Agenda

• Background
• Methods of Analysis
• Results
• Discussion
• Future Directions
• Childhood cancers have been reported to be on the rise

• Primary brain tumors are the most common solid tumor and the second most common cancer in children after Leukemia
  • 20% of all cancers
  • Affects 2,500 children in the U.S. every year

• No definitive risk factors have been found

• Childhood tumors appear in different locations and behave differently from adult brain tumors
Since 2004, benign brain tumors have been consistently collected in registries.

The most common brain tumors:
- Medulloblastoma
- Astrocytoma
- Ependymomas
- Primitive neuroectodermal tumors
- Craniopharyngiomas
- Mixed glial and neuronal tumors
- Choroid plexus tumors
Purpose

• To explore incidence and survival for primary brain tumors (benign vs. malignant) in California children
  • Determine if any differences are present in regards to malignancy among demographic characteristics.

• Analyze trends of malignant and benign brain tumors
Methods

• Study Inclusion Criteria
  • Patients with primary brain tumors were identified through the California Cancer Registry (CCR)
    • Population-based database that contains data on California residents diagnosed with any reportable cancer since 1988
  • Males and Females
  • Children ≤19 years old
  • Diagnosed 1988-2013
    • Analyses including benign brain tumors only use years 2004-2013
  • Malignant or benign brain tumor (Site Codes: C710-C719)
    • Other CNS C700-C709, C720-C729 were not included in this study
  • Resident of California at time of their diagnosis
Methods Cont.

- Data were analyzed using SEER*Stat and the Joinpoint Regression Program
- Incidence rates were calculated for both benign and malignant tumors
  - Years: 2004-2013
- Trend analysis: primary endpoint in this analysis was the annual percent change (APC)
  - Years: 2004-2013
- Survival: Two and Five year cause-specific survival analysis
  - Malignant cancer only
  - Years: 1988-2013
Results

Distribution and Incidence Rates
Total Study Population

N=3,221 cases of childhood brain tumors from 2004-2013

• Malignant
  • 2,544 cases (79%)

• Benign
  • 667 cases (21%)
Distribution: Age

- **MALIGNANT**
  - < 1 year: 6%
  - 01-04 years: 28%
  - 05-09 years: 26%
  - 10-14 years: 21%
  - 15-19 years: 19%

- **BENIGN**
  - < 1 year: 6%
  - 01-04 years: 27%
  - 05-09 years: 22%
  - 10-14 years: 26%
  - 15-19 years: 19%
### Incidence Rates (95% CI)

<table>
<thead>
<tr>
<th>Age</th>
<th>Malignant</th>
<th>Benign</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 year old</td>
<td>3.20 (2.73-3.73)</td>
<td>0.78 (0.56-1.06)</td>
</tr>
<tr>
<td>1-4 years old</td>
<td><strong>3.22 (2.98-3.48)</strong></td>
<td>0.63 (0.52-0.75)</td>
</tr>
<tr>
<td>5-9 years old</td>
<td>2.87 (2.67-3.09)</td>
<td>0.60 (0.51-0.71)</td>
</tr>
<tr>
<td>10-14 years old</td>
<td>2.00 (1.84-2.18)</td>
<td>0.67 (0.57-0.77)</td>
</tr>
<tr>
<td>15-19 years old</td>
<td>1.81 (1.65-1.98)</td>
<td>0.64 (0.55-0.74)</td>
</tr>
</tbody>
</table>
Distribution: Race/Ethnicity

**MALIGNANT**
- Non-Hispanic White: 43%
- Non-Hispanic Black: 6%
- Hispanic: 39%
- Asian/Pacific Islander: 2%
- Other/Unknown: 10%

