WM Radiotherapy Clinical Protocol

Primary CNS

Revision history

Version	Date	Summary of changes
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3.0	17.4.26	Reviewed by Dr Helen Benghiat, Dr Sara Meade, and Dr Paul Sanghera Ratified by EAG
3.1	9.7.26	Peer review section added
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Approved by

This document was ratified by the Radiotherapy Expert Advisory Group (EAG) at its April 2026 meeting.

Related documents/references

Title	Owner	Location
Guidelines for management of brain and central nervous system tumours	West Midlands Neuro EAG	Brain and Central Nervous System - West Midlands Cancer Alliance (wmcanceralliance.nhs.uk)
Estro guidelines on MID: 37059335 Local data PMCID: PMC3608050		

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1. Purpose

To support the delivery of radiotherapy treatments for primary Central Nervous System (CNS) for patients within the West Midlands. This is an addendum to and should be read in conjunction with

- Guidelines for the management of Adult Glioma
- Guidelines for the management of Adult Ependymoma
- Guidelines for the management of Adult Medulloblastoma
- Protocol for Management of patients with intracranial indications for Stereo Radiosurgery
- Protocol for management of patients with suspected primary CNS Lymphoma
- Protocol for Follow up scanning for patients with Meningioma
- Protocol for patients with pineal regional tumours

These are updated and agreed through the regional Brain and Central Nervous System Expert Advisory Group, supported by the West Midlands Cancer Alliance. Brain and Central Nervous System - West Midlands Cancer Alliance (wmcanceralliance.nhs.uk)

Patients are evaluated by a specialised brain/CNS MDT meeting with a special consideration given to performance status and neurological function

- Adult Tumours which require irradiation of the whole craniospinal axis should be referred to UHB.
- Stereotactic RadioSurgery (SRS) is delivered at UHB within the region.
- Each patient should have a designated keyworker, who should ensure that the support required for the patient and family has been assessed and the patient is given the name and contact number of the key worker.

2. Responsibilities

- To comply with the Ionising Radiation (Medical Exposure) Regulations 2017 the following roles are defined:
- Referrer & Practitioner: The consultant clinical oncologist is responsible for the care of the patient including correct referral for treatment consent, justification prescription and treatment authorization as defined in departmental protocol but in accordance with this regional protocol.
- Operators: Radiographers, physicists and technologists Consultant clinical Oncologists and other medical staff are responsible for individual tasks associated with the plan production, verification and treatment delivery as per departmental protocols but in accordance with this regional protocol and are undertaken on the auspices of the practitioner.

- It is the responsibility of department management teams to ensure departmental protocols are consistent with this regional protocol and that any disagreement with the content of this protocol is raised through the West Midlands EAG.

3. Information and Consent

Patients who are referred for external beam radiotherapy will have a consultation with a tumour site specific Oncologist to discuss treatment options. This will include

- Local patient information sheet
- Patients consented with individualised information on risk benefits of planned treatment
- Booking form and consent completed

4. Immobilisation and localisation imaging

- Patient in supine position using thermoplastic shell. Each department should have a policy regarding specific immobilisation and associated quality assurance.
- Planning CT scan with slice thickness of maximum2 mm covering the whole skull and upper cervical spine if indicated.
- Intravenous contrast administered during planning CT scan acquisition is recommended for most patients (unless contraindicated)..
- Scanning levels documented locally

5. Target Delineation

Contrast MRI performed within 2 weeks of radiotherapy should be co-registered to delineate target volumes for radical dose cases. An up-to-date MRI is particularly important if using contemporary reduced CTV margins. When contouring, a review of pre-operative and early post operative MRI (within 72hours unless) is required. Where an up-to-date planning MRI is not available, the early post-operative MRI should be fused with the contrast enhanced CT scan to aid target delineation, however use of larger CTV growth within ranges below recommended.

Suggested glioma MRI fusion sequence :
T1 + gadolinium & T2 or FLAIR. (3D sequences preferred e.g SPACE)

6. Glioma

6.1 IDH Wild Type Glioma WHO grade 4 (Glioblastoma)

EORTC Single dose technique (most patients). The below guidelines take into account local audit data (Sherriff et al, BJR 13) in which the predominant pattern of relapse is within 2cm of original enhancing disease. These data were collected before standardised post-operative MRI scans. With

the use of early post operative MRI scans and a dedicated planning MRI scan within 2 weeks of radiotherapy the lower margins below can be considered as per ESTRO-EANO guidelines 2023 (Niyazi et al, Rad & Onc 2023).

Note that distinguishing peri-tumoural disease versus oedema, and identifying post operative ischaemic and/or gliosis can be challenging. Input from neuroradiology with modifications according to the individual patient requirements may be necessary and this remains the responsibility of the consultant leading care .

