

# Oxidative Stress, Motor Abilities, and Behavioral Adjustment in Children Treated for Acute Lymphoblastic Leukemia

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**A**dvan­ces in primary therapy for childhood acute lymphoblastic leukemia (ALL) have resulted in increased five-year survival, which currently approaches 90% (Hunger et al., 2012). Increased overall survival has led to better appreciation of therapy-related morbidity and impaired quality of life (Barr, Feeny, Furlong, Weitzman, & Torrance, 1995; Krull et al., 2008). In contrast to the recognition of childhood cancer-related neurocognitive complications, limited research exists investigating the trajectory of fine motor and visual-motor difficulties and its impact on behavior and emotional function among children with cancer. Even less understanding exists of physiologic risk profiles for neurobehavioral problems in children with leukemia. This study investigated the influence of the oxidative stress pathway on fine and visual-motor skills, as well as behavioral adjustment in children treated for ALL. Oxidative stress results from an imbalance in the production of reactive oxygen species (ROS) and antioxidant defense systems. ROS are formed as byproducts of cellular metabolism, which in excess can result in damage to cellular structures, and antioxidant systems are the body's first line of defense against cellular injury (Roberts et al., 2010; Stenzel et al., 2010). Brain tissue is particularly vulnerable to oxidative stress because of limited antioxidant capacity, higher energy requirements, and higher concentration of lipids (Floyd, 1999).

A child's motor system experiences rapid development during the first two to five years of life, the time when ALL most commonly occurs in children. Childhood ALL treatment increases the risk for long-term fine motor problems that include peripheral neuropathy, sensory loss, reduced deep tendon reflexes, and motor function changes. Vainionpää, Kovala, Tolonen, and Lanning (1995) were among the first to describe

**Purpose/Objectives:** To examine associations among oxidative stress, fine and visual-motor abilities, and behavioral adjustment in children receiving chemotherapy for acute lymphoblastic leukemia (ALL).

**Design:** A prospective, repeated-measures design.

**Setting:** Two pediatric oncology settings in the southwestern United States.

**Sample:** 89 children with ALL were followed from diagnosis to the end of chemotherapy.

**Methods:** Serial cerebrospinal fluid samples were collected during scheduled lumbar punctures and analyzed for oxidative stress biomarkers. Children completed fine motor dexterity, visual processing speed, and visual-motor integration measures at three time points. Parents completed child behavior ratings at the same times.

**Main Research Variables:** Oxidative stress, fine motor dexterity, visual processing, visual-motor integration, and behavioral adjustment.

**Findings:** Children with ALL had below-average fine motor dexterity, visual processing speed, and visual-motor integration following the induction phase of ALL therapy. By end of therapy, visual processing speed normalized, and fine motor dexterity and visual-motor integration remained below average. Oxidative stress measures correlated with fine motor dexterity and visual-motor integration. Decreased motor functioning was associated with increased hyperactivity and anxiety.

**Conclusions:** Oxidative stress occurs following chemotherapy for childhood ALL and is related to impaired fine motor skills and visual symptoms.

**Implications for Nursing:** Early intervention should be considered to prevent fine motor and visual-spatial deficits, as well as behavioral problems.

**Key Words:** childhood leukemia; fine motor dexterity; visual-motor integration; oxidative stress; cerebrospinal fluid

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