بسم الله الرحمن الرحیم

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Disease-Specific Nutrition

PULMONARY FAILURE

- Optimal pulmonary function is essential to the maintenance of adequate nutritional status.
- Through the process of gas exchange, the lungs and supporting respiratory structures provide oxygen to vital tissues for nutrient metabolism.
- The respiratory system also plays a major role for the regulation of acid–base balance.

- Pulmonary injury or insufficiency can lead to malnutrition and dependence on mechanical ventilation of the critically ill patient.
- Acute respiratory distress syndrome (ARDS), characterized by severe progressive hypoxemia and mechanical ventilation, is a frequent result of trauma, sepsis, or surgery in the critical care setting.
- The patient with chronic obstructive pulmonary disease (COPD) may also undergo periods of acute exacerbation requiring intensive care.

Malnutrition and Metabolic Abnormalities of Pulmonary Disease

- Malnutrition with COPD is the result of an imbalance between energy intake and utilization.
- Hyperinflation of the lung with an associated decrease in abdominal volume can lead to anorexia, early satiety, and tube feed intolerance.

- An increase in energy consumption from COPD has been attributed to an increase in the work of breathing, tobacco use and medication (theophylline.)
- Loss of lean body mass may occur as a result of disuse atrophy, tissue hypoxia from arterial hypoxemia, anabolic hormonal insufficiency or systemic inflammation as a result of recurrent infections and an imbalance of inflammatory cytokines.
- Currently interleukin (IL)-1β is felt to play a more important role.

- Respiratory muscles display reduced efficiency and endurance during nutrition deprivation due to loss of muscle mass and depletion of energy reserves.
- Impaired respiratory muscle function may result in decreased ventilatory drive and inefficient gas exchange with hypercapnia and hypoxemia.
- Phosphate deficiency diminishes diaphragmatic muscle function and adversely affects the hemoglobin–oxygen dissociation curve by limiting the production of adenosine triphosphate and 2,3-diphosphoglycerate.

- Hypoalbuminemia, associated with critical illness and malnutrition, leads to an expansion of extracellular fluid and increased interstitial lung fluid or pulmonary edema.

- Malnutrition also adversely influences the production of secretory IgA, alveolar macrophage recruitment and function and clearance of bacteria from the upper respiratory tract placing patients at risk for nosocomial pneumonia.

Energy and Protein Requirements During Pulmonary Disease

- Substrate utilization is the ratio of oxygen consumed to carbon dioxide produced for a given macronutrients and is referred to as the respiratory quotient (R/Q).

- The oxidation of fat, protein, and carbohydrate produces an R/Q of 0.7, 0.8, and 1.0, respectively.

- Ideally, the R/Q of a given patient should approximate 0.85 to reflect metabolism of mixed substrates.
- When carbohydrate or total calorie provisions exceed energy requirements, R/Q levels rise above 1.0 to suggest fat synthesis.
- An R/Q of less than 0.7 is indicative of inadequate nutritional support with breakdown body fat and protein stores from adipose and lean tissue.

- Underfeeding energy may increase risk of infection, prolong ventilator dependence, delay wound healing, and increase overall hospital morbidity and mortality.

- Overfeeding energy needs is associated with several metabolic, hepatic, and respiratory complications, including increased carbon dioxide production with inability to wean from mechanical ventilation.

- 25 to 30 kcal/kg/d should be used to determine energy needs.

- The provision of IV carbohydrate in excess of 5 mg per kg per minute to severely stressed patients increases carbon dioxide production (V . CO 2) and may delay weaning from mechanical ventilation.

- The intersociety clinical guidelines for critical care suggest withholding or limiting soybean oil IVFE during the first week following initiation of PN to a maximum of 100 g per week (often divided into 2 doses per week if there is concern for essential fatty acid deficiency).

- Rapid infusion of IVFE may adversely affect

I. Gas exchange by decreased rate of clearance,
II. Deposition of lipid particles within the reticuloendothelial system,
III. subsequent reduction of pulmonary diffusion capacity.

