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RESEARCH ARTICLE

How long should survivors of pediatric medulloblastoma and ependymoma be screened for recurrence? A retrospective cohort study

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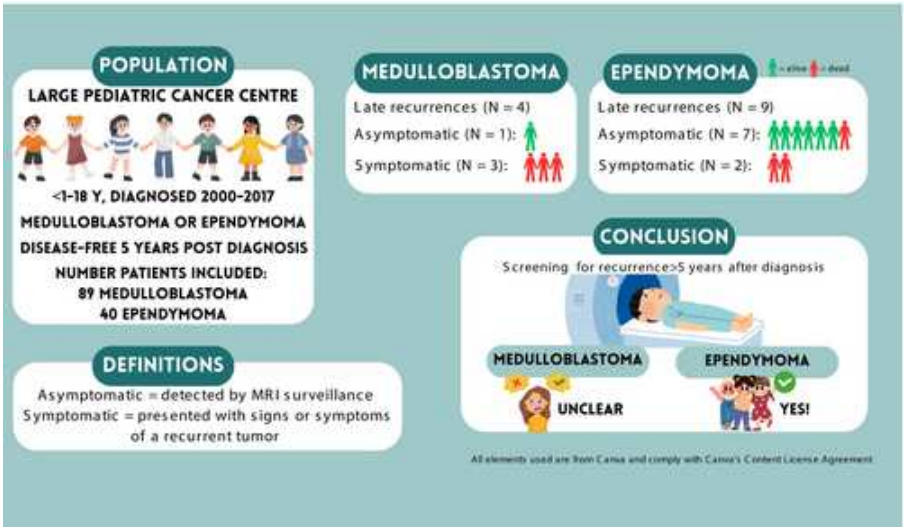
Abstract

Recurrence is the most common cause of late mortality in pediatric brain tumor survivors. However, it is unclear how long such patients should be monitored with periodic neuroimaging. Therefore, we investigated the utility of neuroimaging surveillance for recurrence ≥5 years post diagnosis in survivors of pediatric medulloblastoma and ependymoma. We conducted a retrospective study of survivors of medulloblastoma or ependymoma treated between 2000 and 2017. Eligible survivors were disease-free 5 years after diagnosis and underwent magnetic resonance imaging surveillance ≥5 years after diagnosis. Medulloblastoma survivors with a history of recurrence <5 years after diagnosis were excluded. Of 302 children diagnosed in the study period, 129 met inclusion criteria (89 medulloblastoma/40 ependymoma; 77 (59.7%) male; median age at diagnosis 6 years (range < 1–13); median time from diagnosis to last scan 134 months (61–283)). Four medulloblastoma patients had late recurrent disease, one of which was detected on routine neuroimaging (asymptomatic). All medulloblastoma patients with late recurrence died, except for one previously unirradiated patient who was disease-free 29 months after recurrence. Nine ependymoma patients had late recurrence of which 7 were detected on routine neuroimaging. Six out of seven asymptomatic late recurrent ependymoma patients remain alive with a median time after recurrence of 45.5 months (range: 3–121). Both symptomatic patients died. Among ependymoma survivors, asymptomatic detection of late recurrence by surveillance neuroimaging was associated with better survival than symptomatic detection, supporting the continuation of surveillance for at least 10 years after diagnosis. The benefit of prolonged surveillance in medulloblastoma survivors remains uncertain.

What's New?

The optimal duration of periodic neuroimaging for long-term survivors of pediatric brain tumors remains undefined. In this study, the authors evaluated the utility of neuroimaging surveillance for disease recurrence more than 5 years post-diagnosis among survivors of pediatric medulloblastoma and ependymoma. Analyses show that routine imaging in asymptomatic stages of disease that results in the detection of late ependymoma recurrence is associated with improved survival, relative to detection during symptomatic stages. A similar association was not observed for recurrent medulloblastoma. The findings indicate that continued neuroimaging surveillance at least 10 years after diagnosis is beneficial specifically for ependymoma survivors.



CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

Open Research

DATA AVAILABILITY STATEMENT

Deidentified data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1 Pollack IF. Brain tumors in children. *N Engl J Med*. 1994; **331**(22): 1500-1507.

CAS | PubMed | Web of Science® | Google Scholar

2 Ostrom QT, Price M, Neff C, et al. CBTRUS statistical report: primary brain and other central nervous system tumors diagnosed in the United States in 2015-2019. *Neuro Oncol*. 2022; **24**(Suppl 5): v1-v95.

CAS | PubMed | Google Scholar

3 Wells EM, Packer RJ. Pediatric brain tumors. *Continuum (Minneap Minn)*. 2015; **21**(2): 373-396.

PubMed | Google Scholar

4 Curtin SC, Minino AM, Anderson RN. Declines in cancer death rates among children and adolescents in the United States, 1999-2014. *NCHS Data Brief*. 2016; **257**: 1-8.

Google Scholar

5 Brandão LA, Young PT. Posterior Fossa Tumors. *Neuroimaging Clin N Am*. 2017; **27**(1): 1-37.

PubMed | Web of Science® | Google Scholar

6 Menyhárt O, Győrffy B. Molecular stratifications, biomarker candidates and new therapeutic options in current medulloblastoma treatment approaches. *Cancer Metastasis Rev*. 2020; **39**(1): 211-233.