GTV = any residual enhancing disease on MRI and CT plus surgical cavity.
CTV = GTV + 1.5-2cm margin adjusted according to anatomical barriers*.

In most cases the oedema/ T2 changes will be within the CTV. Where it is not the CTV can be extended according to local judgment.

Consider 2 dose volumes (concurrent boost) for large volume tumours particularly if extensive T2/FLAIR component. Note the optimum strategy for molecularly defined gliomas remains less certain. Aim to keep V54 whole brain <33%.

For example:
GTV = enhancing disease on MRI and CT + surgical cavity + T2/FLAIR if relevant
CTV54 = GTV + 1-1.5cm margin adjusted according to anatomical barriers
CTV60 = GTV + 0.5cm margin adjusted according to anatomical barriers
Use GTV enhancing volume only.

PTV = According to departmental protocol and will depend on level of IGRT used (typically 3-5mm).

Accept some undercoverage of PTV may be required if tumour in close proximity to critical structures e.g. optic pathways / brainstem. Discuss risks/ benefit on individual basis.

*The tentorium, bone and meninges should be considered as anatomical borders for gliomas. Visual pathways / optic chiasm and brainstem margins can also be reduced providing the tumour is distant to the white matter tracts extending into these regions. Reduction to 5mm is reasonable at ventricles. However, it is important to allow adequate margins to allow for spread across the corpus callosum, along cortico-spinal tracts and via cerebral peduncles to brainstem.

Follow similar principles for palliative fractionation schedules listed with EAG document : Guidelines for the Management of Adult Glioma

6.2 IDH Mutant Glioma WHO grade 3

Single dose technique (most patients). Predominant pattern of relapse remains localised and principles are similar to GBM. However more careful consideration for T2/FLAIR disease is required.

GTV = enhancing disease on MRI and CT (+ T2/FLAIR disease if relevant) and/or surgical cavity
CTV59.4 = GTV + 1.5-2cm margin adjusted according to anatomical barriers

A 1cm margin is recommended from the T2/FLAIR component of any disease. Contouring separately as below may be helpful:

GTV_{T1GAD} = Enhancing disease on MRI and CT + surgical cavity
$GTV_{T2/FLAIR}$ = T2/FLAIR abnormality
CTV_{T1GAD} = GTV_{T1GAD} + 1.5- 2cm margin adjusted to respective anatomical barriers of spread.
$CTV_{T2/FLAIR}$ = $CTV_{T2/FLAIR}$ + 1cm
CTV59.4 = $CTV_{T1/GAD}$ + $CTV_{T2/FLAIR}$

Consider 2 dose volumes (concurrent boost) for large volume tumours or secondary tumours with large volume T2/FLAIRcomponent.

GTV = enhancing disease on MRI and CT + surgical cavity + T2/FLAIR if relevant
CTV54.45 = GTV + 1-1.5 cm margin adjusted according to anatomical barriers
CTV59.4 = *GTV + 0.5cm margin adjusted according to anatomical barriers
*Use GTV enhancing volume only.

Note:

- The BED calculations for 54.45Gy in 33 daily fractions of 1.65Gy are 84.0 Gy_3 and 63.43Gy_{10} compared to 80.6 Gy_3 and 59.47Gy_{10} for 50.4Gy in 28 daily fractions of 1.8Gy.

6.3 IDH Mutant Gliomas WHO Grade 2

Single dose: 54Gy in 30 fractions

GTV = Surgical cavity (if applicable) + low grade component as visible on CT and MRI (T2/FLAIR)
CTV = GTV + 1-1.5 and adjusted according to anatomical barriers
PTV = As per local protocol.

6.4 Ependymoma

Consider referral for Proton Beam therapy if appropriate.

Radiotherapy dose for

- Intracranial lesions should be in the range of 54 to 59.4*Gy in 30-33 fractions.
- Spinal ependymomas are treated to a dose of 50.4 – 54 Gy in 28-30 Fractions (aim at least 50Gy).
- Craniospinal RT is recommended in case of CSF or spinal dissemination. Dose for CSI should be 36 Gy in 20 fractions with boost to focal lesions of up to 54 Gy in 30 fractions (refer to UHB).
- Target volumes should be delineated as under:

  a. GTV: It is defined on pre and postoperative MRI fused with planning CT, as any surgical cavity, gross residual enhancing tumour, or gross tumour in case of inoperable lesion.
  b. CTV: minimum 10mm isotropically but respecting the anatomical boundaries. Spinal ependymomas, CTV should be expanded laterally to include the nerve roots up to the meningeal covering.
  c. PTV: It would depend on the location of primary tumour and local protocols. Values below based on UHB data:
     i. Brain: 3mm
     ii. Cervical spine: 5mm
     iii. T1- L2: 10 mm
     iv. L3 and inferior: 12mm

**Aim for 59.4Gy in 33 fractions based on paediatric data. Dose reduction to be considered for inoperable disease into critical OARs.*

Consider discussion at EMAG and proton referral for TYA population.