- This effect is most often seen among patients with existing pulmonary dysfunction and with rates of lipid administration more than 0.11 g/kg/hr

- Protein requirements of critically ill patients with pulmonary failure are elevated in accordance with the hyper catabolism of stressed states.

- Guideline recommendations suggest that protein intake range from 1.2 to 2.0 g/kg/d of actual body weight.

- Unfortunately, an increase in ventilatory drive and minute ventilation may be seen with protein infusion.

Nutritional Assessment During Pulmonary Disease

- Malnutrition, which is typically defined for COPD patients as a BMI of less than 20 kg per m2, is an important co-morbidity with an incidence of approximately 20% to 40%.

- Patients with a BMI < 20 kg per m2 have a significantly lower FEV(1) when compared to patients who were overweight or obese.

- The impact of nutritional intervention has been demonstrated in two meta-analyses of long-term trials of ambulatory malnourished patients with COPD.

- These reports have demonstrated that when given for two or more weeks, oral and enteral supplements lead to significant gain of weight, lean body mass, fat mass, respiratory muscle strength, physical endurance, and quality of life.

- In regard to defining nutritional status in the ICU, Faisy et al. compared changes of bioelectrical impedance analysis (BIA) with various anthropometric and biologic parameters among patients with COPD and acute respiratory failure.

- Low serum albumin levels were also significantly associated with increased mortality among patients in this study.

- Others have found that weight loss and low percentage of ideal body weight can significantly predict the need for mechanical ventilation among hospitalized COPD patients.

- Weight changes, serum albumin levels, and BIA, when available, are thus valuable tools in assessment of nutritional status and prediction of outcomes for patients with severe respiratory insufficiency.

- It has been suggested that all patients admitted to the ICU undergo nutritional assessment utilizing a scoring system that examines both nutritional status and disease severity.

- The Nutrition Risk Screening (NRS) 2002 and NUTRIC score fulfill both of these criteria and have been clinically validated.

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NUTRIC Score[1]

The NUTRIC Score is designed to quantify the risk of critically ill patients developing adverse events that may be modified by aggressive nutrition therapy. The score, of 1-10, is based on 6 variables that are explained below in Table 1. The scoring system is shown in Tables 2 and 3.

Table 1: NUTRIC Score variables

Variable	Range	Points
Age	<50	0
	50 - <75	1
	≥75	2
APACHE II	<15	0
	15 - <20	1
	20-28	2
	≥28	3
SOFA	<6	0
	6 - <10	1
	≥10	2
Number of Co-morbidities	0-1	0
	≥2	1
Days from hospital to ICU admission	0 - <1	0
	≥1	1
IL-6	0 - <400	0
	≥ 400	1

Table 2: NUTRIC Score scoring system: if IL-6 available

Sum of points	Category	Explanation
6-10	High Score	➢ Associated with worse clinical outcomes (mortality, ventilation). ➢ These patients are the most likely to benefit from aggressive nutrition therapy.
0-5	Low Score	➢ These patients have a low malnutrition risk.

Table 3. NUTRIC Score scoring system: If no IL-6 available*

Sum of points	Category	Explanation
5-9	High Score	➢ Associated with worse clinical outcomes (mortality, ventilation). ➢ These patients are the most likely to benefit from aggressive nutrition therapy.
0-4	Low Score	➢ These patients have a low malnutrition risk.

*It is acceptable to not include IL-6 data when it is not routinely available; it was shown to contribute very little to the overall prediction of the NUTRIC score.[2]

[1] Heyland DK, Dhaliwal R, Jiang X, Day AG. Identifying critically ill patients who benefit the most from nutrition therapy: the development and initial validation of a novel risk assessment tool. Critical Care. 2011;15(6):R268.
[2] Rahman A, Hasan RM, Agarwala R, Martin C, Day AG, Heyland DK. Identifying critically-ill patients who will benefit most from nutritional therapy: Further validation of the "modified NUTRIC" nutritional risk assessment tool. Clin Nutr. 2015. [Epub ahead of print]

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Thank you