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RADIATION ONCOLOGY—ORIGINAL ARTICLE

Management of Glioblastoma in Elderly Patients in a Single Australian Centre

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ABSTRACT

Introduction: Glioblastoma management in elderly patients is challenging. The aim of this study was to review oncological treatment strategies at a single institution from 2011 to 2020.

Methods: Patients aged ≥ 70 years who received radiotherapy and/or chemotherapy for radiological or histological glioblastoma were identified from a centralised database. Patients receiving supportive care only were excluded, whether or not they had surgery at diagnosis. Clinicopathologic data and treatment modalities were collected. Median survival from diagnosis was calculated by the Kaplan–Meier method.

Results: Seventy-eight people were identified during the study period, median age 74.5 years (range 70–88). Seventy-five people had surgery (24 biopsy only, and 51 resection) and three people had radiological diagnosis only. The most common first-line treatment was concurrent chemoradiation (33/78, 42%). Only 18/33 (55%) went on to receive adjuvant temozolomide, median of five cycles (interquartile range [IQR] 2–6). The most common radiotherapy dose was 40 Gy in 15 fractions (52/73, 71%) and 60 Gy in 30 fractions was less frequently prescribed over time. Second-line therapy for recurrent or progressive disease was received in 23% overall, and varied in modality. Median survival was 7.0 months (IQR 4.4–12.5), and 6.4% (CI 4.3%–9.1%) at 2 years.

Conclusion: Survival is poor for elderly patients with glioblastoma despite treatment. Concurrent chemoradiation was the most common treatment strategy, and 40 Gy in 15 fractions was the most common radiotherapy schedule. A small proportion of people received treatment for recurrent disease, and modality varied greatly.

1 | Introduction

Glioblastoma is the most common primary glioma affecting adults, and prognosis declines with increasing age [1].

In the context of this disease, the definition of 'elderly' differs within clinical studies, which have applied cut-offs in the range 60–70 years [2–7]. Notably, patients aged over 70 years were excluded from the landmark paper by Stupp et al. defining adjuvant radiotherapy (60 Gy in 30 fractions) with concurrent and then adjuvant temozolomide for 6 months as the standard of care [8]. This was primarily due to concerns of more aggressive biology, in addition to the impact of pre-existing comorbidities, frailty and declining performance status associated with ageing [9]. Conversely, a trial combining hypofractionated radiotherapy with concurrent and then adjuvant temozolomide in elderly

patients included patients aged 65 years or older [5]. Thus, the management of glioblastoma in elderly people is complex and multiple treatment options exist.

Clinical Practice Guidelines from the National Comprehensive Cancer Network (NCCN) and European Association of Neuro-Oncology (EANO) consider conventionally-fractionated radiotherapy (with or without chemotherapy), hypofractionated radiotherapy, and temozolomide monotherapy as possible treatment options for elderly people [10, 11]. For recurrent glioblastoma, there is no clear standard of care regardless of age; the desire to pursue second-line therapy in older patients may be challenged due to the poor outcomes expected.

Our study comes in the context of a number of recent Australian and New Zealand retrospective analyses of glioblastoma treatment. The 2023 paper by Lenffer et al. examined 1079 patients of all ages with glioblastoma between 2001 and 2020, with approximately 60% aged > 60 years. Yan et al. reported on 363 high grade glioma patients treated in Christchurch over a 10-year period, with 220 people being aged > 60 years, and Ruisi et al. recently reported on presenting symptoms at first diagnosis of glioblastoma in 182 people, 46% of whom were aged > 65 years [12–14]. Our paper distinguishes itself and adds to the above analyses by focusing on the elderly patient subgroup.

The aim of this study was to analyse patterns of care for elderly people with glioblastoma, treated at our centre over a 10-year period. We hypothesised that over time we would see increased adoption of molecular diagnostic techniques in line with clinical practice guidelines for diagnosis, and increasing adoption of a 40 Gy in 15 fraction radiotherapy course for elderly patients as the chosen schedule after the publication of the elderly glioblastoma trial by Perry et al. [5].