**BENIGN**
- Non-Hispanic White: 41%
- Non-Hispanic Black: 6%
- Hispanic: 42%
- Asian/Pacific Islander: 8%
- Other/Unknown: 3%
<table>
<thead>
<tr>
<th>Race</th>
<th>Malignant</th>
<th>Benign</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH White</td>
<td>3.09 (2.90-3.29)</td>
<td>0.87 (0.77-0.98)</td>
</tr>
<tr>
<td>NH Black</td>
<td>2.08 (1.75-2.44)</td>
<td>0.56 (0.40-0.76)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2.14 (2.02-2.27)</td>
<td>0.53 (0.47-0.60)</td>
</tr>
<tr>
<td>NH Asian/PI</td>
<td>2.17 (1.91-2.45)</td>
<td>0.43 (0.32-0.57)</td>
</tr>
<tr>
<td>Sex</td>
<td>Malignant</td>
<td>Benign</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Males</td>
<td>2.67 (2.53-2.81)</td>
<td>0.69 (0.62-0.77)</td>
</tr>
<tr>
<td>Females</td>
<td>2.26 (2.13-2.39)</td>
<td>0.59 (0.52-0.66)</td>
</tr>
</tbody>
</table>
### Incidence Rates (95% CI)

<table>
<thead>
<tr>
<th>SES</th>
<th>Malignant</th>
<th>Benign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.54 (0.50-0.59)</td>
<td>0.13 (0.11-0.15)</td>
</tr>
<tr>
<td>Middle Low</td>
<td>0.52 (0.47-0.56)</td>
<td>0.10 (0.08-0.12)</td>
</tr>
<tr>
<td>Middle</td>
<td>0.46 (0.42-0.50)</td>
<td>0.12 (0.10-0.15)</td>
</tr>
<tr>
<td>Middle High</td>
<td>0.49 (0.44-0.53)</td>
<td>0.13 (0.11-0.16)</td>
</tr>
<tr>
<td>High</td>
<td>0.46 (0.42-0.51)</td>
<td>0.15 (0.13-0.18)</td>
</tr>
</tbody>
</table>
Distribution: Histology

**TOP MALIGNANT**
- Glioma: 30%
- Embryonal/Medulloblastoma: 20%
- Astrocytoma: 15%
- Pilocytic astrocytoma: 22%

**TOP BENIGN**
- Glioma: 41%
- Astrocytoma: 20%
- Neurofibroma: 17%
- Neuronal/Glial: 22%
Malignant brain tumors by site

Cerebellum: 27.8%
Cerebrum: 8.03%
Ventricle: 8.03%
Brainstem: 7.83%
Overlapping lesion: 4.9%
Brain NOS: 8.61%
Benign brain tumors by site

- Cerebellum: 2.1%
- Cerebrum: 6.15%
- Ventricle: 8.85%
- Brainstem: 9.45%
- Frontal Lobe: 20.09%
- Overlapping lesion: 10.04%
- Brain NOS: 15.14%

- Cerebrum: 2.55%
- Ventricle: 21.44%
- Brainstem: 4.2%
Results Cont.

Trend Analysis
Trend Analysis: Age

Malignant

Incidence Rates

Year of Diagnosis

Benign

Incidence Rates

Year of Diagnosis

*APC <1 year olds Benign: -39.60^ for 2009-2013
Trend Analysis: Race/Ethnicity

**Malignant**

- NH White
- NH Black
- Hispanic
- NH API

**Benign**

- NH White
- NH Black
- Hispanic
- NH API

*APC NHW Benign: -5.17^ for 2004-2013
APC NHB Malignant: 4.58^ for 2004-2013
APC NHB Benign: 111.81 for 2004-2013
APC Hispanic Malignant: -2.04^ for 2004-2013
Trend Analysis: Sex

**Malignant**

**Benign**

Incidence Rates by Year of Diagnosis for Malignant and Benign conditions, showing trends by sex.
Survival Analysis

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Malignant</th>
<th>Benign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alive</td>
<td>2,422 (75%)</td>
<td>1,781 (70%)</td>
<td>641 (96%)</td>
</tr>
<tr>
<td>Deceased</td>
<td>799 (25%)</td>
<td>773 (30%)</td>
<td>26 (0.04%)</td>
</tr>
</tbody>
</table>
Survival Analysis: Overall (Malignant Only)

Overall 5-Year Survival
Survival Analysis: Age (Malignant Only)

5-Year Survival by Age

Year of Diagnosis

Cause Specific Survival


< 1 Years 01-04 Years 05-09 Years 10-14 Years 15-19 Years
Survival Analysis: Race/Ethnicity (Malignant Only)

