Malnutrition, Vitamin Deficiencies, the Immune System and Infections: Time to Revisit Our Knowledge

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Our immune system needs its nutrition in order to function efficiently in protecting our body against infections. Infections are frequent and chronic in malnourished patients. Recent discoveries provide new information and new challenges regarding the link between nutrition and infections. Almost 900 million people in the world are undernourished. Malnutrition is the primary cause of immunodeficiency worldwide with infants, children, adolescents, and the elderly most affected. Malnutrition in relation to the immune system can be classified into protein-energy malnutrition and micronutrient deficiencies. Both conditions are associated with significant impairments of cell-mediated immunity, antibody concentrations, phagocyte function, complement system, and cytokine production (1). Several studies report effects of nutrients and by-products of microbial metabolism on the expression of antimicrobial peptide genes in order to highlight an emerging appreciation for the role of dietary compounds in modulating the immune response (2).

Specific aims that will be discussed in the presentation are:
1. Contribution of deficiency in selected water-soluble and fat-soluble vitamins and trace element micronutrients to immune dysfunction.
2. The effect of malnutrition on the thymus gland.
3. The gut microbiota involvement in severe acute malnutrition.

Micronutrient deficiencies have effects such as poor growth, impaired intellect, and increased mortality and susceptibility to infection. Their deficiency affects the innate T-cell-mediated immune response and adaptive antibody response. Infections aggravate micronutrient deficiencies by reducing nutrient intake, increasing losses, and interfering with utilization by altering metabolic pathways. Antioxidant vitamins and trace elements (vitamins C, E, selenium, copper, and zinc) counteract potential damage caused by reactive oxygen species to cellular tissues, modulate immune cell function and affect production of cytokines and prostaglandins. Adequate intake of vitamins B 6 , folate, B 12 , C, E, and of selenium, zinc, copper, and iron supports a Th1 cytokine-mediated immune response and avoids a shift to an anti-inflammatory Th2 cell-mediated immune response. Vitamins A and D play important roles in both cell-mediated and humoral antibody response and support a Th2-mediated anti-inflammatory cytokine profile. Vitamin A deficiency impairs both innate immunity (mucosal epithelial regeneration) and adaptive immune response to infection resulting in an impaired ability to counteract extracellular pathogens. Vitamin D deficiency is correlated with a higher susceptibility to infections due to impaired localized innate immunity and defects in antigen-specific cellular immune response (3,4).

The gut microbiota include an enormous number of microorganisms located in our gut. They act at the interface between the host and nutritional intake to modulate not only immune functions but also metabolic pathways. Recent discoveries on how the gut microbiota are also involved in severe acute malnutrition illuminate their
fundamental role in the pathogenesis of severe acute malnutrition (5). In children with kwashiorkor, the microbiota's metabolic capacity affects the development of the disease (6). Moreover, antibiotic therapy together with ready-to-use therapeutic food improved recovery and reduced mortality in children with kwashiorkor (7). These findings suggest that an immature gut microbiome is an important contributing factor in children with kwashiorkor.

The thymus gland is the main organ for cellular immunity including T cell development, maturation and self- tolerance. Malnutrition due to protein energy deficiency results in changes in the thymus. This includes severe atrophy due to apoptosis-induced thymocyte depletion, as well as a decrease in cell proliferation. The micro environmental compartment of the thymus is also affected in acute infections which are common in malnourished patients (8). Profound changes in the thymus can also be seen in deficiencies of vitamins and trace elements. These changes can be reversed by appropriate supplementation (9). Strategies inducing thymus replenishment should be considered in therapeutic approaches in malnutrition.

References: