**Achlorhydria**

**Category:** Diseases, Symptoms, and Conditions  
**Also known as:** Profound hypochlorhydria

**Related conditions:** *Helicobacter pylori* infection, chronic atrophic gastritis, gastric adenocarcinoma, gastric carcinoid

**Definition:** Achlorhydria is the absence of acid secretion by the stomach caused by either atrophy of the acid-producing parietal cells or direct inactivation of the proton-pumping enzyme in parietal cells responsible for acid secretion.

**Risk factors:** The risk of achlorhydria increases with age and with long-term, untreated infection with the bacteria *Helicobacter pylori*. Patients with autoimmune conditions are also at increased risk. The condition has no predilection for sex or race.

**Etiology and the disease process:** Chronic inflammation of the stomach in response to untreated *H. pylori* infection lasting many years leads to the atrophy of stomach cells and a corresponding loss of acid-secreting capacity. Some patients may be more predisposed to achlorhydria in the presence of *H. pylori* because they respond to the infection by producing a specific inflammatory agent that is also a potent proton pump inhibitor. Autoimmune disease can also produce achlorhydria if the body makes antibodies that inactivate parietal cell proteins.

Achlorhydria is associated with the development of malignant cancer of the stomach. Over 60 percent of patients with gastric cancer have achlorhydria compared with 20 percent of healthy individuals. Acid normally acts as a disinfectant to prevent overgrowth of harmful bacteria; achlorhydria contributes to cancer development because the bacteria synthesize carcinogenic chemicals from nitrates present in food.

Achlorhydria is also associated with the formation of gastric carcinoid tumors. If acid output by the stomach is disrupted, the body overproduces the hormone gastrin, which stimulates overgrowth of enterochromaffin-like (ECL) cells in the stomach. This overgrowth may progress to carcinoid formation.

**Incidence:** Gastric carcinoids constitute 0.5 percent of gastric cancers. They are typically associated with autoimmune conditions and have a low risk of malignancy.

**Symptoms:** Achlorhydria itself causes no symptoms; rather, symptoms are secondary to the absence of acid. Lack of acid can cause vitamin B₁₂ or calcium deficiency. Diarrhea may occur because of the overgrowth of bacteria.

**Screening and diagnosis:** Diagnosis is made by measuring the acidity of a stomach fluid sample after an intravenous injection of pentagastrin, which stimulates acid secretion in normal patients. Acidity will not increase in the stomach fluid of achlorhydric patients.

**Treatment and therapy:** Treatment focuses on addressing the underlying condition causing achlorhydria. Because vitamin B₁₂ and calcium absorption are decreased, supplementation or injections of B₁₂ may be necessary.

**Prognosis, prevention, and outcomes:** Restoration of normal acid production depends on prognosis and treatment for the underlying condition responsible for achlorhydria.

*Pamela S. Cooper, Ph.D.*

**See also:** Adenocarcinomas; Bacteria as causes of cancer; Gastric polyps; Gastrointestinal cancers; *Helicobacter pylori*; Hereditary diffuse gastric cancer; Premalignancies; Stomach cancers

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**Acoustic neuromas**

**Category:** Diseases, Symptoms, and Conditions  
**Also known as:** Vestibular schwannomas

**Related conditions:** Neurofibromatosis type 2

**Definition:** Acoustic neuromas are benign (or nonmalignant) tumors that originate from Schwann cells surrounding the vestibular nerve (eighth cranial nerve) in the internal auditory canal. The term “neuroma” is somewhat misleading, as the tumors are not neuromas, nor do they arise from the acoustic or cochlear nerve. Acoustic neuroma typically occurs as unilateral (one-sided) sporadic tumors in 95 percent of all cases, but in rare cases tumors can be bilateral (two-sided) and are associated with an inherited syndrome called neurofibromatosis type 2 (NF2). Approximately 2 to 4 percent of patients diagnosed with acoustic neuromas have NF2 type, a prevalence of 1 in 50,000 in the general population.

**Risk factors:** Although high-dose ionizing radiation is a known risk factor of acoustic neuroma, environmental factors including noise exposure, radio frequency electromagnetic fields, and allergens have been reported as
Diseases, Symptoms, and Conditions: Acoustic neuromas

potential sources that may contribute to the formation of acoustic neuroma. One publication has reported the findings from an international multicenter case-control study that investigated the effects of these environmental factors in ninety-seven patients with acoustic neuroma and in age-matched control subjects. The study reported that increased risks were found for exposure to persistent noise and hay fever, but not for ionizing radiation or for regular mobile phone use.

Etiology and the disease process: Currently, the etiology of acoustic neuroma is not known. However, as an anomaly, it is rarely inherited. Nonetheless, neurofibromatosis type 2 should be suspected in young patients and those with family history. Neurofibromatosis is an autosomal dominant disease; thus patients who inherit a defective copy of the NF2 tumor-suppressor gene have a 95 percent chance of developing bilateral tumors; however, half of the cases have no family history of NF2, which could indicate mutations in the germline that were not inherited.