PubMed | Web of Science® | Google Scholar

7 Zeltzer PM, Boyett JM, Finlay JL, et al. Metastasis stage, adjuvant treatment, and residual tumor are prognostic factors for medulloblastoma in children: conclusions from the Children's cancer group 921 randomized phase III study. *J Clin Oncol*. 1999; **17**(3): 832-845.

CAS | PubMed | Web of Science® | Google Scholar

8 Hill RM, Kuijper S, Lindsey JC, et al. Combined MYC and P53 defects emerge at medulloblastoma relapse and define rapidly progressive, therapeutically targetable disease. *Cancer Cell*. 2015; **27**(1): 72-84.

CAS | PubMed | Web of Science® | Google Scholar

9 Ramaswamy V, Remke M, Bouffet E, et al. Recurrence patterns across medulloblastoma subgroups: an integrated clinical and molecular analysis. *Lancet Oncol*. 2013; **14**(12): 1200-1207.

CAS | PubMed | Web of Science® | Google Scholar

10 Pizer B, Donachie PH, Robinson K, et al. Treatment of recurrent central nervous system primitive neuroectodermal tumours in children and adolescents: results of a Children's cancer and Leukaemia group study. *Eur J Cancer*. 2011; **47**(9): 1389-1397.

PubMed | Web of Science® | Google Scholar

11 Sabel M, Fleischhack G, Tippelt S, et al. Relapse patterns and outcome after relapse in standard risk medulloblastoma: a report from the HIT-SIOP-PNET4 study. *J Neurooncol*. 2016; **129**(3): 515-524.

PubMed | Web of Science® | Google Scholar

12 Tsang DS, Murray L, Ramaswamy V, et al. Craniospinal irradiation as part of re-irradiation for children with recurrent intracranial ependymoma. *Neuro Oncol*. 2019; **21**(4): 547-557.

CAS | PubMed | Web of Science® | Google Scholar

13 Tsang DS, Burghen E, Klimo P Jr, Boop FA, Ellison DW, Merchant TE. Outcomes after reirradiation for recurrent pediatric intracranial ependymoma. *Int J Radiat Oncol Biol Phys*. 2018; **100**(2): 507-515.

PubMed | Web of Science® | Google Scholar

14 Byer L, Kline CN, Coleman C, Allen IE, Whitaker E, Mueller S. A systematic review and meta-analysis of outcomes in pediatric, recurrent ependymoma. *J Neurooncol*. 2019; **144**(3): 445-452.

PubMed | Web of Science® | Google Scholar

15 Saleh AH, Samuel N, Juraschka K, Saleh MH, Taylor MD, Fehlings MG. The biology of ependymomas and emerging novel therapies. *Nat Rev Cancer*. 2022; **22**(4): 208-222.

CAS | PubMed | Web of Science® | Google Scholar

16 Morris EB, Gajjar A, Okuma JO, et al. Survival and late mortality in long-term survivors of pediatric CNS tumors. *J Clin Oncol*. 2007; **25**(12): 1532-1538.

PubMed | Web of Science® | Google Scholar

17 Mertens AC, Liu Q, Neglia JP, et al. Cause-specific late mortality among 5-year survivors of childhood cancer: the childhood cancer survivor study. *J Natl Cancer Inst*. 2008; **100**(19): 1368-1379.

PubMed | Web of Science® | Google Scholar

18 Coltin H, Pequeno P, Liu N, et al. The burden of surviving childhood medulloblastoma: a population-based, matched cohort study in Ontario. *Canada J Clin Oncol*. 2023; **41**(13): 2372-2381.

CAS | PubMed | Web of Science® | Google Scholar

19 Janss AJ, Mazewski C, Patterson B. Guidelines for treatment and monitoring of adult survivors of pediatric brain tumors. *Curr Treat Options Oncol*. 2019; **20**(1): 10.

PubMed | Web of Science® | Google Scholar

20 Main C, Stevens SP, Bailey S, et al. The impact of routine surveillance screening with magnetic resonance imaging (MRI) to detect tumour recurrence in children with central nervous system (CNS) tumours: protocol for a systematic review and meta-analysis. *Syst Rev*. 2016; **5**(1): 143.

PubMed | Google Scholar

21 Landier W, Wallace WH, Hudson MM. Long-term follow-up of pediatric cancer survivors: education, surveillance, and screening. *Pediatr Blood Cancer*. 2006; **46**: 149-158.

PubMed | Web of Science® | Google Scholar

22 Stevens SP, Main C, Bailey S, et al. The utility of routine surveillance screening with magnetic resonance imaging to detect tumor recurrence/progression in children with high-grade central nervous system tumors: a systematic review. *Pediatr Blood Cancer*. 2019; **66**(2):e27509.

PubMed | Web of Science® | Google Scholar

23 Weiser DA, Kaste SC, Siegel MJ, Adamson PC. Imaging in childhood cancer: a Society for Pediatric Radiology and Children's oncology group joint task force report. *Pediatr Blood Cancer*. 2013; **60**(8): 1253-1260.

