

A Comparative Departmental Census of Intra-Cranial and Spinal Tumours

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Abstract

Aims

Concerns have been raised that the incidence of brain and spinal tumours in adults and children is increasing, potentially having implications for support services in immediate and long-term. We compared the incidence of brain and spinal tumours diagnosed in 2019 and 2024, and contrasted these findings with historical data from the same department.

Methods

Neuropathology files at Beaumont Hospital for 2019 and 2024 were reviewed. Tumours with pathologically confirmed diagnoses were included and classified using the International Classification of Diseases. Information regarding topography, genetic data, and patient age was harvested. Comparative analyses were performed using Fisher's exact test, and paired t-tests.

Results

No significant differences were identified between 2019 and 2024 in tumour frequency, morphology, mean age, or incidence of childhood tumours. However, an increase from an average of 123 patients between 1969 and 1983 to an average of 750 patients across 2019 and 2024 was noted, reflecting a 510% increase.

Conclusion

Over the period between 2019 and 2024, no significant increase in brain or spinal tumours was observed, suggesting no immediate rise in demand for support services based on case numbers alone. The marked increase relative to historical likely reflects improved access to neurological care, advanced neuroimaging, and evolving clinical management strategies rather than a true rise in tumour incidence.

Introduction

Concern has been expressed that the incidence of brain and spinal tumours is increasing, this apparent rise is hypothesised to be underpinned by improved detection through greater access to diagnostic imaging and population aging. Earlier diagnosis has been associated with improved survival, while advances in oncological care have created surgical treatment options for patients with previously inoperable brain metastases. These advancements seemingly have captured an increased number of patients and expanded the amount of time patients interact with neuro-oncological services

Due to the rarity of brain and spinal tumours patients experience challenges in accessing support services. Patient rights organisations have highlighted persistent inequities in diagnosis, treatment, care, and long-term support. In order to address these unmet needs, it is pertinent to acquire accurate and up to date epidemiological data. For this reason, this study examined trends in the incidence of adult and paediatric brain and spinal tumours in Ireland over 5-year and 34-year periods.

Methods

This clinical audit aimed to compare the incidence of brain and spinal tumours in the years of 2019 and 2024 diagnosed in the Neuropathology Department in Beaumont Hospital. The neuropathology database was interrogated for information pertaining to all primary and secondary brain and spinal tumours, including tumours arising from the vertebral column and skull. Only tumours in which a definite pathological diagnosis was established were included. For each tumour, the following information was extracted from the neuropathology archives; morphology, topography, genetic information, and patient age. All tumours were classified using the International Classification of Diseases¹. The level of genetic information varied by tumour type and complexity. Childhood tumours (<16 years) were subjected to more comprehensive genetic analyses. In general, all tumours of glial lineage were examined for GFAP expression as well as for IDH, ARTX and p53 mutations. DNA Methylation Profiling was used to refine diagnoses, in complex tumours, often of uncertain origin or unpredictable behaviour². A comprehensive neuro-endocrine analysis was carried out on every pituitary tumour.

A similar prior audit of brain and spinal tumours published in 1985 by the neuropathology department of The Richmond Hospital, was reviewed to look for differences in tumour incidence between then and now³. The Richmond Hospital, which closed and transferred to The Beaumont Hospital Campus in 1987 had the same geographic referral region as today's Beaumont Hospital. Both the Richmond Hospital and Beaumont Hospital Neuropathology

Departments handled brain and spinal tumour specimens from patients living above a line between Limerick and Waterford with patients below that line being cared for at Cork University Hospital. One of the investigators (MAF) was involved in both the 1985 and current study.

Statistical analyses were undertaken to compare the incidence and mean age of diagnosis of each brain tumour type. To investigate the statistical difference in incidence between 2019 and 2024, Fisher's Exact Test was used. To investigate the difference in mean age of diagnosis between tumour type and year studied, paired t-tests were used. All statistical analysis was undertaken using StataSE⁴. All available data were harvested where available.

Results

Population Characteristics

A total of 1,501 samples identified tumours over the two-year study period, comprising 144 distinct pathological entities. In 2019, 728 tumours were diagnosed (mean age 51 years), predominantly in adults (n = 664). Most tumours were cranial (n = 660), with spinal tumours accounting for just over 9% (n = 68). Sixteen DNA methylation tests were performed. In 2024, 773 tumours were identified (mean age 51 years), again largely in adults (n = 705). Cranial tumours predominated (n = 703), with spinal tumours again comprising just over 9% (n = 70). During this period, 149 DNA methylation tests were conducted.

Intra-Cranial Tumours of Adulthood

In 2019, 603 of 660 intra-cranial tumours occurred in adults. Tumour lineage distribution was glial (49%), non-glial (24%), pituitary (14%), metastases (13%), and embryonal (<1%). Astrocytoma was the most common glial tumour. Non-glial tumours were primarily meningiomas, with additional nerve sheath and haematolymphoid tumours. Less common non-glial tumours included haemangioblastoma (n = 8), glioneuronal tumour (n = 3), capillary haemangioma (n = 2), central neurocytoma (n = 2), and single cases of chondroma, dysembryoplastic neuroepithelial tumour, Rosai–Dorfman disease, osteoma, osteoid osteoma, olfactory neuroblastoma, germinoma, and pineocytoma. Pituitary adenomas accounted for most sellar tumours (Figure 1.0).

In 2024, 641 of 703 intra-cranial tumours occurred in adults. Glial tumours were again most frequent (50%), followed by non-glial (24%), pituitary (14%), metastases (12%), and embryonal tumours (<1%). Astrocytoma remained the most common glial tumour. Non-glial tumours were predominantly meningiomas, with fewer nerve sheath and haematolymphoid

tumours. Rare non-glial tumours included haemangioblastoma (n = 4), olfactory neuroblastoma (n = 3), glioneuronal tumour (n = 3), and single cases of multinodular and vacuolating neuronal tumour, pineal parenchymal tumour of intermediate differentiation, solitary fibrous tumour (grade 2), myxoid glioneuronal tumour, central neurocytoma, diffuse leptomeningeal glioneuronal tumour, Rosai–Dorfman disease, and polymorphous low-grade neuroepithelial tumour of the young (Figure 2.0).

Intra-Cranial Tumours in Childhood

In 2019, 57 intra-cranial tumours (8.6%) occurred in children (≤ 16 years). Glial tumours were most common (53%), followed by embryonal (23%), non-glial (12%), pituitary (8%), and metastatic tumours (4%). Glial tumours were astrocytic or ependymal. Embryonal tumours included medulloblastoma, non-WNT/non-SHH (n = 5), medulloblastoma, SHH-activated TP53-mutant (n = 3), CNS embryonal tumour, Not Otherwise Specified (n = 2), and single cases of atypical teratoid/rhabdoid tumour, medulloblastoma WNT-activated, and classic medulloblastoma. Non-glial tumours each occurred once and included meningioma, neuroblastoma, germinoma, choroid plexus papilloma, glioneuronal tumour, diffuse leptomeningeal glioneuronal tumour, and meningeal melanomatosis.

In 2024, 62 intra-cranial tumours (8.8%) occurred in children. Glial tumours again predominated (53%), followed by embryonal (21%), non-glial (16%), pituitary (9%), and metastatic tumours (<1%). Glial tumours were mainly astrocytomas. Embryonal tumours included classic medulloblastoma (n = 3), dysembryoplastic neuroepithelial tumour (n = 2), atypical teratoid/rhabdoid tumour (n = 2), and single cases of medulloblastoma with extensive nodularity, germinoma, mature teratoma, medulloblastoma SHH-activated TP53-wildtype, and medulloblastoma WNT-activated (large cell type). Non-glial tumours were heterogeneous, with each morphology represented once.

