National Institutes of Health

Fact Sheet — *Brain and Other Central Nervous System Cancers*

Yesterday

- In 1975, the age-adjusted incidence of brain and other central nervous system (CNS) cancers, including cancers of the spinal cord, among adults in the United States was 5.9 per 100,000 persons. The age-adjusted incidence of these cancers among children 19 years of age or younger was 2.1 per 100,000. (*Note*: Age adjustment allows more accurate comparison of statistics obtained for different groups.)
- In the same year, the age-adjusted number of deaths from brain and other CNS cancers among adults was 4.1 per 100,000 persons; among children 19 years of age or younger it was 0.9 per 100,000.
- Magnetic resonance imaging (MRI), which allows for the diagnosis and treatment of brain and other CNS tumors with surgery and radiation therapy, first became widely available in the 1980s.
- Clinical trials in the 1970s and 1980s showed that adding radiation therapy to surgery prolonged the survival of patients with glioma, the most common type of malignant brain tumor in adults.
- Chemotherapy was not a standard treatment for brain tumors because most early chemotherapy drugs could not cross the blood-brain barrier. One class of drugs, the nitrosoureas, was found to cross the blood-brain barrier and, when combined with surgery and radiation therapy, was shown in clinical trials to produce a small but clear improvement in the duration of patient survival.

Today

- In 2005, the age-adjusted incidence of brain and other CNS cancers among adults was 6.5 per 100,000 persons; among children 19 years of age or younger it was 2.8 per 100,000. The higher incidence rates observed today are likely due, in part, to an improved ability to diagnose brain and other CNS tumors with advanced imaging technologies.
- MRI is now an accepted standard for imaging brain and other CNS tumors. A newer technology called functional MRI, which measures changes in blood flow that accompany brain activity, can be helpful in determining how well brain regions are working, in assessing potential risk from surgery, and in planning treatment. New intraoperative MRI machines can be used to monitor the extent of tumor removal during surgery.
- The orally administered drug temozolomide, which first became available in the United States in 1999, can prolong the survival of patients with glioma when combined with radiation therapy. High-dose chemotherapy regimens for the treatment of some types of childhood brain tumor can delay the need for radiation therapy, possibly reducing harm to the developing brain.
- Advanced radiation therapy techniques that target tumor tissue more precisely and reduce radiation damage to surrounding normal tissue (such as 3-dimensional conformal therapy, stereotactic radiation therapy, and intensity-modulated radiation therapy) are being refined.
- Researchers are exploring the use of other novel approaches such as targeted therapy, gene therapy, immunotherapy, and vaccine therapy for the treatment of brain and other CNS cancers.

- Scientists are beginning to understand the genetic complexity of brain tumors, which facilitates the design of more effective treatments.

- The Cancer Genome Atlas project reported the first results of its large-scale, comprehensive study of gene changes in glioblastoma (a type of glioma). The Glioma Molecular Diagnostic Initiative has already made extensive genetic and related clinical data, from more than 500 glioma patients, available to researchers worldwide in a public data repository and bioinformatics work space known as REMBRANDT.

- In 2003, the discovery of cancer stem cells in human brain tumors opened new avenues of research. Cancer stem cells make up only a small proportion of the tumors that contain them, but are thought to drive tumor growth and spread. Cancer stem cells may be more resistant to chemotherapy and radiation therapy than other tumor cells, perhaps explaining why many brain cancers are resistant to treatment.

- Despite tremendous advances in our understanding of brain cancer biology, significant progress in our ability to diagnose and treat brain tumors, and marked improvement in patients' quality of life, the long-term prognosis for most patients with brain cancer remains poor. Over the last 30 to 40 years, the mortality rate for brain and other CNS cancers has remained largely unchanged.

Tomorrow

- We will continue to explore the use of new imaging technologies for the diagnosis, treatment, and follow-up care of brain and other CNS cancers.

- Promising new technologies will allow doctors to measure the volume of blood flowing through the brain. These measurements can be used to better estimate tumor grade, size, and location before surgery. They can also improve the ability to distinguish recurrent tumor tissue from damage to brain tissue caused by radiation therapy, reducing the need for follow-up surgical biopsies.

- Additional technologies that could be helpful in assessing response to treatment will measure tumor metabolic activity, tumor-cell proliferation, and the amount of oxygen that reaches tumor cells.

- We will refine methods of delivering chemotherapy drugs and other agents to the brain and CNS, such as developing drugs that have the ability to penetrate the blood-brain barrier. Other delivery techniques, such as convection-enhanced delivery, in which drugs or other anticancer agents are delivered under pressure (convection) through a catheter inserted directly into or near a tumor, may prove valuable.

- New radiation therapy techniques will improve the ability to deliver effective doses of radiation to malignant cells while sparing the normal tissue.

- Intensive research into the genetic changes that lead to the formation of brain and other CNS cancers will yield new opportunities for developing therapies that target these changes.

- We will expand our understanding of the role that cancer stem cells play in the formation and treatment resistance of brain and other CNS tumors and use that knowledge to develop new treatments that target cancer stem cell signaling pathways.

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