Incidence: Sporadic acoustic tumors, the most common form of manifestation, occur in approximately 10 per 1 million persons per year—in other words the chance of an average person developing an acoustic neuroma in his or her lifetime is about 1 in 100,000. Neurofibromatosis is rarer, with only several thousand affected persons in the entire United States, corresponding to 1 in 40,000 individuals. However, a study has highlighted that the true incidence of acoustic neuroma may be higher than what has been envisaged, as 7 unsuspected schwannomas per 10,000 brain magnetic resonance imaging studies were identified, an equivalent of 0.07 percent. Acoustic neuromas, or schwannomas, occur largely in adults, typically in the fourth and fifth decades, with a mean presentation age of fifty years. They are uncommon in children; only thirty-nine cases had been reported as of 2007.

Symptoms: Acoustic neuromas are histologically benign; however, if large, they can cause hydrocephalus, brainstem compression, herniation, and eventually death. Hearing loss is the most prevalent symptom, occurring in more than 95 percent of patients, and the duration of hearing loss may extend to three or four years before clinical diagnosis is made—a majority of the patients experience one-sided, slowly progressing hearing impairment associated with high-frequency sounds. Alternative complaints or accompanying symptoms include tinnitus, dizziness, vertigo, and a sensation of fullness in the ear. With the progression of the tumor, patients may experience facial numbness, headaches, loss of coordination, and difficulty in swallowing. Vertigo is prevalent with smaller tumors, while unsteadiness, headache, and facial sensory disturbance are associated with large tumors.

Screening and diagnosis: Acoustic neuroma can be diagnosed by a number of screening methods. These include conventional audiometry, auditory brainstem response (ABR), and gadolinium-enhanced magnetic resonance imaging (MRI). Among these, gadolinium-enhanced MRI is the optimal diagnostic test. Typically, on MRI scans acoustic neuromas appear as dense and uniformly enhanced. Acoustic neuromas are staged according to their location and size. Small tumors are less than 1.5 centimeters (cm), moderate tumors between 1.5 and 3 cm, and large tumors greater than 3 cm in size. Based on the location, they are staged as intracanalicular (located in the internal auditory canal), cisternal (extending outside the internal auditory canal), compressive (having progressed to touch the cerebellum or brainstem), and hydrocephalus (having progressed to obstruct the drainage of cerebrospinal fluid in the fourth ventricle).

Treatment and therapy: The treatment options for acoustic neuroma include observation, microsurgery, stereotactic radiosurgery, and radiotherapy. Patients with advanced age or those deemed unfit for surgical intervention with small tumors at diagnosis are observed; treatment is withheld while tumor progression is monitored in serial imaging studies. However, treatment by observation has its own risks, as there is a greater risk of losing useful hearing.

If microsurgery is the choice for treatment, many factors need to be assessed when evaluating its primary and secondary outcomes. First, there are three standard surgical approaches, each with its own advantages and disadvantages: suboccipital, middle fossa, and translabyrinthine. In the suboccipital approach, the tumor is reached through the skull behind the ear. As the procedure involves the retraction of the cerebellum, the approach is intrinsically dangerous and prone to complications. Although the middle fossa method can preserve hearing in theory, this approach is also dangerous as it too requires the retraction of part of the brain. In the translabyrinthine approach, the tumor is accessed through the inner ear, and thus hearing loss is expected and inevitable. However, this method is unsuitable for large tumors. Second, microsurgery is technically challenging; therefore the rate of success is lower with a less experienced surgeon. Third, large tumors (greater than 3 cm) are difficult to resect without concomitant morbidity, such as facial palsy. Some of the
complications that may arise from microsurgery are cerebrospinal fluid leak (12 percent of all cases), meningitis (5 percent), intracranial hemorrhage (2 percent), facial weakness with complete paralysis (31 percent), and delayed or partial paresis (50 percent).

Radiosurgery refers to the administration of a single fraction of radiotherapy using stereotactic techniques to localize the tumor and align the fields. Radiosurgery may be performed either with a Gamma Knife or a linear accelerator (linac) based system. Gamma Knife is an emerging treatment option for those who are at high risk during microsurgery. High-dose Gamma Knife procedures are less favored due to the possibility of radiation complications; thus low-dose radiation (for example, 13 gray, or Gy) therapies are advised because of safety and lower risk of facial weakness.

Radiotherapy refers to the administration of fractionated radiotherapy and includes stereotactic radiotherapy (radiation with other than gamma rays) and conventional radiotherapy techniques.

