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THE EPIDEMIOLOGY OF BRAIN TUMORS IN CHILDREN

PART 1: Descriptive Epidemiology

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Among the childhood malignancies, central nervous system tumors are the most common solid tumor and the second most common malignancy, after leukemia, and represent 20% of all childhood cancers (Figure 1). Central nervous system, or CNS, tumors refer to neoplasms that originate in the brain and spinal cord, with over 90% located in the brain. Approximately one in every 30,000 to 40,000 U.S. children will get a brain tumor. Current treatments include surgery, radiation and chemotherapy. Improving survival in pediatric brain tumors continues to be a challenge. Between 1985-1994, 67% of children with malignant brain tumors survived five years or more from diagnosis (Gurney, 2001). This compares favorably to 59% five-year survival between 1975-1984, and not so favorably to 75% five-year survival between 1983-1990 for children with acute lymphoblastic leukemia (National Cancer Institute, 1996).

CNS tumors are heterogeneous in regards to histology and clinical course and are therefore difficult to classify. Malignancies are grouped according to the International Classification of Childhood Cancer (ICCC) system in broad histological categories. From 1975-1995 astrocytomas accounted for 52% of CNS malignancies, PNET (primitive neuroectodermal tumor including medulloblastomas) 21%, gliomas 15%, ependymomas 9% and other CNS tumors 3% (Figure 2). In this article, we are considering primary (originating in the CNS) and malignant brain tumors only.

Unfortunately, the incidence of malignant pediatric brain tumors is on the rise with a 25% increase in brain cancer incidence from 1973-1991 among children aged 0-15 (National Cancer Institute, 1996). However, during the same time interval mortality declined by 8%. Various factors have been investigated to account for this increase in incidence. Among them have been: 1) improvements in diagnostic techniques, and 2) environmental exposures, such as food preservatives and electromagnetic fields. These topics are the subjects of much research and investigation, but firm results have been inconclusive.

Changes in Incidence--Every year, about 2,200 US children aged less than 20 years are diagnosed with a malignant brain tumor (Gurney, 2001). The overall annual incidence in the United States of pediatric malignant CNS tumors is about 28 per million children younger than 14 years of age (Bunin, 2000).

Differences by age: The overall incidence of CNS tumors is highest in children younger than 8 years of age. This difference is largely attributable to cerebellar PNETs (medulloblastomas), brain stem gliomas and ependymomas that occur almost exclusively in children less than 10-years-old. According to Surveillance, Epidemiology and End Results (SEER) data, the average annual incidence of CNS cancer between 1986 to 1994

varied only slightly by age of diagnosis from infancy through age 7 years (36 per million). For all CNS tumors from age 7 to 10 years, a 40% drop in the incidence rate was observed, with a slight increase from ages 10 to 12, and a second decline from age 12 to 20 (Figure 3). For all ages, the incidence of astrocytomas was highest, peaking at age 5 and 13 years (20 per million). For ages 0-3 years, PNET and ependymoma rates were highest (11 and 7 per million respectively) and then steadily declined. Gliomas had the lowest incidence during infancy with peaks at ages 8 and 17 (9 and 7 per million). Overall ependymoma was the rarest type of brain tumor in children ages 3 to 20 years (Gurney, 2001).

Differences by sex: The overall incidence of invasive CNS tumors between 1990-95 for children ages 0-20 was 24% higher in males than females, with rates of 30 and 24 per million respectively. PNETs showed the largest difference between males and females, followed by ependymomas. There were more males than females with CNS tumors for both white and black children, with a greater difference between boys and girls seen among white children (Gurney, 2001).

Differences by race: CNS tumors are more common in white children compared to black children, with an 18% higher rate between 1900-95. The greatest difference was seen in white males at a 26% higher rate, compared to an 8% higher rate for white females (Gurney, 2001).

Changes Over Time--Pediatric CNS cancer incidence is increasing at an estimated rate of 1.5 % a year. There is a considerable debate as to possible etiologies. Improvements in diagnostic technology may be responsible. The question arises: Is increasing incidence a true rise in new cases or is it an artifact of improved detection by computed tomography (CT) and magnetic resonance imaging (MRI)? In addition, changes in neurosurgical practices, such as stereotactic biopsies, might have contributed to better identification and reporting of pediatric brain tumors as well.