2 | Methods

2.1 | Data

The Queensland Oncology Repository (QOR) is a centralised online databank governed by Cancer Alliance Queensland, collating demographic, clinicopathological, and treatment data from over 60 sources for all cancer patients who are residents of Queensland. With ethical approval by our Human Research Ethics Committee (EX/2024/QMS/114078), the QOR was used to identify all patients aged ≥ 70 years at diagnosis with glioblastoma between 2011 and 2020 treated at the Princess Alexandra Hospital, Brisbane. Those without histological confirmation but a presumed (radiological) diagnosis were included if they received treatment for this indication and glioblastoma was recorded on their death certificate. Those with high-grade transformations of a previously diagnosed lower-grade glioma or primary glioblastoma of the spinal cord were excluded. Patients who received best supportive care alone (with or without surgery) were excluded from analysis.

Isocitrate dehydrogenase (*IDH*) and O^6-methylguanine-DNA methyl-transferase (*MGMT*)-promoter methylation status was collected if available. The frequency of molecular testing before and after the 2016 World Health Organisation (WHO) Classification of Tumours of the Central Nervous System update was captured [15].

Treatment details for first and subsequent lines of therapy were recorded. First line therapy included both adjuvant and definitive radiotherapy and/or chemotherapy, depending on what upfront surgery was performed. Surgery was subclassified as biopsy or resection based on Medicare billing codes. Extent of resection was not reported because it was inconsistently recorded, and post-operative imaging was not standardised. Radiotherapy and systemic therapy details were recorded and checked manually against individual patient records where necessary. Radiotherapy completion rates were determined by comparing prescribed fractions with start and stop dates for treatment delivered.

2.2 | Analysis

Differences between two time periods (2011–2016 vs. 2017–2020) were assessed using a chi-square test or Fisher's exact test, as appropriate. Survival time from the date of diagnosis to death was analysed using the Kaplan–Meier method. Median survival was calculated separately for subgroups with factors of clinical interest. Subgroup analysis was performed with the Wilcoxon rank-sum test or log-rank Mantel–Cox test, as appropriate.

3 | Results

3.1 | Demographics

In total, 78 patients with glioblastoma aged ≥ 70 years were identified during the study period. Baseline characteristics are given in Table 1. Median age was 74.5 years (range 70–88). The

TABLE 1 | Baseline characteristics of elderly glioblastoma patients treated between 2011 and 2020 at a single Australian centre ($n = 78$).

	Number (%)
Age at diagnosis (years)	
70–74	40 (52%)
75 or older	38 (49%)
Gender	
Male	46 (59%)
Female	32 (41%)
Anatomical location of GBM	
Frontal lobe	20 (26%)
Parietal lobe	20 (26%)
Temporal lobe	23 (30%)
Occipital lobe	4 (5%)
Overlapping lobes	8 (10%)
Other	3 (4%)
Greatest extent of surgery	
Resection	51 (65%)
Biopsy only	24 (31%)
No surgery	3 (4%)

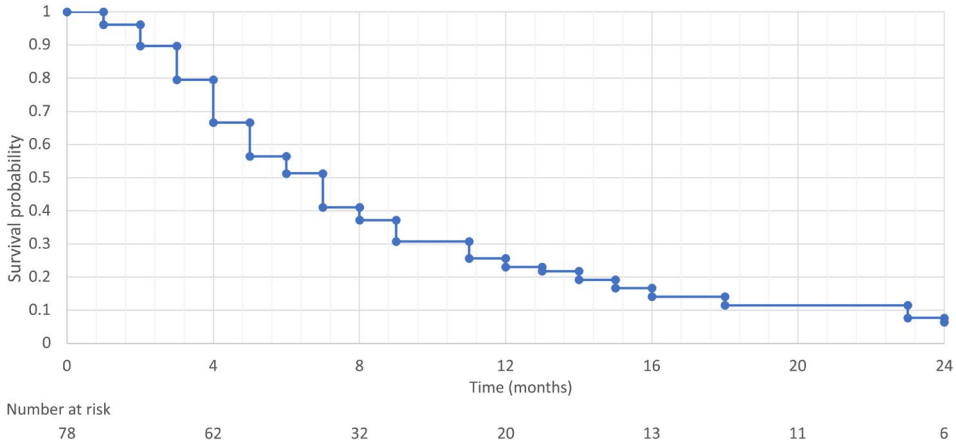

FIGURE 1 | Kaplan–Meier plot showing 2-year survival for elderly glioblastoma patients treated between 2011 and 2020. Patients surviving at 24 months post diagnosis were censored.