Spinal Tumours of Adulthood

In 2019, 61 adult spinal tumours were identified: non-glial (57%), glial (25%), and metastatic (18%). Non-glial tumours were dominated by schwannomas (n = 16) and meningiomas (n = 10), with smaller numbers of haemangioblastoma (n = 3), myxoid glioneuronal tumour (n = 2), lipoma (n = 2), angioleiomyoma (n = 1), and chondroma (n = 1). Glial tumours were mainly ependymomas (n = 10), with glioma NOS (n = 4) and astrocytoma (n = 1). Eleven metastatic tumours were identified (Figure 3.0).

In 2024, 64 adult spinal tumours were diagnosed: non-glial (53%), glial (27%), and metastatic (20%). Non-glial tumours were predominantly nerve sheath tumours (schwannoma $n = 20$; neurofibroma $n = 3$), followed by meningioma ($n = 5$), haematolymphoid tumours ($n = 2$), haemangioblastoma ($n = 2$), haemangioma ($n = 1$), and lipoma ($n = 1$). Glial tumours were mainly ependymomas ($n = 14$), with glioma NOS ($n = 2$) and astrocytoma ($n = 1$). Thirteen metastatic tumours were identified (Figure 4.0).

Spinal Tumours of Childhood

Seven spinal tumours were identified in children in 2019 and included three Neuroblastomas and one of each the following morphologies (Lipoma, Glioma NOS, Myxopapillary ependymoma, and Pilocytic Astrocytoma).

Six childhood spinal tumours were identified in 2024 and were accounted for by two Diffuse Midline Glioma-H3 K27-altered, one Meningioma, one Embryonal tumour with multilayered rosettes - C19MC altered, one Malignant peripheral nerve sheath tumour, and one Myxopapillary ependymoma.

Pituitary Neuroendocrine Tumours

In 2019, 82 pituitary adenomas were diagnosed. PIT-1, SF1, and TPIT positivity was seen in 5, 13, and 7 tumours, respectively. Sixty-four tumours stained positive for at least one hormone: prolactin ($n = 12$), growth hormone ($n = 12$), ACTH ($n = 13$), TSH ($n = 3$), FSH ($n = 21$), and LH ($n = 36$). The most frequent staining profiles were LH only ($n = 16$) and LH + FSH ($n = 13$), followed by ACTH only and GH + prolactin ($n = 6$ each). Other profiles were rare.

In 2024, 85 pituitary adenomas were diagnosed. PIT-1, SF1, and TPIT positivity was observed in 13, 48, and 13 tumours, respectively. Sixty-five tumours stained positive for at least one hormone: prolactin ($n = 12$), growth hormone ($n = 12$), ACTH ($n = 16$), TSH ($n = 6$), FSH ($n = 12$), and LH ($n = 30$). The most common profiles were LH only ($n = 15$), ACTH only ($n = 10$), and LH + FSH ($n = 9$); all other profiles occurred infrequently.

Analysis of tumour Incidence between 2019 and 2024

No statistical differences in tumour frequency or morphology were observed. Furthermore, the mean patient age and incidence of number of childhood across all morphologies of tumours was not significantly different. Any fall off in the number of patients undergoing brain and spinal tumour resection during the COVID pandemic was followed by a return to

pre-Covid numbers of all neuropathology specimens in the first full year after Ireland re-opened.

Comparison with Historical Data

A comparison was also conducted with historical data generated from the Neuropathology files of the Richmond Hospital between the years 1969 and 1983 as reported by Grant & Colleagues (1985)². The Neuropathology files of the Richmond Hospital were transferred to and incorporated into the Beaumont Hospital neuropathology files in 1987. In the 14 years between 1969 and 1983, there were 1730 patients with brain and spinal tumours diagnosed in the Richmond Hospital Neuropathology Department, giving a mean number of 123 new patients each year which compares with 728 patients in 2019 and 773 patients in 2024. This illustrates approximately a 510% increase in the number of brain and spinal cord tumours across this 36-year period.

Discussion

We have not found any appreciable change in the incidence of brain and spinal tumours diagnosed at Beaumont Hospital between 2019 and 2024. Furthermore, we have not found any difference in the age at diagnosis of either brain or spinal tumours in adults or in children. However, there has been a massive increase in the number of patients diagnosed by the same neuropathology department between the years 1969-1983 and 2019.