5-Year Survival by Race/Ethnicity

Year of Diagnosis

Cause Specific Survival

- Non-Hispanic White
- Non-Hispanic Black
- Hispanic
- Asian/Pacific Islander
Survival Analysis: Sex (Malignant Only)

5-Year Survival by Sex

Year of Diagnosis

Cause Specific Survival

Male

Female
Discussion

• No major difference for the distribution of benign and malignant cancer by age, sex, race, SES
  • 1-4 year olds had the highest incidence rate for malignant, <1 year olds for benign
  • Non-Hispanic Whites and Hispanics have the largest percentage of malignant and benign brain tumors
    • Non-Hispanic White highest incidence rate

• Trend Analysis:
  • Age: decreasing, most not significant
    • < 1 year old statistically significant decrease in benign incidence rates
  • Non-Hispanic whites showed a statistically significant decrease in benign
    • Non-Hispanic black statistically significant increase in malignant
      • Large increase in benign, but not statistically significant

• Survival:
  • Two and five year survival has remained steady with some evidence of increased survival trends occurring.
Future Directions

• Conduct a trend test using joinpoint on the survival analysis results to detect any statistically significant increases and/or decreases in survival

• Conduct spatial analysis of childhood brain tumors (benign vs. malignant)
  • Spatial clusters, distribution of cases

• Investigate birth characteristics in relationship to CA children with benign and malignant brain tumors
  • Probabilistic record linkage to match cases from two data sources
Thank you!

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916-779-0284
estewart@crgc-cancer.org
Trend Analysis: Histology

### Malignant Only

<table>
<thead>
<tr>
<th>Year of Diagnosis</th>
<th>Glioma</th>
<th>Embryonal/Medulloblastoma</th>
<th>Astrocytoma</th>
<th>Pilocytic Astrocytoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.8</td>
<td>0.6</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>2005</td>
<td>0.7</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>2006</td>
<td>0.6</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2007</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2008</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2009</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td>2010</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2011</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td>2012</td>
<td>0.1</td>
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<td>0.1</td>
<td>0.1</td>
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<tr>
<td>2013</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Benign Only

<table>
<thead>
<tr>
<th>Year of Diagnosis</th>
<th>Glioma</th>
<th>Astrocytoma</th>
<th>Neurofibroma (B Only)</th>
<th>Neuronal/Glia (B Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.2</td>
<td>0.1</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>2005</td>
<td>0.2</td>
<td>0.1</td>
<td>0.05</td>
<td>0.05</td>
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<tr>
<td>2006</td>
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<td>0.1</td>
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<td>2010</td>
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<tr>
<td>2012</td>
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<td>0.1</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>2013</td>
<td>0.2</td>
<td>0.1</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

### Total 2 Most Common Histologies

<table>
<thead>
<tr>
<th>Year of Diagnosis</th>
<th>Total Glioma</th>
<th>Total Astrocytoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>2005</td>
<td>0.7</td>
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<td>0.3</td>
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<tr>
<td>2008</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>2009</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>2010</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2011</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2012</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2013</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Joinpoint Results: Average Percent Change

<table>
<thead>
<tr>
<th>Histology</th>
<th>Overall</th>
<th>Malignant</th>
<th>Benign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glioma</td>
<td>-1.71</td>
<td>-1.33</td>
<td>-3.91</td>
</tr>
<tr>
<td>Embryonal/ Medulloblastoma</td>
<td>-2.16</td>
<td>-2.16</td>
<td>N/A</td>
</tr>
<tr>
<td>Astrocytoma</td>
<td>1.18</td>
<td>0.38</td>
<td>4.51</td>
</tr>
<tr>
<td>Pilocytic Astrocytoma</td>
<td>-0.12</td>
<td>-0.12</td>
<td>N/A</td>
</tr>
<tr>
<td>Neurofibroma</td>
<td>-1.67</td>
<td>N/A</td>
<td>-1.67</td>
</tr>
<tr>
<td>Neuronal/Glia</td>
<td>-1.08</td>
<td>N/A</td>
<td>-1.08</td>
</tr>
</tbody>
</table>
Survival Analysis: Histology (Malignant Only)

2-Year Survival by Histology

5-Year Survival by Histology