most common location was temporal lobe (30%), followed by frontal lobe (26%) and parietal lobe (26%). Glioblastoma was determined radiologically without histological confirmation in three people.

There were 49 people diagnosed between 2011 and 2016, and 29 people diagnosed from 2017 to 2020. *IDH* status was available in 48% (36/75) of patients with a histological diagnosis, all *IDH*-wildtype. Rates of *IDH* testing increased over time; 21% (10/47) in 2011–2016 versus 93% (26/28) in 2017–2020 ($p = 0.0001$). *MGMT* testing was only performed in 12% (9/75) and all were during the 2017–2020 time period (9/28 patients, 32%). There were 6/9 *MGMT* promoter unmethylated.

Median survival was 7.0 months (interquartile range [IQR] 4.4–12.5). This was similar across the two timeframes: 6.8 months (IQR 4.1–13.5) for 2011–2016 versus 7.1 months (IQR 4.6–11.9) between 2017 and 2020 ($p = 0.82$). The 1- and 2-year survival rates were 23.1% (confidence interval [CI] 14.4%–33.0%) and 6.4% (CI 4.3%–9.1%), respectively (Figure 1).

Analysis of gender ($p = 0.14$) and location of tumour ($p = 0.53$) did not yield statistically significant correlations with survival. There was, however, possible evidence of longer median survival with patients aged 70–74 (8.7 months, IQR 4.8–15.0) versus patients aged 75 and older (5.8 months, IQR 3.7–9.2), $p = 0.07$. Female patients had a median survival of 7.6 months, IQR 5.0–14.9, versus male patients 6.3 months, IQR 3.8–11.6. Median survival varied according to anatomical location of tumour, with the longest associated with a frontal lobe location (median 10.0 months, IQR 5.3–15.5) and the shortest associated with overlapping lobes (median 3.5 months, IQR 2.3–8.5). There was no significant difference comparing the three most common locations of tumour (frontal, parietal and temporal lobe), $p = 0.53$.

3.2 | First-Line Therapy

Surgery was performed in 75/78 (96%) patients; 24 (32%) had biopsy alone, and 51 (68%) underwent resection. Overall, the rates of surgery did not change significantly over time; 47/49 (96%) during 2011–2016 compared to 28/29 (97%) during 2017–2020. However, the proportion of people undergoing resection (as opposed to biopsy) reduced; 36/47 (77%) in 2011–2016 versus 15/28 (53%) during 2017–2020 ($p = 0.039$).

TABLE 2 | First-line therapy for glioblastoma in elderly patients at a single centre ($n = 78$).

Treatment received	Number (%)
Concurrent chemoradiation	33 (42%)
Received adjuvant temozolomide	19
Received other adjuvant systemic therapy	4
Not fit for further systemic therapy	10
Radiation alone	32 (41%)
Sequential radiation then chemotherapy	7 (9%)
Temozolomide alone	3 (4%)
Other	3 (4%)

Radiotherapy and/or chemotherapy treatment approaches are summarised in Table 2. Median time from surgery to start of radiotherapy (monotherapy or concurrent) was 30 days (IQR 26–36). The most common treatment was radiotherapy with concurrent systemic therapy in 33/78 (42%). Among these 33 patients, 18 (55%) went on to receive adjuvant temozolomide with a median of five cycles completed (IQR 2–6). Only three people completed a full 12 months of adjuvant temozolomide. Five patients received additional agents (including nivolumab and bevacizumab), some within the context of clinical trials. Overall, 10/78 people (13%) enrolled in a clinical trial during the study period.

