

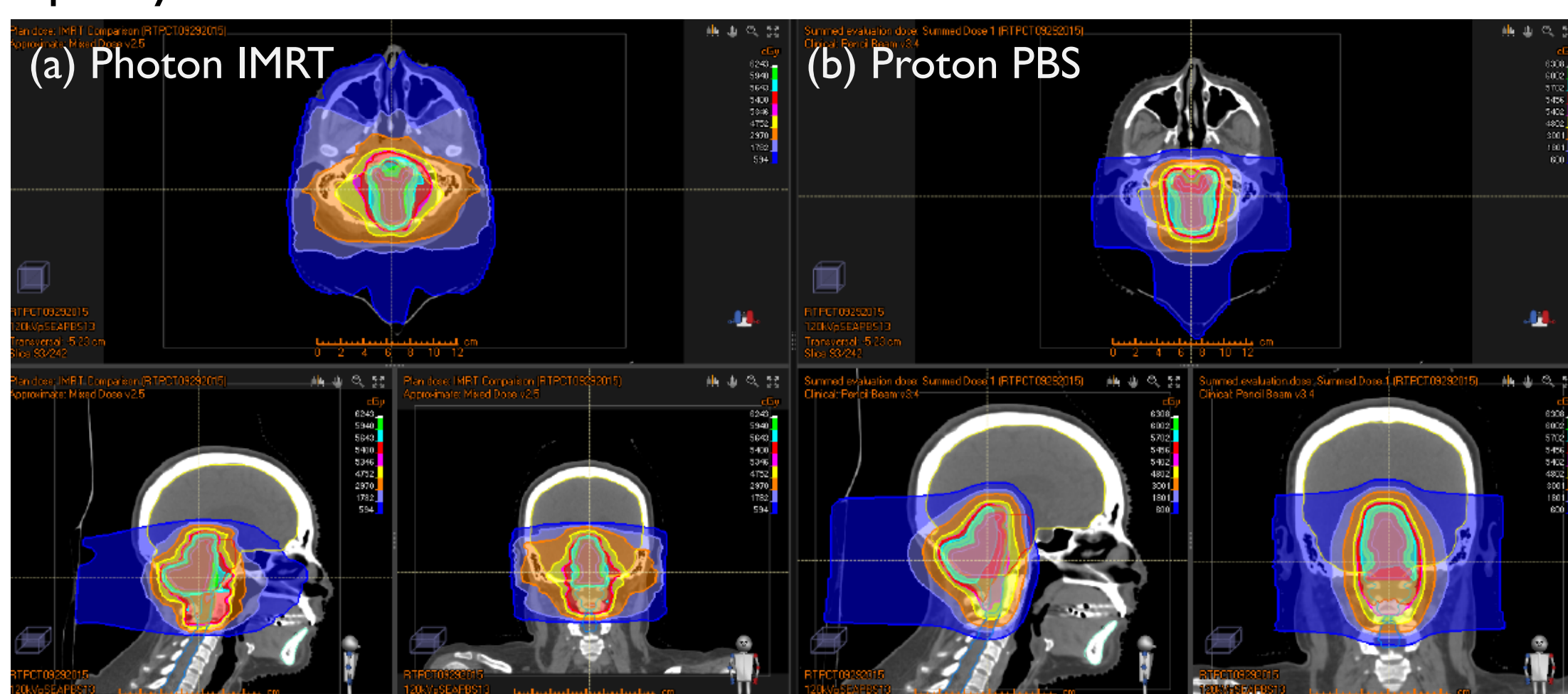
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## Background

- Proton therapy (PT) is associated with reduced integral dose to normal brain tissue (Figure 1). While preliminary data is evolving on the efficacy of PT for CNS tumors, little is known regarding which CNS patients are treated with PT.
- We hypothesized that a large proportion of CNS patients treated with PT are young (pediatrics:  $\leq 18$  years, young adults: 19-40 years) given the longer life expectancy over which they are at risk for CNS toxicity.

**Figure 1.** (a) Photon intensity-modulated RT (IMRT) plan and (b) proton pencil-beam scanning (PBS) plan for a 5-year-old boy with ependymoma.