Complications of Gamma Knife radiosurgery include injury to facial and trigeminal nerves. However, with the current dosing regimen of 12.5 Gy, the risk of trigeminal or facial nerve injury has decreased significantly. Although the potential for complications is higher with microsurgical procedures than with radiotherapy or radiosurgery, an important issue that should be considered is the low risk of inducing malignancies within the radiation area. Current recommendations are to offer microsurgery and radiosurgery options for patients with definite treatment indications. While microsurgery is the treatment of choice for large tumors because of the low risk of radiation-induced malignancies, microsurgery is also considered for younger patients.

**Prognosis, prevention, and outcomes:** The microsurgical techniques for acoustic neuroma have improved the anatomical and functional preservation of the facial and cochlear nerves. These techniques, accompanied by continuous electrophysiological monitoring, have resulted in marked changes in the primary goals of management. In the past, the primary goal of acoustic neuroma management was to preserve the patient’s life, whereas the objective today is to preserve the neurological function.

Long-term follow-ups show negligible recurrence rates, suggesting that the preservation of neurological function does not restrict the tumor removal. Despite these advances, loss of nerve function and even deafness may occur postoperatively in some cases.

*Bagirathy Ravishankar, Ph.D.*

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**FOR FURTHER INFORMATION**


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**OTHER RESOURCES**

*Acoustic Neuroma Association*
http://anausa.org

*American Cancer Society*
http://www.cancer.org

*See also:* Ependymomas; Neurofibromatosis type 1 (NF1); Schwannoma tumors; Stereotactic Radiosurgery (SRS)

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**Acute Lymphocytic Leukemia (ALL)**

**Category:** Diseases, Symptoms, and Conditions

**Also known as:** Acute childhood leukemia, acute lymphoblastic leukemia, acute lymphoid leukemia

**Related conditions:** Acute myeloid leukemia, chronic lymphocytic leukemia, chronic myeloid leukemia

**Definition:** Acute lymphocytic leukemia (ALL) is a cancer of the white blood cells. A lymphocyte is a type of white blood cell made in the bone marrow that helps fight infection. In this fast-growing type of cancer, for unknown reasons, the bone marrow begins to make lymphocytes that develop abnormally. “Acute” means that the disease affects lymphocytes before they are fully formed and that it progresses rapidly if not treated.

**Risk factors:** Few risk factors exist for ALL. Receiving high doses of radiation, usually as treatment for another
type of cancer, is one risk factor. Exposure to benzene may also be a factor. Risk increases in people with certain other diseases, such as Down syndrome, Fanconi anemia, Bloom syndrome, and some other genetic diseases. In about 25 percent of ALL cases, the patient has a chromosome mutation in which parts of chromosome 9 and chromosome 22 have changed places. Having a sibling, especially a twin, with ALL also increases the risk for this disease. Researchers are exploring lifestyle or environmental relationships, but it appears that many factors, including a combination of genetic and environmental factors, may be involved in developing ALL.

Etiology and the disease process: Through a genetic process that is not completely understood, cells in bone marrow begin to form abnormally. ALL can begin in two different types of lymphocytes, either B cells or T cells. As the abnormal lymphocytes quickly grow, they crowd out the red and white blood cells and platelets that the body needs and that are also created in the bone marrow. The symptoms of ALL come from the crowding out of these normal, healthy cells. These cells may then spread into the lining of the spine and brain.

Incidence: About 5,200 people in the United States were diagnosed with ALL in 2007. It is slightly more common in men than in women and slightly more common in white children than in children of other races. ALL occurs in people of all ages but has a peak incidence in children between the ages of two and five. After age five, risk decreases, then increases again in people over age fifty. It is the most common type of leukemia in children under the age of fifteen, accounting for about 80 percent of childhood leukemias. It occurs more often in developed countries and in people with higher socioeconomic status.

Symptoms: Symptoms of ALL include anemia, body aches, bone pain, bruises without any injury, enlarged lymph nodes, an enlarged spleen, excessive bleeding from minor injuries, fever with no illness or lasting low-grade fever, frequent infections, headaches, joint pain, nosebleeds, paleness, shortness of breath during activity, tiredness, vomiting, and unexplained weight loss.

Screening and diagnosis: There is no screening test for ALL. Blood and bone marrow tests are necessary to diagnose ALL. These tests look for abnormal lymphocyte cells. A bone marrow aspirate test (using a long needle to take marrow out of the bone) and a bone marrow biopsy (surgical removal of some bone marrow) are two possible tests. The bone marrow aspirate test looks for abnormal cells in the bone marrow and can also be used for other types of analysis. A bone marrow biopsy can show how much disease is already in the bone marrow. The results of these tests help determine which type of drug therapy to use and how long treatment should last.

If a patient has been diagnosed with ALL, a lumbar puncture may be performed to see if the abnormal cells have moved into the fluid surrounding the spine and brain. Chest X rays, ultrasounds, or additional blood tests may also be used to determine the spread of the disease.