There were 32/78 patients (41%) who received radiotherapy alone, and 7/78 (9%) who received radiotherapy and then adjuvant temozolomide sequentially (median four cycles, IQR 2–7).

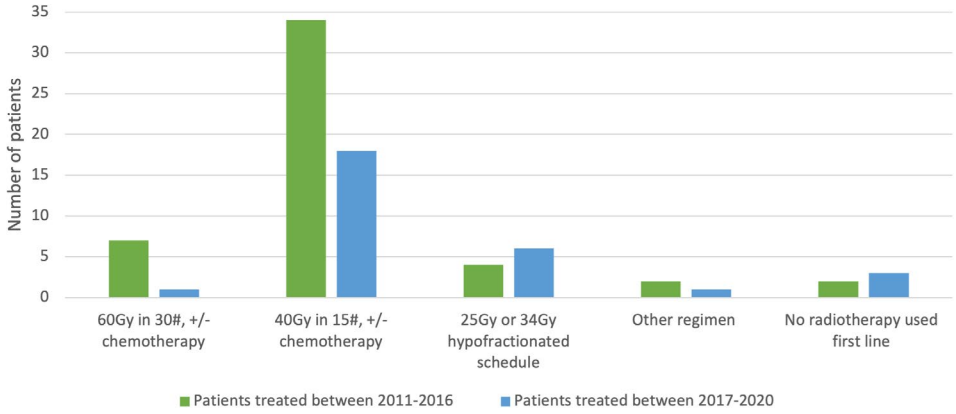

FIGURE 2 | Radiotherapy dose-fractionation schedules prescribed as first-line therapy for elderly glioblastoma patients, from 2011 to 2016 and 2017 to 2020.

There were three patients (4%) who received systemic therapy alone.

Patients who did not receive any surgery ($n=3$) had a median survival of 3.8 months (IQR 2.3–7.3). The median survival of those undergoing biopsy only, 4.7 months (IQR 3.1–8.3) differed significantly from those undergoing resection, which was 8.6 months (IQR 5.3–15.9); $p=0.001$.

Median survival was similar for those who received radiotherapy and then chemotherapy sequentially (9.9 months, IQR 5.8–18.7) versus concurrent chemoradiation (7.6 months, IQR 4.9–15.5). Median survival was shorter for patients receiving radiotherapy alone (5.4 months, IQR 3.7–9.7) and chemotherapy monotherapy (5.0 months, IQR 3.1–5.3). Comparing the groups receiving concurrent radiotherapy versus radiotherapy alone, the difference in median survival was approaching significance favouring chemoradiotherapy ($p=0.051$) with the Wilcoxon rank-sum test. Small patient numbers in other groups precluded further subgroup analysis. Of interest, at the time of data collection, the longest survivor was censored at 77 months. This person had undergone biopsy only, followed by radiotherapy alone (34 Gy in 10 fractions) then adjuvant temozolomide for 12 months. Their tumour was found to be *IDH*-wildtype and *MGMT* methylated.

3.3 | Radiotherapy Dose-Fractionation

Of 73 patients receiving radiotherapy as first-line treatment, the most common dose-fractionation schedule was hypofractionated at 40 Gy in 15 fractions in 52/73 (71%). There were 8/73 people prescribed 60 Gy in 30 fractions, and this proportion appeared to reduce over the study period; 7/47 in 2011–2016 (15%), versus 1/26 (4%) in 2017–2020 ($p=0.245$). Further hypofractionated schedules of 25 Gy in five fractions and 34 Gy in 10 fractions were prescribed for 10/73 patients (14%). Dose-fractionation schedules prescribed over the two time periods are shown in Figure 2.

Radiotherapy completion rates varied according to dose-fractionation schedule; 100% (10/10) for people receiving 25 or 34 Gy hypofractionated courses, 90% (47/52) for 40 Gy in 15 fractions, and 75% (6/8 people) for those receiving 30 fractions.

TABLE 3 | Therapy options for elderly patients with glioblastoma receiving subsequent lines of therapy following progression.