## Methods

**Cohort:** 1295 patients with diagnosis of primary brain tumor treated with PT between 2009-2017 at 8 academic and community PT centers in the United States

- Patients enrolled onto prospective Proton Collaborative Group (PCG) registry
- Excluded patients with spine tumors (n=8)
- Pathology locally reviewed and classified as per 2007 WHO classification of tumors of the CNS<sup>1</sup>
- Age categorized as
  - Pediatrics:  $\leq 18$  years
  - Young adult: 19-40 years
  - Adult:  $>40$  years

### Statistical considerations

- Descriptive analysis: relative proportion of WHO classification of tumors by age category

## Results

### Patient characteristics (Table 1)

- Patients were young at PT treatment
- Most common WHO classification of tumors: astrocytic tumors, tumors of the meninges, and embryonal tumors

### WHO classification of tumors by age category (Figure 1)

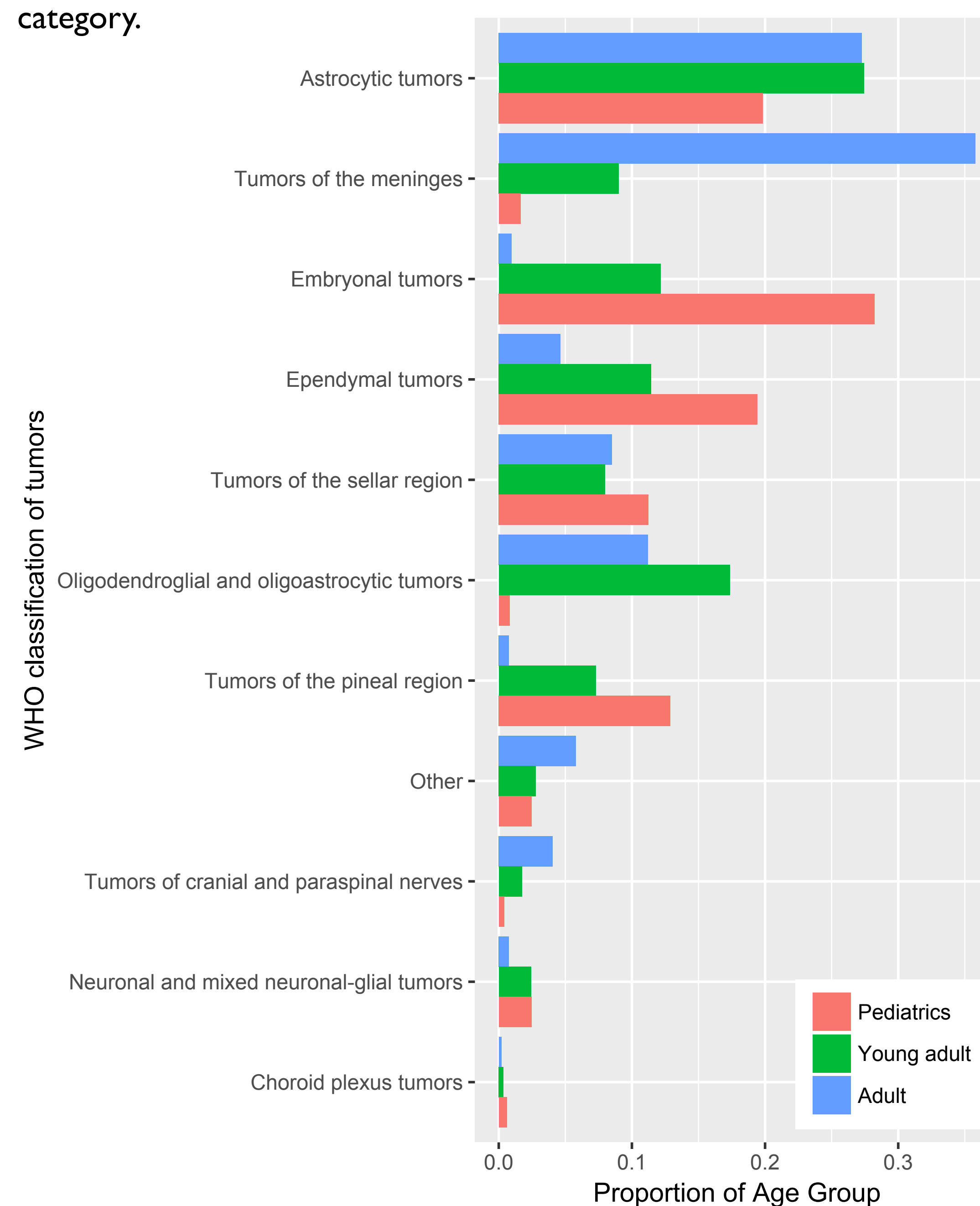
- Pediatrics: embryonal tumors (28.2%), astrocytic tumors (19.8%), ependymal tumors (19.4%)
- Young adults: astrocytic tumors (27.4%), oligodendroglial and oligoastrocytic tumors (17.4%), embryonal tumors (12.2%)
- Adults: tumors of meninges (35.8%), astrocytic tumors (27.3%), oligodendroglial and oligoastrocytic tumors (11.2%)

