtain C. Diff toxins & fecal leukocytes.
   2. Start lactobacillus acidophilus (cultured yogurt, Lactinex granules).
   3. Start anti-diarrheal agent if C. Diff positive.
   4. Review enteral medications for potential to promote diarrhea.

Figure 7

- Calculate stool osmotic gap = stool osmolality – 2(serum Na⁺ + stool K⁺)
- Consider altering fat/volume/nutrient density of enteral formula in large gap.
- Obtain speech pathology consult for swallowing evaluation once patient is intubated, awake and alert and following commands, to rule out dysphagia.
- When patient is no longer critical and demonstrates normal gastric emptying with or without the use of pharmacologic intervention, transition into intermittent feedings every 4 to 6 hours to provide same daily volume of formula as continuous feedings.
- When patient passes swallow evaluation by speech therapist:
  1. Give supplemental tube feedings at night (continuous drip) or other meals (bolus) to provide 50% calorie/protein needs.
  2. Advance diet with nutritional supplements as per dietitian/speech path notes.
  3. Have nursing staff assist patient with all meals and supplements.
  4. Monitor oral intake via I & O’s.
  5. Adjust tube feedings per p.o. intake.

Figure 8

- Obtain central venous access with clean port dedicated to TPN.
- Start TPN to provide 100% calorie/protein/micronutrient needs.
  1. Standard TPN: 50 grams protein, 850 non-protein kcal/day.
  2. Non-standard TPN: for diabetes, insulin resistance, renal or hepatic dysfunction, refractory syndromes, risk, fluid restriction, electrolyte abnormalities.
- Start low rate enteral feedings or oral diet as soon as medically feasible to preserve normal GI function, reducing TPN as enteral feeds advanced.

Figure 9

- Assess appropriateness of peripheral parenteral support and patient's ability to tolerate it.
  1. Serum triglycerides < 200.
  2. Good peripheral access.
  3. Able to tolerate 3 liters intravenous fluid volume daily.
  4. All forms of enteral and central venous access contraindicated.

Figure 10

- Peripheral parenteral nutrition solutions limited to:
  1. < 10% amino acid solution.
  2. < 20% initial/12.5% final dextrose concentration.
  3. < 2 grammes lipid/kg/day, not to exceed 60% of total kcal.
  4. Minimize additives to reduce osmolality: Vitamins, insulin, H₂ blockers and standard electrolytes can generally be added to solution if no other access route is available.
- Start oral/enteral feedings as soon as feasible to maintain normal GI function.

VI. Protocol for parenterally fed patients, central access

- If patient meets all 4 criteria, start peripheral nutrition to provide > 75% calorie/protein needs.
- If patient does not meet all 4 criteria, start support via central line or reconsider enteral feedings.

VII. Protocol for parenterally fed patients, peripheral access

- If patient meets all 4 criteria, start peripheral nutrition to provide > 75% calorie/protein needs.
- If patient does not meet all 4 criteria, start support via central line or reconsider enteral feedings.

VIII. Monitor the patient and adjust nutrition support as indicated.
IX. Parenteral Electrolyte Requirements

Potassium and sodium are available as phosphorus or chloride, or as acetate, a bicarbonate precursor. Calcium is available as gluconate or chloride. Magnesium is available as sulfate.

X. Parenteral Electrolyte and Vitamin Requirements in Acute or Chronic Renal Failure

References
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