Mode of treatment	Second-line therapy ($n=18$)	Third-line therapy ($n=6$)
Repeat resection ± systemic therapy	7	3
Temozolomide alone	5	1
Bevacizumab alone	2	0
Re-irradiation	2	2
Chemoradiation	2	0

The median survival for people receiving 60 Gy was 8.7 months (IQR 6.2–21.9), versus 7.1 months (IQR 4.6–12.7) for 40 Gy. Due to small patient numbers, this was not statistically meaningful to compare. Patients receiving 25–34 Gy had a median survival of 5.9 months (IQR 3.5–10.2).

3.4 | Subsequent Lines of Therapy

There were 18/78 (23%) people who received second-line therapy for recurrent disease, and their median age was 74 years (range 70–78) at diagnosis. People not offered second-line therapy followed best supportive care at progression. Of those, 7/18 (39%) people underwent repeat surgery; 4/18 (22%) received radiotherapy, 5/18 (28%) received temozolomide, and 2/18 (11%) received bevacizumab. This represented a mix of patients receiving either a re-challenge of systemic therapy or re-irradiation, versus receiving an alternative new modality. There were 5/18 (28%) patients who received two or more modalities, whilst 13/18 (72%) received a single treatment modality. Second- and third-line therapy options are shown in Table 3.

There were 6/78 people (8%) who received third-line therapy; median age was 74.5 years (range 70–75) at diagnosis. This

included 3/6 (50%) who underwent further surgery. Only one patient had three resections in total.

4 | Discussion

This retrospective study describes the varied treatment approaches recommended for elderly patients with glioblastoma at our centre over a 10-year period. Median survival from diagnosis was overall poor at 7.0 months in our elderly cohort. This is consistent with other contemporaneous studies of elderly patients; 6.4–7.9 months in the 2015 IAEA study, and 7.6–9.3 months in the Perry et al.'s study [4, 5]. Survival duration was associated with the extent of surgery, and the proportion of patients undergoing resection (as opposed to biopsy) was noted to decrease over time. This may warrant further investigation; however, it should be noted that variables such as patient preference, performance status, and comorbidities were not available to better understand clinical decisions on an individual basis. The proportion of elderly patients offered biopsy alone over resection in our centre (32%) was similar to reported rates in the Lenffer et al.'s study, 21% in patients aged 70–79 and 38% in ages 80 and above [12]. Survival times for the various subgroups of treatment approaches are comparable with the randomised studies in this population [2–5].

The most common first-line therapy was radiotherapy with concurrent chemotherapy. It is noteworthy that only 75% of patients commencing 6-week radiotherapy completed the course, and only 55% went on to receive any adjuvant temozolomide. This reflects the difficulty of applying the Stupp protocol to the elderly population, and the growing interest in hypofractionation during the study period [5]. The most common radiotherapy dose-fractionation was 40 Gy in 15 fractions, and the proportion of patients prescribed 60 Gy in 30 fractions reduced over time. This is consistent with the randomised literature that suggests no significant benefit for higher radiotherapy doses or longer courses in this population, but a greater risk of neurocognitive decline and steroid requirements. Furthermore, our centre was a participant in the Perry trial utilising 40 Gy in 15 fractions, which could have increased the speed of translation into clinical practice, in keeping with our hypothesis [2, 5, 6].

The proportion of patients able to successfully complete radiotherapy as planned decreased as treatment course length increased. The number of patients receiving hypofractionated courses of radiotherapy alone (25 Gy in five fractions and 34 Gy in 10 fractions) was relatively low (10/78) although randomised data supporting their utility was published in 2012 and 2015 [3, 4]. In a select group of patients, radiotherapy alone was followed by sequential temozolomide. Survival outcomes in this cohort were not apparently inferior to those who received the standard concurrent chemoradiotherapy approach. In younger adults with anaplastic *IDH*-wildtype astrocytomas (historical grading; some now considered WHO Grade 4 glioblastoma), adjuvant temozolomide prolongs survival whereas temozolomide delivered concurrently with radiotherapy does not [16]. Given the challenges to complete treatment in some cases observed in this cohort, the sequential approach may be worthy of further assessment compared to the current standard of care in larger studies. The number of patients receiving upfront temozolomide alone was low (4%). This likely reflects the low test rate observed overall, but also the limited number of patients with *MGMT* promoter methylation identified and the prohibitively long wait times usually required before the information is available to implement in the clinic. As testing rates increase and laboratory processing times improve, more patients may be able to receive this treatment approach, which could be the preferred approach in certain cases [3]. The anticipated *MGMT* methylation rate was 47% in one study of elderly Japanese people with glioblastoma [17]. There were 13% who participated in clinical trials during the study period, and this may be useful information for future planning in this population in an Australian context.