## Results

**Table 1.** Characteristics of patients with CNS tumors treated with PT.

	N=1295
Sex	
Male	680 (52.5%)
Female	614 (47.4%)
Age at RT, median (range, years)	30.7 (0.73-92.2)
Race	
White	1020 (78.8%)
African American	81 (6.3%)
American Indian or Alaska native	9 (0.7%)
Pacific Islander	3 (0.2%)
Other/unknown	141 (10.9%)
WHO classification of tumors	
Astrocytic tumors	317 (24.5%)
Tumors of the meninges	220 (17.0%)
Embryonal tumors	178 (13.7%)
Ependymal tumors	152 (11.7%)
Tumors of the sellar region	122 (9.4%)
Oligodendroglial and oligoastrocytic tumors	112 (8.6%)
Tumors of the pineal region	88 (6.8%)
Other	50 (3.9%)
Tumors of the cranial and paraspinal nerves	28 (2.2%)
Neuronal and mixed neuronal-glioma tumors	23 (1.8%)
Choroid plexus tumors	5 (0.4%)
Age category	
Pediatrics ( $\leq 18$ years)	489 (37.8%)
Young adult (19-40 years)	288 (22.2%)
Adult ( $>40$ years)	517 (39.9%)

**Figure 1.** Grouped bar chart of WHO classification of tumors by age category.



### References

1. Louis DN et al. The 2007 WHO classification of tumours of the central nervous system. *Acta Neuropathol* 2007;114(2): 97-109.