Depending on where the cancer started and the results of testing, ALL may be categorized into early pre-B-cell ALL, common ALL, pre-B-cell ALL, mature B-cell ALL, pre-T-cell ALL, or mature T-cell ALL. The type of ALL helps determine which therapy to use and how long treatment should last. About 85 percent of ALL cases begin in B cells, and these cases are generally classified as lower risk.

ALL may also be classified or staged using the French-American-British (FAB) classification system. In this older system, ALL is classified according to the type of abnormal cells as follows:

- ALL-11: small, uniform abnormal cells
- ALL-12: large, varied abnormal cells
- ALL-13: large, varied, bubble-like cells

Age at Death for Acute Lymphocytic Leukemia, 2001-2005

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Deaths (%)</th>
</tr>
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<tbody>
<tr>
<td>Under 20</td>
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<tr>
<td>20-34</td>
<td>15.9</td>
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<tr>
<td>35-44</td>
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<td>75-84</td>
<td>11.5</td>
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<td>85 and older</td>
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</table>

Source: Data from National Cancer Institute, Surveillance Epidemiology and End Results, Cancer Stat Fact Sheets, 2008

Note: The median age of death from 2001 to 2005 was forty-seven, with an age-adjusted death rate of 0.5 per 100,000 men and women.
Treatment and therapy: Patients diagnosed with ALL should start treatment immediately. The course and length of treatment chosen depend on the results of the patient’s bone marrow tests, the patient’s age, the number of ALL cells in the blood, whether certain chromosomal changes have already happened, whether ALL cells began in the B cells or the T cells, and whether ALL has spread to the brain covering or spinal cord. During therapy, bone marrow tests may be done again to make sure the treatment is destroying the cancer cells.

The first part of treatment for ALL is called induction therapy. This therapy helps kill ALL cells and get a patient’s blood counts back to normal (remission). Some of the drugs used in induction therapy are given by mouth. Others are given in a vein, usually through the patient’s chest. Most often, this chemotherapy for ALL involves combining drugs to improve the effects of the drugs. Often, ALL spreads into the lining of the spinal cord and the brain. To kill these ALL cells, drugs are injected directly into the spinal fluid. Radiation therapy may be used on the spine and brain either with or without the injected drugs.

Post-induction therapy, the second part of treatment for ALL, begins when a patient has reached remission. This type of therapy is needed because usually some ALL cells that cannot be detected by tests remain in the body. Post-induction therapy usually happens in two- or three-year cycles. The drugs used in post-induction therapy are usually different from those used in induction therapy, and the type of drugs used depends on how the patient responded to induction therapy and whether the patient has certain chromosome abnormalities. A patient may also need maintenance therapy after post-induction therapy to prevent the cells from regrowing.

T-cell ALL, infant ALL, and adult ALL are all forms of high-risk ALL. These types of ALL are usually treated with higher doses of drugs during both induction and post-induction therapy. Some patients with high-risk types of ALL may respond well to bone marrow or cord blood transplant therapy.

A bone marrow or cord blood transplant may be used when high doses of drugs are given to kill the ALL cells. These high doses of drugs may also kill healthy cells in the bone marrow. This transplant gives a patient healthy cells to replace the killed bone marrow cells. A transplant is a high-risk procedure and will probably not be used unless a patient does not have a good possibility of long-term remission with chemotherapy. High-risk ALL patients are more likely to have a transplant. The timing of a transplant is important; a patient has a better chance of a successful transplant when he or she is in remission at the time of transplant.

Prognosis, prevention, and outcomes: There is no known way to prevent ALL. Most children with ALL can be cured of this disease with proper treatment. The overall survival rate for children after chemotherapy is nearly 80 percent. Children with low-risk ALL have even higher survival rates.

Most adults also improve with treatment; the number of adults who have remissions has increased, and the length of adult remissions has improved. The overall survival rate for adults after chemotherapy is about 40 percent, and adults with low-risk ALL have even higher survival rates.

Marianne M. Madsen, M.S.

For Further Information

Other Resources
Association of Cancer Online Resources
http://www.acor.org
CureSearch: National Childhood Cancer Foundation, Children’s Oncology Group
http://www.curesearch.org
Leukemia and Lymphoma Society
http://www.leukemia-lymphoma.org
National Cancer Institute
http://www.cancer.gov/cancertopics/treatment/

See also: Acute Myelocytic Leukemia (AML); Aleukemia; Blood cancers; Childhood cancers; Chronic Lymphocytic Leukemia (CLL); Chronic Myeloid Leukemia (CML); Hemolytic anemia; Leukemias; Myelodysplastic syndromes; Myelofibrosis; Myeloproliferative disorders; Topoisomerase inhibitors