

Childhood Leukemia: Peer-Reviewed Analysis

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Childhood Leukemia

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Leukemia is a cancer of the cells in the bone marrow that produce white blood cells. These cells become abnormal and proliferate out of control. Leukemia is the most common kind of cancer in children, causing more deaths than any other form of cancer. Fortunately, improved treatment methods have greatly reduced deaths from leukemia.

There are several forms of leukemia, two of which are particularly important in children - Acute lymphoblastic leukemia (ALL) and acute myelogenous leukemia (AML). ALL is the most common form in children and represents nearly eighty percent of cases of leukemia¹. ALL reaches its greatest frequency in children between 2 and 6, with a peak of more than 80 cases per million children per year at ages 3 to 4. Rates then decline steadily. Leukemia rates are higher among white children than black children.

From 1991 to 1994, the overall incidence rate (number of new cases per year) was 59 cases per million children under five. ALL increased by about 1% per year between 1977 and 1995, though some of this change may result from changes in the groups that are tracked for cancer¹. However, many scientists believe that this change represents a genuine increase in the frequency of the disease that could be caused by environmental factors.

Acute non-lymphocytic leukemia is the second most common form of leukemia in children and represents 19% of cases. It is also called acute myelogenous leukemia (AML). It is the form of leukemia most commonly diagnosed in children less than one year old. Rates are higher at ages 1-3 and in late adolescence. Unlike ALL, the rates for AML do not appear to have increased since 1975¹.

Known and Suspected Causes of Leukemia

Leukemia occurs because of damage to chromosomes or genes². The damage disrupts the process by which blood cells achieve their final and functional form. Scientists believe that two genetic changes are needed to cause leukemia and that one occurs before a child is born.

Environmental exposures that have been linked to childhood leukemia include exposure to ionizing radiation (particularly X rays), exposure of parents or children to pesticides, and certain chemical exposures, particularly to solvents^{3 4 5}. Some studies show that exposure to electric and magnetic fields (EMFs) is associated with increased risk of leukemia. There has been some evidence for an association between leukemia and smoking by parents, though the largest study performed to date did not find that smoking by parents, either before birth or afterwards, increased risk of ALL or AML in children⁶.

Certain parental occupations have been associated with increased risks of having children that develop leukemia. For occupations of the mothers, the most significant are employment in personal services industries, in the chemical industry, in metal processing, and in textiles. For occupations of fathers, employment in painting, in the motor vehicle service industry, in the chemical industry, and in agriculture is associated with increased risk of leukemia in a child.

Ionizing Radiation

Ionizing radiation is considered a "known" cause of childhood leukemia. Follow-up studies of people who survived the detonation of atomic bombs at Hiroshima and Nagasaki found that the risk of leukemia was higher for those exposed to radiation. The risk is also higher for those exposed at an earlier age⁷. Radiation from nuclear power plants is a known cause for both kinds of leukemia⁸. A recent study found that exposure to X rays after birth also increased the risk of leukemia. Infants receiving diagnostic X rays had 60% more leukemia than other children⁹.

Pesticides

Numerous studies have linked leukemia to pesticides. Two recent reviews concluded that pesticide exposure may be a cause of leukemia^{10 11}. These reviews report that most, though not all, studies find that leukemia is more likely in children whose fathers were exposed to pesticides at work. A study of childhood leukemia cases in Shanghai found a more than three-fold increase in risk for children whose mothers were exposed to pesticides at work¹². A small study in the Netherlands reported increased risk of leukemia in children who were exposed to pesticides directly or whose fathers were exposed at work¹³

In 1989, the Children's Cancer Study Group reported that, among families of 204 children with AML, children whose fathers worked with pesticides for more than 1000 days had nearly three times the risk of other children. The risk was greater for children under the age of 6. Children regularly exposed to pesticides in the household had 3.5 times greater risk of leukemia than those not exposed¹⁴. These results have been replicated in another study that found that exposure to either parent or to the child after birth increases risk of AML¹⁵.

