Pathology – Research and Practice 211 (2015) 748–753

Contents lists available at ScienceDirect

Pathology – Research and Practice

journal homepage: www.elsevier.com/locate/prp

Original Article

Assessing the accuracy of death records and pre-mortem clinical diagnoses in children diagnosed with brain tumors: A retrospective chart review of children in British Columbia, Canada

Haroon Hasan[a,b,*], Glenda Hendson[c,d], A. Fuchsia Howard[a,e], Juliette Hukin[f,g], Christopher Dunham[c,d], Tareq Ahmed[e], Andrea C. Lo[a,h], Karen Goddard[a,h]

[a] Department of Radiation Oncology, British Columbia Cancer Agency, 600 West 10th Avenue, Vancouver, British Columbia V5Z 4E6, Canada
[b] Pediatric Oncology Group of Ontario, 480 University Avenue, Suite 1014, Toronto, Ontario M5G 1V2, Canada
[c] Department of Pathology and Laboratory Medicine, Division of Anatomical Pathology, British Columbia Children's Hospital, Room 2H45, 4480 Oak Street, Vancouver, British Columbia V6H 3V4, Canada
[d] Department of Pathology and Laboratory Medicine, Faculty of Medicine, University of British Columbia, Room G227, 2211 Wesbrook Mall, Vancouver, British Columbia V6T 2B5, Canada
[e] School of Population and Public Health, Faculty of Medicine, University of British Columbia, 2206 East Mall, Vancouver, British Columbia V6T 1Z3, Canada
[f] Division of Neurology and Oncology, Department of Pediatrics, University of British Columbia Faculty of Medicine, Room 2D19, 4480 Oak Street, Vancouver, British Columbia V6H 3V4, Canada
[g] Pediatric Neurology and Oncology/Hematology/BMT Programs, British Columbia Children's Hospital, Room K3-147, 4480 Oak Street, Vancouver, British Columbia V6H 3V4, Canada
[h] Department of Surgery, University of British Columbia, 950 West 10th Avenue, Vancouver, British Columbia V5Z 1M9, Canada

ARTICLE INFO

Article history:
Received 5 March 2015
Received in revised form 5 June 2015
Accepted 17 June 2015

Keywords:
Pediatric brain tumors
Autopsy
Clinical utility
Childhood cancer
Clinical discrepancies

ABSTRACT

The advantages of autopsy have been demonstrated in pediatric oncology; however, it is unknown to what extent the utility of autopsy is in deceased children diagnosed with a pediatric brain tumor (PBT). The purpose of this study was to describe the frequency of autopsy, prevalence of clinical discrepancies, and accuracy of cancer registry death records for deceased children diagnosed with a PBT in British Columbia, Canada. A retrospective chart review was performed of medical records and autopsy reports of pediatric patients diagnosed with a PBT that died between 1982 and 2012 in British Columbia. Clinical discrepancies between pre- and post-mortem findings were classified based on a modified classification system of the Goldman Criteria. The overall autopsy rate was 15.5% (32 of 206) during 1982–2012, with a significant ($P = 0.001$) decrease of 22.4% observed between decade 1 (32.8%) and decade 2 (10.4%) and a further slight decrease (4.5%) between decade 2 (10.4%) and decade 3 (5.9%) ($P = 0.379$). A third of patients had discrepancies between pre-mortem and post-mortem clinical diagnoses, with slightly over 10% of these cases revealing information that would have altered the probability of survival had it been known prior to death. More than half (59.3%) of cases had discordant cause of death as recorded in the cancer registry when compared to autopsy findings. Autopsy for children diagnosed with a PBT can provide health care professionals with important information about the accuracy of their diagnoses and evaluate the efficacy of therapy.

Introduction

Multiple studies have outlined significant disparities between clinical diagnoses and autopsy findings [1–4]. Autopsy remains an indispensable tool to ensure that the clinical diagnosis and cause of death are accurate [1,5,6]. Autopsies provide invaluable information that can serve to educate clinicians, and feedback regarding the accuracy of diagnosis and appropriateness of patient management [2,7]. Despite these evident benefits, autopsy rates have steadily decreased over time worldwide [8]. The decline of autopsy rates

Abbreviations: BCCA, British Columbia Cancer Agency; BCCH, British Columbia Children's Hospital; CNS, central nervous system; IQR, interquartile range; PBT, pediatric brain tumor; PNET, primitive neuroectodermal tumor; RT, radiation therapy; SAS, Statistical Analysis Software.

* Corresponding author at: Department of Radiation Oncology, British Columbia Cancer Agency, 600, West 10th Avenue, Vancouver, British Columbia V5Z 4E6, Canada. Tel.: +1 604 877 6000; fax: +1 604 877 0505.
E-mail address: Haroon.Hasan@bccancer.bc.ca (H. Hasan).

http://dx.doi.org/10.1016/j.prp.2015.06.008
0344-0338/

has been attributed to increasing confidence in the accuracy of diagnostic and imaging techniques, decreased allocation of funding to autopsy services, fear of litigation due to medical errors, reluctance from guardians to consent to autopsy and disinterest by pathologists and clinicians due to the perception that autopsy provides little additional information after clinical investigation [1,2,4,9–11].

Importantly, studies have shown significant differences in pre- and post-mortem diagnoses in up to 35% of patients [3,12–16]. Comparisons between pre- and post- mortem diagnoses have indicated that up to 29% of cases would have been dealt with differently if diagnoses determined post-mortem had been made preceding death [1,17]. These discrepancies raise concerns about the validity of death certificates and the accuracy of statistics compiled from these death certificates that ultimately play a role in influencing the prioritization and development of health services [18].