Treatment of recurrent glioblastoma remains unclear, particularly in the elderly. There were 23% in this study who received second-line therapy. Surgery was the most common intervention modality followed by temozolomide. This differs from a similar cohort of elderly and/or frail patients within the International Atomic Energy Agency phase III trial, which was chemotherapy, then surgery, and then re-irradiation [18]. A recent systematic review of recurrent glioblastoma treatment options supported the use of combined chemoradiotherapy and offered some support for concurrent bevacizumab, but elderly patients were not able to be analysed as a subgroup and data in this space remain sparse [19].

The ability to combine demographic and treatment data from all public and private centres using QOR is a strength of this study. Given the low numbers and relative rarity of elderly patients receiving radiotherapy and chemotherapy for glioblastoma, this permitted individual patients to be tracked between centres if their care was shared with another. Regardless, a weakness of the study remains the overall small population size and inability to acquire all relevant factors. A further potential limitation of this study is the lack of progression-free survival (PFS) data. This was intentional because radiological and clinical data were not captured in a standardised way and therefore were felt to be unreliable. Time to next intervention and death were considered the most robust outcome measures.

In conclusion, diagnosis and management of elderly people with glioblastoma in our centre has changed over time. Our study shows patients receiving a variety of options, which are reflected in the numerous treatments recommended for patients aged > 70 with glioblastoma in NCCN guidelines [10]. Surgical resection is associated with longer survival compared to biopsy alone. Hypofractionated radiotherapy with concurrent and then adjuvant temozolomide remains the most common treatment approach, with the 40 Gy in 15 fraction schedule being most common at our centre. Radiotherapy alone followed by sequential temozolomide might be a reasonable approach in select individuals. Most patients did not receive additional lines of therapy for recurrent disease.

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Disclosure

Matthew C. Foote is an Editorial Board member of JMIRO and a co-author of this article. To minimize bias, they were excluded from all editorial decision-making related to the acceptance of this article for publication.

Ethics Statement

This study was reviewed by the Metro South Health HREC, Project ID: 114078/Review Ref: EX/2024/QMS/114078 (Nov ver 1).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1. A. Brodbelt, D. Greenberg, T. Winters, M. Williams, S. Vernon, and V. P. Collins, "Glioblastoma in England: 2007–2011," *European Journal of Cancer* 51, no. 4 (2015): 533–542.

2. W. Roa, P. M. Brasher, G. Bauman, et al., "Abbreviated Course of Radiation Therapy in Older Patients With Glioblastoma Multiforme: A Prospective Randomized Clinical Trial," *Journal of Clinical Oncology* 22, no. 9 (2004): 1583–1588.

3. A. Malmström, B. H. Grønberg, C. Marosi, et al., "Temozolomide Versus Standard 6-Week Radiotherapy Versus Hypofractionated Radiotherapy in Patients Older Than 60 Years With Glioblastoma: The Nordic Randomised, Phase 3 Trial," *Lancet Oncology* 13, no. 9 (2012): 916–926.

4. W. Roa, L. Kepka, N. Kumar, et al., "International Atomic Energy Agency Randomized Phase III Study of Radiation Therapy in Elderly and/or Frail Patients With Newly Diagnosed Glioblastoma Multiforme," *Journal of Clinical Oncology* 33, no. 35 (2015): 4145–4150.