Between 1984 and 1985, the incidence of CNS malignancies jumped from 24 to 30 per million and then remained steady (Gurney, 2001). The timing of this increase coincides with the introduction of MRI in the United States in 1986. This jump could therefore be due to improved imaging modalities that became widely available in the mid-1980s. This observed jump has been seen only for CNS tumors compared to other malignancies during this time, and occurred over a short period. If environmental causes were responsible, a linear increase in incidence would be expected. Although the increase in incidence may be due to improvements in technology and detection, environmental exposures are still a major concern including N-nitroso compounds, food preservatives, and electromagnetic radiation. Future studies will be done to evaluate possible role of different exposures in the etiology of pediatric brain tumors.

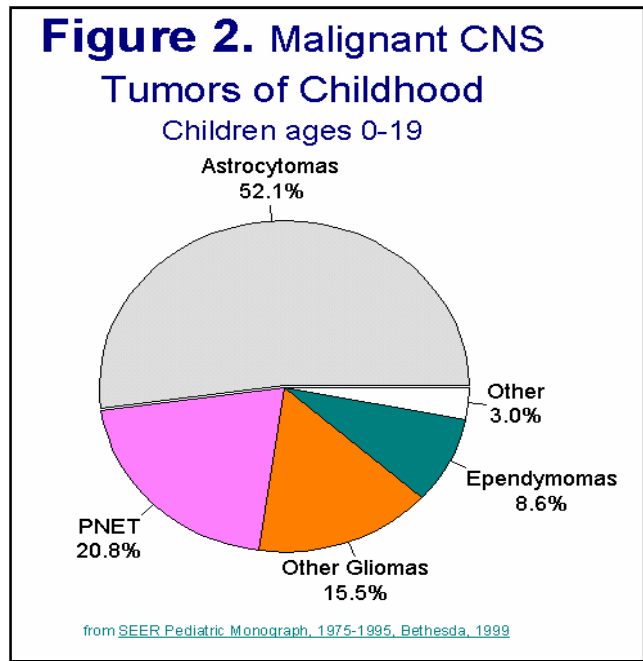
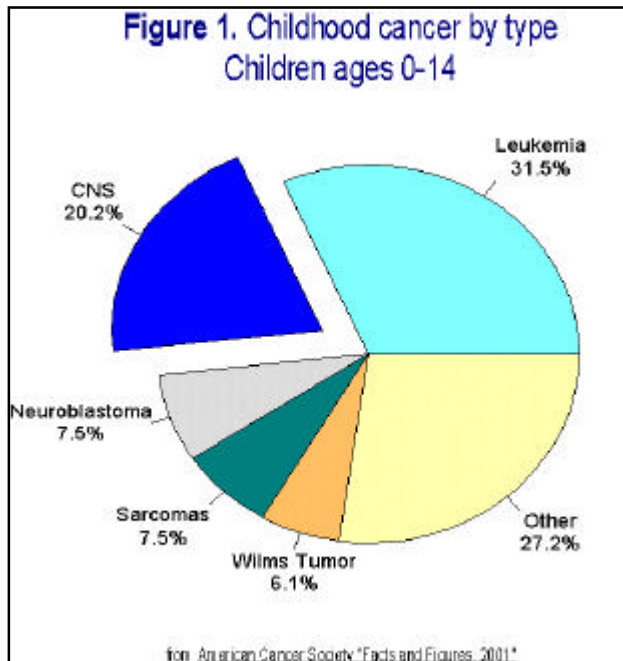
Survival After CNS Tumors--Although children with malignant CNS tumors do not have as favorable a prognosis as do children with other cancers, five-year relative survival rates increased from 59% between 1975-84 to 67% between 1985-94. During these time periods, the greatest increase in survival by age was seen in ages 15-19 by 15% (from 62-77%) with only a 2% increase in ages 0-5 (from 54-56%). Males had a greater increase in survival of 9% compared to 2% for females. White and black children

had similar increase in survival of 6% and 5% respectively. These increases were seen in all tumor types with the greatest improvement in ependymomas (39% to 56%) followed by gliomas (46% to 57%) (Gurney, 2001).