Of interest, a study conducted by Pastores et al. [19] demonstrated that the majority of important diagnoses that were missed were associated with severe and/or rare disease. Childhood cancers account for approximately 1% percent of all cancers diagnosed in Canada, with 20% of childhood cancer cases arising in the central nervous system (CNS) [20]. Although the majority of children diagnosed with a pediatric brain tumor (PBT) will become long-term survivors, survivors of PBTs are at significant risk for premature mortality and are 13 times more likely to die than the general population [21]. Specific tumor types still have survival rates that remain unchanged and dismal, such as diffuse brain stem gliomas, which have an overall survival rate of less than 15% [22,23]. Thus, given the high risk of mortality within children diagnosed with a PBT as well as difficulty of obtaining adequate diagnostic tissue biopsy samples, it is important to confirm clinical diagnoses with autopsies to assess the validity of diagnostic and treatment modalities. Autopsies can also be used to obtain quality tumor samples, which can facilitate advancements in our knowledge of the biology of PBTs [24].

In 1993, Koszyca et al. [25] showed that 39.0% (11 of 28) of cases revealed major clinical discrepancies. Also, in 2006, Buckner et al. [26] showed that at least one pre-mortem misdiagnosis occurred in 25.6% (11 of 43 cases) of all pediatric oncology cases.

These studies demonstrate the concerning prevalence of clinical diagnostic discrepancies in pediatric oncology cases, and little has been published on this subject since. No studies have been published addressing the extent of pre-mortem misdiagnosis of PBTs. Thus, to address this gap of knowledge, we conducted a retrospective chart review with the primary aim of addressing these deficits on all deceased children diagnosed with a PBT from 1982 to 2012 in British Columbia, Canada.

Materials and methods

This study was conducted under the ethics approval of the British Columbia Cancer Agency (BCCA) Research Ethics Board. The BCCA Cancer Registry was searched to identify all patients under the age of 18 who were diagnosed with a PBT at the BCCA or the British Columbia Children's Hospital (BCCH) (including neuroblastoma with histology confirmed disease within the brain), and died between 1982 and 2012. A retrospective chart review was performed to evaluate medical records and autopsy reports to determine whether there was a discrepancy between pre-mortem and post-mortem clinical diagnoses. The following data were abstracted from the medical records: age, sex, underlying cancer and treatment, relapse or secondary cancer status, complications from therapy, and pre-mortem clinical diagnoses and cause of death, which comprises of the immediate cause of death. The immediate cause of death is recorded in the BCCA Cancer Registry and is the patient's primary or underlying cause of death as determined by the British Columbia Vital Statistics Agency. Post-mortem clinical diagnoses were abstracted from the autopsy report, which includes the pathology confirmed diagnosis of the underlying cancer and cause of death. Clinical discrepancies between pre-mortem and post-mortem findings were classified into categories consisting of major (I), minor (II–IV), or no discrepancy (V) based on the modified classification system of the Goldman Criteria [27] developed by Buckner et al. [26] (Table 1). The accuracy of cause of death as recorded in the cancer registry was assessed by comparison to cause of death as determined by autopsy and classified as either discordant or concordant.

Table 1
Modified Goldman criteria for autopsy discrepancies [26,27].

Major discrepancy	Class I	Missed diagnosis would have resulted in a change in therapy and/or potentially affected the probability of patient survival[a]
Minor discrepancy	Class II	Missed diagnosis involving the primary condition that resulted in the cause of death, which would have not resulted in a change in therapy and/or potentially affected the probability of patient survival
	Class III	Missed diagnoses that were clinically significant (i.e., related to terminal disease), but was not the primary cause of death, and were clinically inapparent or misdiagnosed pre-mortem
	Class IV	Missed diagnoses that were clinically inapparent and unexpected, which did not significantly contribute to the primary cause of death
No discrepancy	Class V	No discrepancy between pre-mortem and post-mortem clinical diagnoses

[a] Discrepancy must involve primary pathologic condition identified as the cause of death in the patient and should be evaluated based on the medical knowledge and treatment protocols at the time of the initial diagnosis to account for improvements in treatment modalities and increased medical knowledge in pediatric oncology over time.

The autopsy rate was calculated by dividing the number of children diagnosed with a PBT who had an autopsy by the number of children diagnosed with a PBT who died. To investigate whether there was a change in autopsy rate over time, the year of autopsy was divided into three decades: Decade 1 (1982–1991), Decade 2 (1992–2001), and Decade 3 (2002–2012). The proportion of autopsies was compared by their respective decades using Fisher's exact test. Age at diagnosis and death were compared between patients who underwent autopsy and those that did not using the Mann–Whitney *U* test. All statistical tests were two-sided and *P*-values less than 0.05 were determined to be statistically significant and 95% confidence intervals for binomial proportions were calculated where applicable. The autopsy rate was compared descriptively by PBT type. Statistical analyses were performed using Statistical Analysis Software (SAS) version 9.3 (SAS Institute, Inc., Cary, NC).

Results

Patient demographics

There were 206 pediatric patients (104 females and 102 males) with available autopsy status who were identified, of whom 32 (15 females and 17 males) had an autopsy performed. Of the 32 pediatric patients who underwent autopsy, a total of 5 patients were excluded. Two patients were coroner's cases, and we were unable to retrieve their respective autopsy reports. The remaining three