Household and garden pesticide use has been repeatedly associated with childhood leukemia in general, and ALL specifically. In a 1987 National Cancer Institute study, the risk of childhood leukemia increased nearly four times when pesticides were used within the house at least once per week. The risk increased more than six times when garden pesticides were used at least once per month¹⁶. Another large recent study of 491 children with ALL found that risk was increased by home use of some kinds of pesticides and by use of multiple different pesticides. Use of weed killers during pregnancy was associated with a 50% increase in risk. Use of insecticides in the home was associated with increased risk of ALL, and frequent use, or use of multiple products, was associated with higher risk¹⁷. Use of pest strips in the home was specifically linked to leukemia in children under age 15 in a different study in the Denver area¹⁸.

Solvents

A 1998 review concluded that the evidence for an association between childhood leukemia and paternal exposure to solvents is "quite strong." Chemicals that have been specifically implicated include chlorinated solvents, benzene, carbon tetrachloride, and trichloroethylene⁵.

Several research studies have looked at paternal occupation, and identified occupational exposures or job categories associated with an increased likelihood of fathering a child who develops leukemia. Job exposures associated with AML include petroleum products¹⁵, solvents in general, plastics (which may contain solvents)¹⁴, chlorinated solvents¹⁶, and benzene¹⁹. Paternal

employment in motor vehicle related jobs is also associated with a doubling of leukemia risk in children²⁰.

Maternal occupational exposures are also relevant. Children born to mothers with exposure to metal dusts, pigments and paints were more likely to have AML¹⁴. Maternal employment in personal service industries (such as drycleaning and hairdressing) are at nearly three-fold risk of having a child who develops leukemia¹⁶. Mothers who work in the chemical industry during pregnancy or who are exposed to hydrocarbons at work, are at greater risk of having a child with ALL²¹, mothers exposed to benzene have children at greater risk for AML, and gasoline exposures to the mother confer increased risk of both AML and ALL¹². A study of nearly 2,000 children found that the risk of ALL was increased if the children's mothers were exposed to solvents, paints, or thinners before conception or during pregnancy, or to plastics after birth. This study reported that the timing of exposure was an important factor²².

EMF - Electric and Magnetic Fields

Evidence about whether non-ionizing radiation, known as electromagnetic fields (EMF), contribute to leukemia in children is contradictory. Several studies have found that exposure to EMF increases risk of leukemia for children^{23 24 25}. Specifically, the risk of leukemia was elevated when exposure to EMF was consistent over the term of the pregnancy and in cases where the design of the water system in the home led to "ground currents" from connections between plumbing pipes and the grounding for the electricity²⁶. However, other large and well-designed studies have failed to find any link^{27 28 29}. A 1995 review of numerous studies reported a link between EMF exposure and childhood leukemia that cannot be explained by errors in the studies³⁰. Yet it seems baffling that large, well-designed studies have found such discordant results.

One possible reason why the studies do not agree is that there are many ways to measure EMF³¹, and the various measurement approaches do not correlate in all cases³². Some of the contradictory results could be due to differences in methods of measuring the EMF. More positive results are found when EMF are measured according to "wire codes," which are classifications based on how wiring is configured³³ than when EMF are measured directly³⁴. Also, as is true with other possible causes, there may be a specific time period when children are most susceptible, or specific subgroups of children that are at higher risk, studies do not necessarily identify the relevant time period and susceptible groups.

One study has looked at exposures of parents to EMF at work before their children were born. Fathers with high exposures were more likely to have children who got leukemia³⁵. This study had several good design elements that avoided problems with recall of exposures by parents.

Radon

One study reported an association between levels of radon in geographic areas and increased risk of childhood leukemia³⁶. Radon is a naturally occurring radioactive gas that gets into homes from materials underneath houses, such as soil or rocks, or from water piped into the houses. Two more studies have investigated whether radon exposure is related to ALL but have not found any relationship^{37 38}. Both of these studies were limited in the conclusions that they could draw because participation rates were low. More research is needed into possible links between radon and childhood leukemia.

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