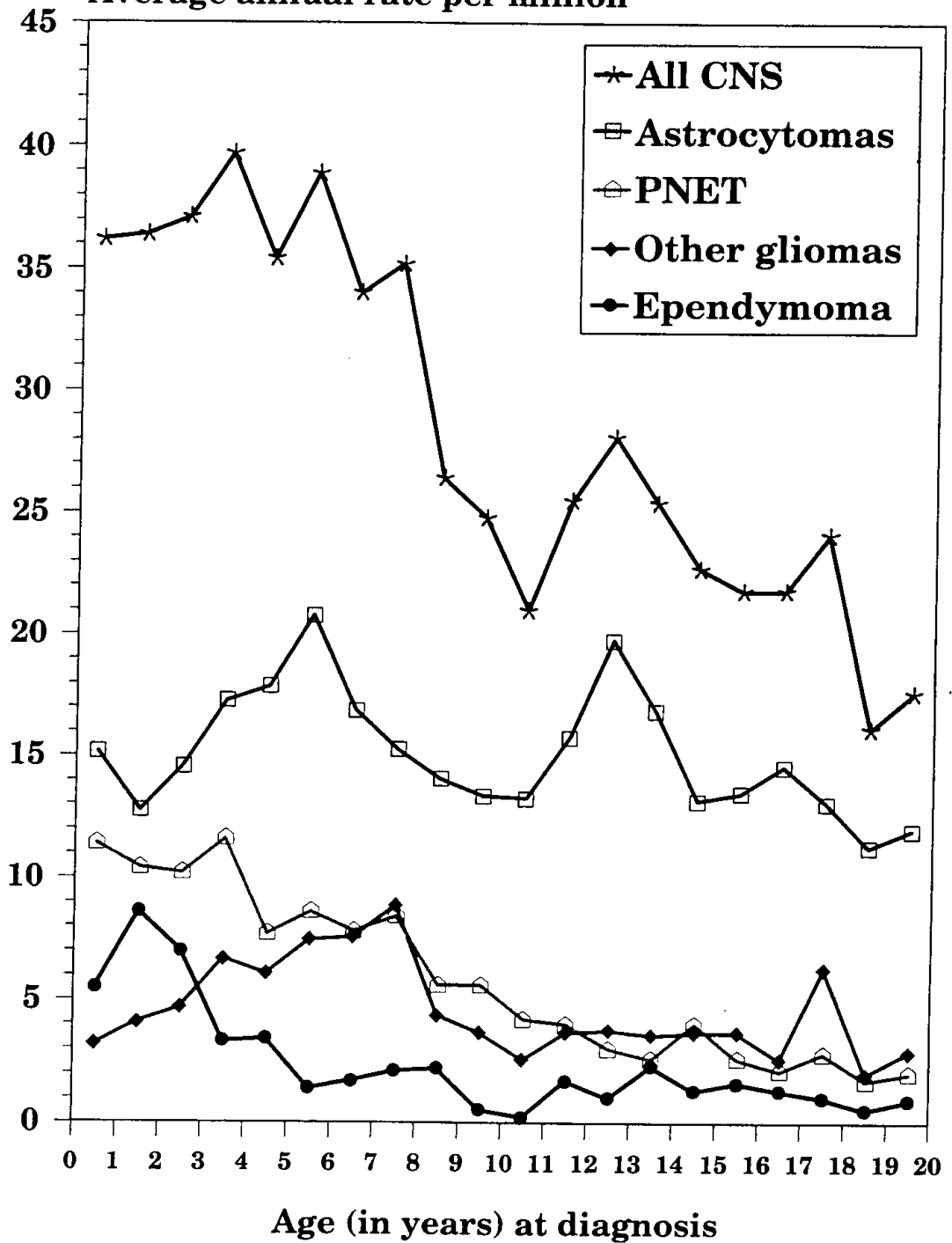
Survivors of pediatric brain tumors may have significant long-term morbidity from their disease and treatment. Fortunately, survival rates for childhood CNS tumors continue to be on the rise as improvements in therapy are being pursued to improve patient survival.

Risk Factors--Like most pediatric cancers, no specific risk factor explains more than a small proportion of childhood brain tumors. The known risk factors for childhood brain tumors include ionizing radiation and certain genetic conditions. Therapeutic doses of ionizing radiation to the head increase the risk of brain tumors in children (Bunin, 2000). Some hereditary conditions clearly predispose to CNS cancer in children. These include neurofibromatosis Type 1, nevoid basal cell carcinoma syndrome, tuberous sclerosis, Turcot syndrome and Li-Fraumeni syndrome (Bunin, 2000). These diseases are rare and not all children with these conditions will get brain tumors.

A number of other potential risk factors are linked to CNS tumors from which the evidence is less conclusive. These include family history, N-nitroso compounds, consumption of cured meat, nutritional habits during pregnancy, pesticides, and of more current interest, electromagnetic fields. These will be discussed further in the second part of this two-part series, which will deal with the risk factors for childhood brain tumors.



Average annual rate per million



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