

Leukemia is characterized by the accumulation of immature, abnormal blood cells in the blood and bone marrow, which compete with normal hematopoietic cells. This condition leads to the failure of normal hematopoiesis, manifesting as anemia, infections, and bleeding. In addition, leukemic cells can invade other tissues and organs. The suppression of normal blood formation is directly related to the clinical symptoms of the disease.

Based on clinical presentation, leukemia is classified as either acute (AL) or chronic, and based on the type of cells from which it originates, it is divided into two main groups: lymphoid and myeloid. In children, leukemia accounts for about one-third of all cancers. Of these, approximately 80% are acute lymphoblastic leukemia (ALL), with an incidence of 3 new cases per 100,000 children and adolescents under the age of 15 per year. In the Czech Republic, approximately 65–70 children are diagnosed annually. Another 15–20% of cases are acute myeloid leukemia, with the remaining cases being chronic myeloid leukemia and other related types. The most common age at diagnosis is between 2 and 6 years.

Molecular analyses of common genetic abnormalities in leukemic cells have contributed to a better understanding of the pathogenesis and to improved prognosis of ALL in children. Chromosomal rearrangements, often present in this disease, lead to aberrant expression of proto-oncogenes and the formation of fusion genes that encode constitutively active kinases and aberrant transcription factors. These genetic changes contribute to the leukemogenic transformation of hematopoietic cells by altering critical regulatory mechanisms—maintaining or promoting self-renewal capacity, disrupting control of normal proliferation, blocking differentiation, and supporting resistance to apoptosis.

Treatment of ALL has made great progress in recent decades. Complete remission is achieved in 98% of all treated children, and more than 70% remain in remission. However, 20–25% of children experience relapse. A key focus in current therapy is the treatment of minimal residual disease—leukemic cells that are resistant to initial chemotherapy.