5. J. R. Perry, N. Laperriere, C. J. O'Callaghan, et al., "Short-Course Radiation Plus Temozolomide in Elderly Patients With Glioblastoma," *New England Journal of Medicine* 376, no. 11 (2017): 1027–1037.

6. G. Minniti, C. Scaringi, G. Lanzetta, et al., "Standard (60 Gy) or Short-Course (40 Gy) Irradiation Plus Concomitant and Adjuvant Temozolomide for Elderly Patients With Glioblastoma: A Propensity-Matched Analysis," *International Journal of Radiation Oncology, Biology, Physics* 91, no. 1 (2015): 109–115.

7. F. Keime-Guibert, O. Chinot, L. Taillandier, et al., "Radiotherapy for Glioblastoma in the Elderly," *New England Journal of Medicine* 356, no. 15 (2007): 1527–1535.

8. R. Stupp, W. P. Mason, M. J. Bent, et al., "Radiotherapy Plus Concomitant and Adjuvant Temozolomide for Glioblastoma," *New England Journal of Medicine* 352, no. 10 (2005): 987–996.

9. N. K. Mazarakis, S. D. Robinson, P. Sinha, et al., "Management of Glioblastoma in Elderly Patients: A Review of the Literature," *Clinical and Translational Radiation Oncology* 46 (2024): 100761.

10. National Comprehensive Cancer Network, "Central Nervous System Cancers (Version 3.2024)," https://www.nccn.org/professionals/physician_gls/pdf/cns.pdf.

11. M. Weller, M. van den Bent, M. Preusser, et al., "EANO Guidelines on the Diagnosis and Treatment of Diffuse Gliomas of Adulthood," *Nature Reviews. Clinical Oncology* 18, no. 3 (2021): 170–186.

12. B. Lenffer, J. Ruben, S. Senthi, J. Millar, and W. L. Ong, "Management and Outcomes of Glioblastoma: 20-Year Experience in a Single Australian Institution," *Journal of Medical Imaging and Radiation Oncology* 68, no. 2 (2024): 208–216.

13. I. Ruisi, D. Jayamanne, M. Kastelan, N. Cove, M. Cheng, and M. Back, "Nature and Impact of Symptoms at Time of Initial Presentation for Patients With Glioblastoma," *Journal of Medical Imaging and Radiation Oncology* 69, no. 2 (2025): 264–273.

14. S. S. Yan, M. L. James, P. Kerstens, M. de Lambert, B. A. Robinson, and M. Yi, "High-Grade Glioma—A Decade of Care in Christchurch," *Journal of Medical Imaging and Radiation Oncology* 63, no. 5 (2019): 665–673.

15. D. N. Louis, A. Perry, P. Wesseling, et al., "The 2021 WHO Classification of Tumors of the Central Nervous System: A Summary," *Neuro-Oncology* 23, no. 8 (2021): 1231–1251.

16. M. J. van den Bent, B. Baumert, S. C. Erridge, et al., "Interim Results From the CATNON Trial (EORTC Study 26053-22054) of Treatment With Concurrent and Adjuvant Temozolomide for 1p/19q Non-Co-Deleted Anaplastic Glioma: A Phase 3, Randomised, Open-Label Intergroup Study," *Lancet* 390, no. 10103 (2017): 1645–1653.

17. M. Okada, K. Miyake, and T. Tamiya, "Glioblastoma Treatment in the Elderly," *Neurologia Medico-Chirurgica (Tokyo)* 57, no. 12 (2017): 667–676.

18. J. Socha, L. Kepka, S. Ghosh, et al., "Outcome of Treatment of Recurrent Glioblastoma Multiforme in Elderly and/or Frail Patients," *Journal of Neuro-Oncology* 126, no. 3 (2016): 493–498.

19. R. Marwah, D. Xing, T. Squire, Y. Y. Soon, H. K. Gan, and S. P. Ng, "Reirradiation Versus Systemic Therapy Versus Combination Therapy for Recurrent High-Grade Glioma: A Systematic Review and Meta-Analysis of Survival and Toxicity," *Journal of Neuro-Oncology* 164, no. 3 (2023): 505–524.