## Results

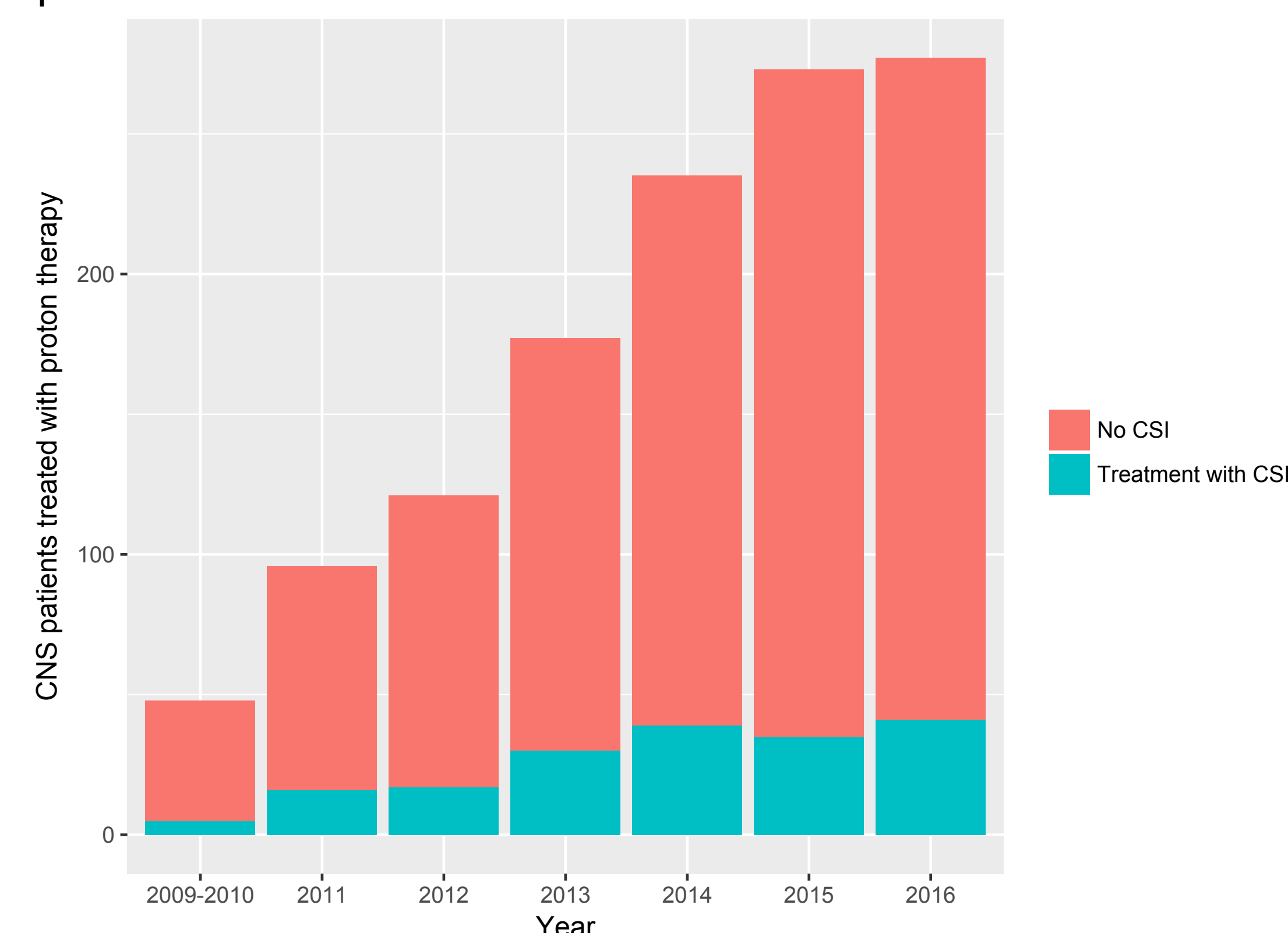
### Proton radiation timing and intent

- PT used more frequently at initial diagnosis (67.3%) than recurrence (32%). Timing was unknown in n=7 (0.5%)
- N=184 (14.2%) had prior radiation
  - Astrocytic tumors (35.3%)
  - Tumors of the meninges (27.2%)
  - Oligodendroglial and oligoastrocytic tumors (10.3%)
- N=19 (1.5%) treated with palliative intent
  - 5 at initial diagnosis (26.3%)
  - 14 at recurrence (73.7%)

### Cranial-spinal irradiation (CSI) (Figure 2)

- N=195 (15.1%) treated with CSI
  - Embryonal tumors (71.3%)
  - Tumors of the pineal region (16.9%)
  - Ependymal tumors (4.1%)
- CSI use by age category
  - Pediatrics (63.6%)
  - Young adult (30.3%)
  - Adult (6.2%)
- CSI use remained relatively constant over time

**Figure 2.** Bar chart of number of CNS patients treated with proton therapy over time, categorized by receipt of cranial and spinal irradiation (CSI) or not. Note that PT centers joined the PCG registry at different times, which in part contributes to the increased number of patients treated over time.



## Summary and conclusions

- Primary brain tumor patients treated with PT are young, with the majority treated for relatively favorable tumor types
  - Likely reflects selection of patients that may derive the greatest benefit from reduction in brain dose
- A wide variety of tumors are being treated with PT
- PT is used in a notable minority of patients for recurrent disease. Approximately 15% of patients had prior RT
  - PT likely used to minimize dose to adjacent cranial structures in light of re-treatment
- Additional studies including comparison of tumor types among CNS patients treated with photons are warranted