A very small number of new pathologic entities are being recognised and are described in detail in the revised 5th edition of the WHO Classification of Tumours published in 2021⁵. In overall terms these rare entities are more often encountered in children where they present particular diagnostic and therapeutic challenges.

Whilst the retrospective comparison with historic pathology data is fraught with ascertainment biases and challenges, it is apparent that the number of patients with brain and spinal tumours who have managed to obtain neurosurgical care has increased massively. CT brain imaging was introduced at The Richmond Hospital in the late 1970's and it was several more years before patients had easy access to MRI Scanning. Access to clinical neurology was severely restricted in the 1980's, given that the catchment area stretching from a line above Limerick to Waterford was served by just 4 neurologists and 5 neurosurgeons.

Today, every new patient with a brain or spinal cord tumour is discussed at a weekly multidisciplinary tumour meeting where optimum further care is meticulously planned.

Additionally, patients waiting for admission are discussed to ensure that key performance indicators for access are not contravened. This may require that patients be transferred to a private facility for neurosurgery, but all neuropathology diagnoses are made at Beaumont's neuropathology department. Thus, it is gratifying to see that the number of new patients with brain and spinal tumours has remained remarkably constant over the last 5 years.

As access for patients with brain and spinal tumours is no longer as difficult as it used to be, attention has now turned to duration and quality of patient survival. Apart from a small number of new and extremely rare pathologic entities, tumour types have remained constant between 2019 and 2024. However, whilst broad tumour pathologic types have remained generally unchanged, much work is being done to refine tumour subtypes so that for instance, there are now over 12 molecular subtypes of medulloblastoma, each with its own prognosis. Evidence of the ever-changing molecular investigation of brain tumours was found in this census, in which there was nearly 10 times increase in the number of DNA Methylation Tests carried out between 2019 and 2024. The spectacular developments in molecular genetic diagnostics, now in daily use at Beaumont Hospital has meant that patients have access to the very best pathology investigative tools.

This study was commissioned by "Brain Tumour Ireland" to inform on the services likely to be required by patients with brain and spinal in the years ahead. As numbers appear stable, attention will increasingly focus on access to and provision of support services such as rehabilitation after complex surgery and improved seizure control. Brain Tumour Ireland plays a vital role in advocating on behalf of patients with brain and spinal tumours

Acknowledgements:

The Authors are indebted to Brain Tumour Ireland for its support of this study.

Declarations of Conflicts of Interest:

None declared.

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References:

1. World Health Organization. (2024). International statistical classification of diseases for oncology (4th ed.). <https://icd.who.int/>
2. Capper D et al. DNA methylation-based classification of central nervous system tumours. Nature. 2018; 555(7697):469-474.
3. Grant JA, Gaffney EF, Farrell MA. Intracranial and Spinal Tumours in a Homogenous Population from 1969-1983. Irish Medical Journal 1985; 78: 96-99
4. StataCorp. 2025. Stata Statistical Software: Release 19. College Station, TX: StataCorp LLC.
5. WHO Classification of Tumours Editorial Board. Central nervous system tumours. Lyon (France): International Agency for Research on Cancer; 2021. (WHO classification of tumours series, 5th ed.; vol. 6). <https://publications.iarc.fr/601ferences>

Appendix:

Supplementary Material



Adult Intra-Cranial Tumours by Morphology 2019

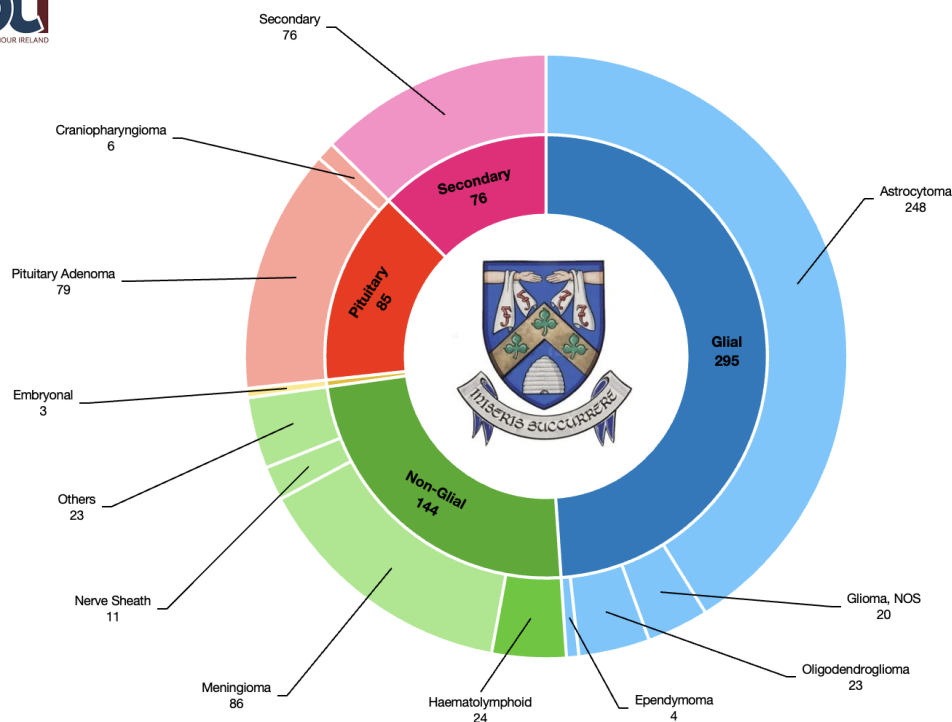


Figure 1.0: Incidence of Adulthood Intra-Cranial Tumours 2019



Adult Intra-Cranial Tumours by Morphology 2024

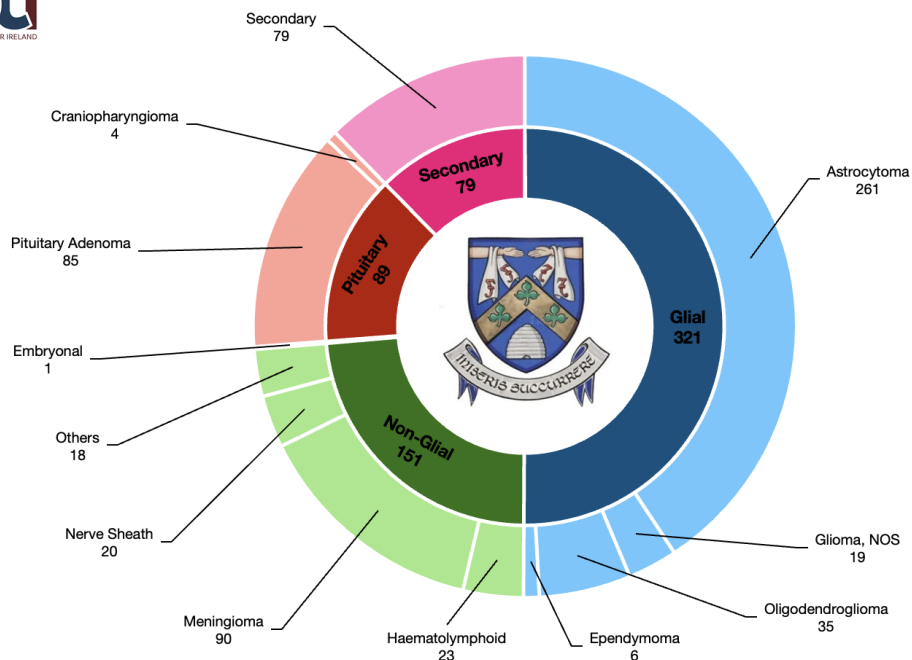


Figure 2.0: Incidence of Adulthood Intra-Cranial Tumours 2024



