

Nutrition in the Cardiac Newborns



Evidence-based Nutrition Guidelines for Cardiac Newborns

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KEYWORDS

- Congenital heart disease • Neonates • Nutrition • Necrotizing enterocolitis • Growth
- Feeding • Breast milk

KEY POINTS

- Both protein and energy malnutrition are common in neonates and infants with congenital heart disease (CHD).
- Neonates with CHD are at increased risk of developing necrotizing enterocolitis (NEC), particularly the preterm population.
- Mortality in patients with CHD and NEC is higher than for either disease process alone.
- Standardized feeding protocols may affect both incidence of NEC and growth failure in infants with CHD.
- The roles of human milk and probiotics have not yet been explored in this patient population.

NUTRITIONAL REQUIREMENTS IN NEONATES WITH CONGENITAL HEART DISEASE

In the simplest terms, malnutrition is result of inadequate energy intake or an increase in energy expenditure, resulting in an energy imbalance. Studies of critically ill children have estimated that energy requirements may increase by 30% for mild to moderate stress and up to 50% in severe stress.¹ Suboptimal nutrition during periods of critical illness, resulting in energy and protein deficits, has been associated with poor clinical outcomes in both pediatric and adult populations.² Poor nutrition exacerbates the stress-induced catabolic responses during surgery or severe illness and has been associated with poor wound healing, myocardial dysfunction, impaired vascular

Disclosure: None.

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Clin Perinatol 43 (2016) 131–145

<http://dx.doi.org/10.1016/j.clp.2015.11.009>

perinatology.theclinics.com

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endothelial integrity, reduced muscle function, and an increased risk of postoperative pneumonia.³

These deficits often compound throughout the course of an illness and are difficult to overcome.^{4,5} Children are particularly disadvantaged by malnutrition during periods of critical illness and surgery because of the concomitant metabolic requirements for growth, cognitive development, and motor development. Within this population, neonates represent a uniquely vulnerable subset, because the first 12 months of life are a period of critical growth and development that often portends lifelong consequences. Growth failure in infancy has been correlated with long-term cognitive deficiencies such as attention deficit disorder, aggressive behavior, and poor social and emotional development.^{6–8}

Most infants born with congenital heart disease (CHD) are of normal weight for gestational age at birth but develop nutritional and growth deficiencies during the first few months of life. Both cardiac and extracardiac factors contribute to the development of malnutrition in infants with CHD. Sources of increased metabolic demand in CHD include increase in resting oxygen consumption, left-to-right shunts increasing cardiac workload, increased pulmonary pressures, and increased catecholamine secretion.⁹ Associated genetic conditions such as Down syndrome, DiGeorge syndrome, Turner syndrome, and trisomies 13 and 18, in particular, may also influence energy intake, gastrointestinal absorption, expenditure, and growth expectations.

Abnormalities in the use of nutritional resources also play a role in malnutrition of patients with CHD. The hormonal stress response and the therapeutic administration of catecholamines in the perioperative period shift metabolism toward fatty acid oxidation and impaired carbohydrate use.¹⁰ Increased resting energy expenditure (REE) in patients with CHD has been directly associated with increased inflammation and higher cardiac output and inversely associated with antiinflammatory strategies.¹¹

Patients with both single-ventricle and biventricle repairs in the neonatal period have persistently low weight for age z-scores at 3 months of age, primarily because of a lack of fat mass (FM). This lack of FM, as opposed to fat-free mass, most likely stems from insufficient energy intake necessary to support a state of positive energy balance, which is needed to increase fat stores.

PROTEIN STUDIES IN SICK/PRETERM NEONATES

Critical illness, including CHD and surgical conditions, leads to increased protein catabolism and turnover. A constant flow of amino acids is necessary for the synthesis of new proteins and for tissue repair and growth. The goals of nutrition in critically ill patients are to provide sufficient dietary protein to enable adequate new protein synthesis, facilitate wound healing, modulate inflammatory responses, and preserve skeletal muscle mass.

In addition to poor caloric intake, critically ill infants and children are predisposed to the effects of accumulating negative nitrogen balance and protein malnutrition, with these deficits exacerbated in the preterm population (**Fig. 1**).⁵ A study of critically ill, mechanically ventilated infants showed a significant association between the adequacy of enteral protein intake and 60-day mortality that was independent of the enteral energy adequacy.¹²

In infants with CHD, the prevalence of acute and chronic protein energy malnutrition has been documented in nearly half of the patients, with only 68% of energy and 40% of protein requirements met on day of life (DOL) 7, despite an “evidence-based feeding protocol” and the daily presence of a nutritionist on rounds.¹³ There are disparate data regarding the amount of protein and energy intake needed to produce anabolism in

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