5. NUTRITIONAL MANAGEMENT

Principles

- Children and adults with SCD have higher metabolic expenditure and are at higher risk of malnutrition, poor growth and micronutrient deficiencies.
- Early referral to a registered dietician and close monitoring of growth is essential for early detection of malnutrition and nutritional deficiencies.

Recommendations

Nutrition

- At each medical visit, a nutrition-focused physical examination should be performed to screen for the presence of nutrient deficiencies.
- Referral to a Registered Dietitian is essential for nutrition screening and assessment, which should include an ascertainment of malnutrition risk, an assessment for possible weight loss and nutrient deficiencies, and education and planning for the management of nutritional concerns.
- A stress factor of 1.3 to 1.5 should be added to standard basic metabolic rate/resting energy expenditure equations for age to account for increased metabolic rates in individuals with SCD.
- Protein energy estimations should exceed the standard recommended dietary allowance intakes for age by adding a stress factor range of 1.5 to 1.7 to protein calculations.

Growth Monitoring

- Serial growth measurements should be performed to capture both acute changes and long-term growth velocity.
- Recumbent length for infants should be measured supine until 24 months of age; head circumference should be measured serially until an infant reaches at least 36 months of age, as brain development in chronic malnutrition can be critically altered during this important phase of growth.[8]
- Age-appropriate growth charts should be used to identify suitable trajectories in growth in infants, children, and adolescents, and identify suboptimal growth.
- Mid-arm circumference or skinfold measurement should be conducted during dietician assessments to assess changes in muscle mass and identify potential muscle wasting with assessment based on reference population data.
- There are no evidence-based guidelines for the frequency of bone density monitoring in SCD, but dual-energy X-ray absorptiometry (DXA) assessments should be considered to evaluate for deviations in bone mineral density compared with reference data.[9]

Monitoring for Micronutrient Deficiencies

- A 24-hour dietary food recall should be undertaken to assess dietary intake of vitamin D compared with age-based requirements.
- Request serum 2-OH vitamin D levels bi-annually to identify whether vitamin D insufficiency/deficiency exists and to provide vitamin D supplementation as necessary.
- Serum zinc levels should be measured annually and analyzed for potential deficiency.
- Consider annual serum levels of vitamin B6, vitamin B12, and folate to screen for deficiency.
- Daily supplementation should be considered with a complete age-appropriate multivitamin containing vitamins B6, B12, folic acid, a minimum of 400 International Units vitamin D, and zinc.

Background

There are several nutritional considerations that are necessary for the assessment of patients with sickle cell disease (SCD). It is well established in the scientific literature that individuals with SCD have higher resting energy expenditure rates. This can be attributed to greater hematopoiesis due to the shorter half-life of erythrocytes, increases in cardiac output, febrile episodes associated with frequent acute crises, frequent infections, increased protein turnover, acute and chronic inflammation, and elevated substrate utilization for growth and development, particularly in the pediatric population.

Adequate energy and protein intake are paramount to favor utilization of nutrients obtained via dietary intake versus breakdown of body stores. There are no standard equations that exist to account for elevated resting energy expenditure. Individuals with SCD can require 13% to 15% more energy than standard resting energy expenditure estimations to account for their increased energy expenditure.[1,2]

Increased protein turnover and catabolism are further consequences of the effects of SCD. Individuals with SCD have an elevated consumption of the amino acid arginine, which is particularly needed for the synthesis of nitric oxide and cysteine.[3] Vaso-occlusive crises require effective nitric-oxide production to promote vasodilation. Inherent to SCD is the lysis of sickle-shaped red blood cells resulting in cell damage; this cell breakage increases the rate of protein catabolism, and promotes reactive oxygen species.

Growth Monitoring

Delayed and ineffective growth is a crucial area of consideration when working with pediatric patients with SCD. There are many reasons to account for the lack of adequate growth in this population. Firstly, fatigue and anorexia commonly accompany acute painful crises and febrile illnesses. Pain and febrile episodes may also drive up energy expenditure and concurrently release pro-inflammatory cytokines and mediators, which can down-regulate appetite, reducing the effective ingestion of nutrients. Children admitted to hospital for acute crises or illness may not adapt well to changes in environment, and, therefore, may reduce their energy intake.[4] There may also be cultural food preferences that limit appropriate dietary intake. Lastly, frequent hemolysis demands that adequate energy and protein is ingested to rebuild healthy cells. When unavailable in the diet, nutrients within body stores will be broken down and utilized to achieve the building blocks necessary for red blood cell synthesis.

Individuals with suboptimal height- and BMI-for-age velocities and trajectories may be at risk for deficits in cognitive potential and brain growth.[5] Linear growth is correlated with long-term nutrition status, which means that chronic malnutrition may be present in those individuals with suboptimal linear growth.[6] Moreover, there is evidence that demonstrates a decline in adequate dietary intake with increasing age, which reaches its nadir during adolescence.[7] Lactose intolerance and reduced affinity for vitamin D and calcium-rich milk products may decrease the absorption of bone-building nutrients, especially during important phases of growth.

Monitoring for Micronutrient Deficiencies

There are several micronutrients that require special attention in relation to SCD. Vitamin D plays a crucial role in bone health, but also has an important function in immunity. Vitamin D is obtained via dietary intake and sunlight exposure. Most Canadians will not be able to gain adequate vitamin D concentrations necessary to convert to active vitamin D, due to sunlight constraints from October through April. Moreover, melanin concentrations in the skin are higher in individuals of African descent, which further limits vitamin D absorption via sunlight.

Foods that are rich in vitamin D include cod liver oil, salmon, tuna, mackerel, egg yolk, beef liver, mammalian milk, and orange juice fortified with vitamin D.[10] Many people affected with SCD have poor total energy intake, limiting intake of food sources rich in vitamin D. Individuals with SCD generally have a reduced tolerance of outdoor physical activity, which also decreases their exposure to sunlight and further reduces vitamin D intake.[11,12] It is important to monitor serum 2-OH vitamin D levels periodically.

Zinc is directly associated with growth and development, particularly sexual maturation and linear growth. Delayed wound healing and impaired immune function are devastating consequences of zinc deficiency, which can be frequently seen in individuals with SCD.[13] Zinc has also been studied with regard to rates of infection and chronic inflammation. Individuals with SCD have high rates of both infection and inflammation due to vaso-occlusion, hemolysis, and resultant organ damage. As an antioxidant, zinc is a component of superoxide

dismutase, which is known to inhibit pro-inflammatory cascades and thereby reduce reactive oxygen species activity and oxidative stress. As a component of thymulin, zinc is incorporated into hormones that assist in differentiating and maturing T-cells, and also is incorporated into immune cells that exert macrophagic-monocytic activity.[14] Zinc supplementation has been shown to help reduce the frequency of pain crises and rates of infection in those receiving supplementation.[15]

Folate, an essential B vitamin, is vital for DNA, RNA, and protein synthesis. It is a widely accepted practice to supplement patients with SCD with 1 to 5 mg of folic acid daily to ensure adequate folate supply for erythrocyte production.[16] Since folate requires the co-factors vitamin B6 (pyridoxine) and vitamin B12 (cobalamin) to promote synthesis of red blood cells, it would be prudent to evaluate serum levels of patients with SCD to screen annually for deficiencies in folate, vitamin B6, and vitamin B12. Deficiency of vitamin B6 is rare, since it is found in a wide variety of foods; however, those who do not consume meat products over time can become deficient in vitamin B12.[17]

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