Adult Spinal Tumours by Morphology 2019

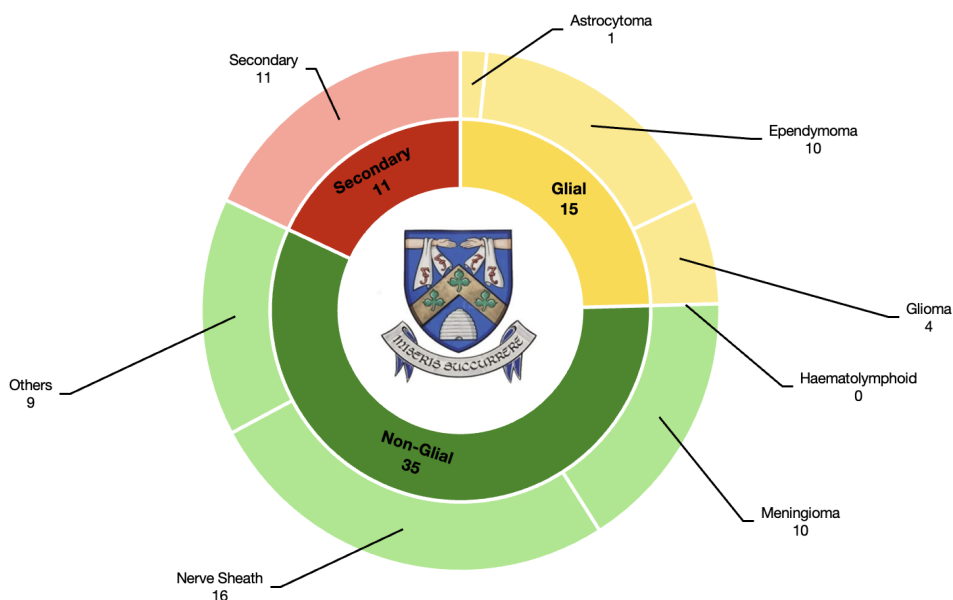


Figure 3.0: Incidence of Adulthood Spinal Tumours 2019



Adult Spinal Tumours by Morphology 2024

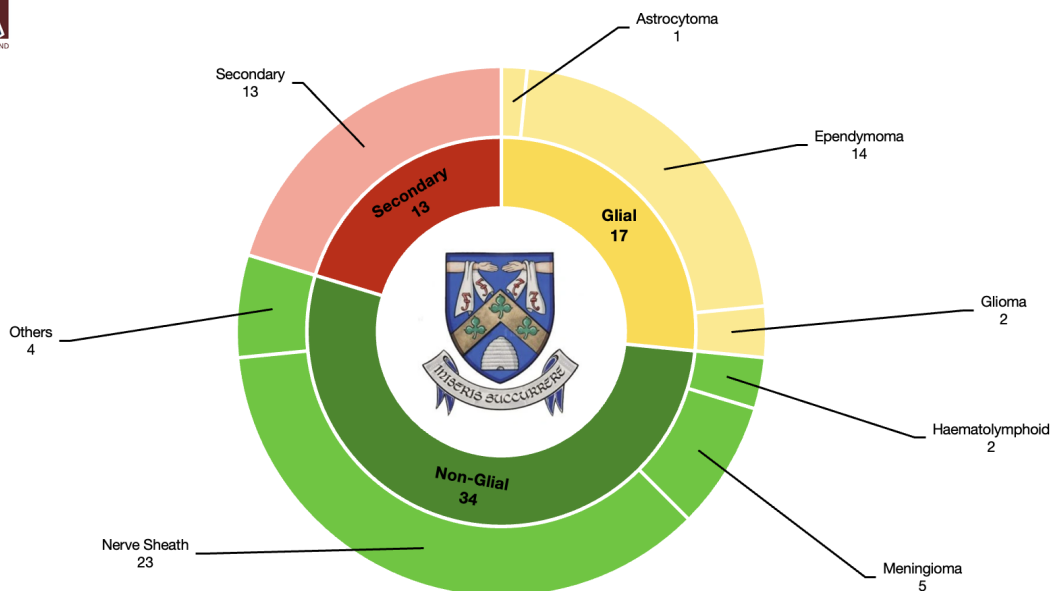


Figure 4.0: Incidence of Adulthood Spinal Tumours 2024