PubMed | Web of Science® | Google Scholar

24 Pérez-Martínez A, Lassaletta A, González-Vicent M, Sevilla J, Díaz MA, Madero L. High-dose chemotherapy with autologous stem cell rescue for children with high risk and recurrent medulloblastoma and supratentorial primitive neuroectodermal tumors. *J Neurooncol*. 2005; **71**(1): 33-38.

CAS | PubMed | Web of Science® | Google Scholar

25 Torres CF, Rebsamen S, Silber JH, et al. Surveillance scanning of children with medulloblastoma. *N Engl J Med*. 1994; **330**(13): 892-895.

CAS | PubMed | Web of Science® | Google Scholar

26 Roebuck DJ, Villablanca JG, Maher K, Nelson MD Jr. Surveillance imaging in children with medulloblastoma (posterior fossa PNET). *Pediatr Radiol*. 2000; **30**(7): 447-450.

CAS | PubMed | Web of Science® | Google Scholar

27 Klawinski D, Indelicato DJ, Hossain J, Sandler E. Surveillance imaging in pediatric ependymoma. *Pediatr Blood Cancer*. 2020; **67**(11):e28622.

PubMed | Web of Science® | Google Scholar

28 Cacciotti C, Lenzen A, Self C, Pillay-Smiley N. Recurrence patterns and surveillance imaging in pediatric brain tumor survivors. *J Pediatr Hematol Oncol*. 2024; **46**(3): e227-e232.

CAS | PubMed | Web of Science® | Google Scholar

29 Hill RM, Richardson S, Schwalbe EC, et al. Time, pattern, and outcome of medulloblastoma relapse and their association with tumour biology at diagnosis and therapy: a multicentre cohort study. *Lancet Child Adolesc Health*. 2020; **4**(12): 865-874.

PubMed | Web of Science® | Google Scholar

30 Perreault S, Lober RM, Carret AS, et al. Surveillance imaging in children with malignant CNS tumors: low yield of spine MRI. *J Neurooncol*. 2014; **116**(3): 617-623. doi:10.1007/s11060-013-1347-4 Epub 2014 Jan 9.

PubMed | Web of Science® | Google Scholar

31 Chen F, Chandrashekar DS, Scheurer ME, Varambally S, Creighton CJ. Global molecular alterations involving recurrence or progression of pediatric brain tumors. *Neoplasia*. 2022; **24**(1): 22-33.

PubMed | Web of Science® | Google Scholar

32 Korones DN, Butterfield R, Meyers SP, Constine LS. The role of surveillance magnetic resonance imaging (MRI) scanning in detecting recurrent brain tumors in asymptomatic children. *J Neurooncol*. 2001; **53**(1): 33-38.

CAS | PubMed | Web of Science® | Google Scholar

33 Lam DL, Pandharipande PV, Lee JM, Lehman CD, Lee CI. Imaging-based screening: understanding the controversies. *AJR Am J Roentgenol*. 2014; **203**(5): 952-956.

PubMed | Web of Science® | Google Scholar

34 Heleno B, Thomsen MF, Rodrigues DS, Jørgensen KJ, Brodersen J. Quantification of harms in cancer screening trials: literature review. *BMJ*. 2013; **347**:f5334.

PubMed | Web of Science® | Google Scholar

35 Bowers DC, Verbruggen LC, Kremer LCM, et al. Surveillance for subsequent neoplasms of the CNS for childhood, adolescent, and young adult cancer survivors: a systematic review and recommendations from the international late effects of childhood cancer guideline harmonization group. *Lancet Oncol*. 2021; **22**(5): e196-e206.

PubMed | Web of Science® | Google Scholar

36 Harris PA, Taylor R, Minor BL, et al. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform*. 2019; **95**:103208.

PubMed | Web of Science® | Google Scholar

37 Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009; **42**(2): 377-381.

PubMed | Web of Science® | Google Scholar

38 Taylor MD, Northcott PA, Korshunov A, et al. Molecular subgroups of medulloblastoma: the current

consensus. *Acta Neuropathol*. 2012; **123**(4): 465-472.

CAS | PubMed | Web of Science® | Google Scholar

39 Larrew T, Saway BF, Lowe SR, Olar A. Molecular classification and therapeutic targets in ependymoma. *Cancers*. 2021; **13**(24): 6218.

CAS | PubMed | Web of Science® | Google Scholar

40 Packer RJ, Zhou T, Holmes E, Vezina G, Gajjar A. Survival and secondary tumors in children with medulloblastoma receiving radiotherapy and adjuvant chemotherapy: results of Children's oncology group trial A9961. *Neuro Oncol*. 2013; **15**(1): 97-103.

CAS | PubMed | Web of Science® | Google Scholar

41 Michalski JM, Janss AJ, Vezina LG, et al. Children's oncology group phase III trial of reduced-dose and reduced-volume radiotherapy with chemotherapy for newly diagnosed average-risk medulloblastoma. *J Clin Oncol*. 2021; **39**(24): 2685-2697.

CAS | PubMed | Web of Science® | Google Scholar