7. Meningioma

7.1 Indications for radiotherapy or SRS/T:

- Recurrent or residual grade I tumours post-surgery unless further complete resection possible. (A period of observation recommended following 1st surgery unless prior documented progression.)

- Primary treatment for *inoperable tumours lacking pathological confirmation if progression at a rate consistent with benign meningioma.
- Offer fractionated radiotherapy to all grade 3 (anaplastic) meningiomas regardless of resection extent.

*Inoperable : surgery associated with high risk / poor surgical candidate / unprepared to have surgery.

The role of radiotherapy for completely resected Grade 2 meningioma is being investigated as part of the ROAM trial. It is reasonable to discuss on a case-by-case basis. If there is residual or recurrent inoperable disease radiotherapy should be discussed.

7.2 Relative contraindications to radiotherapy / SRS/T

- Symptomatic oedema / mass effect (consider surgery)
- Rapidly growing tumours lacking pathological verification or uncertainty in diagnosis
- *Fractionated radiotherapy is preferred over SRS/T for lesions >10cc, grade II pathology and lesions in close proximity to optic pathways

*These are relative and individual cases considered for SRS/T should be discussed within and MDT with SRS/T expertise. For example, grading for meningioma remains controversial and growth kinetics should be considered.

8. Radiotherapy Planning and Dose Fractionation

Grade 1 (incl slow growing radiological)

Dose 50.4Gy in 28# to 54Gy in 30#
GTV defined using MRI + Gd and CT (incl bone windows) to include dural tail.
CTV = GTV + 2-5mm margin (consider 5mm along dura / any areas of uncertainty)
PTV = as per department

Grade 2
Dose 54-60Gy in 30#
GTV is defined as the resection cavity plus residual inoperable disease on the post-operative MRI and planning CT-scan. If bone is involved, a CT bone window setting is strongly advised. Clearly thickened dural tails and hyperostotic bones should be included whereas non-enhancing but thickened dura does not need to be included. It may be helpful to consider pre-op MRI scan when outlining.

CTV = Min +10mm along dura / 5mm all other directions. If brain invasion +10mm into brain parenchyma. Can be edited where extends outside cranium.

PTV = as per department

Grade 3
Dose 60Gy in 30#

GTV is defined as the resection cavity on the post-operative MRI and planning CT-scan. If bone is involved, a CT bone window setting is strongly advised. Clearly thickened dural tails and hyperostotic bones should be included.

CTV = GTV + min 15mm along dura and 10mm into brain parenchyma

9. Peer review

Peer review should be undertaken in line with the West Midlands regional guidance agreed in December 2025 which identifies which cases should be subject (as a minimum) to peer review. Please refer to the West Midlands Peer Review guidance (December 2025).

10. Pituitary Tumours

Indications for radiation therapy (SRS or Radiotherapy)

1. Symptomatic, or progressing NFA, not suitable for surgical resection.
2. Recurrent NFA that have undergone maximal safe surgical resection and further resection is not likely to be beneficial (e.g extension into cavernous sinus)
3. Residual NFA following maximal surgical resection where concerns exist for early progression (discuss at pituitary MDT)
4. Functional tumours fulfilling the above criteria or where hypersecretion is not adequately controlled with surgical resection and/or medical therapy.

Selection for SRS

1. < 4 cm^3 and radiologically defined target
2. Typically >2-3mm separation of tumour from optic pathways (ability to meet dose constraints)
3. Ability to consent and comply with SRS process (e.g. lie flat for 90minutes and undertake required planning process including volumetric MRI scan)

Where possible, SRS is preferred over conventional fractionated radiotherapy.

Patients unable to meet optic pathway constraints and/or with higher volume tumours should be treated with fractionated radiotherapy, unless further surgical resection is a low risk option to facilitate SRS.

Fractionated Radiotherapy

Use 1.8Gy per fraction: 45Gy in 25# over 5 weeks is adequate for most patients
Consider up to 54Gy in 30# (selective aggressive pathology / functional tumours)

Recommend 5 or 9 points IG IMRT BDS and planning with 1mm slice CT for small volume tumours and use volume MRI fusion to assist planning (typically T1 plus Gd 1mm slice axial).

- GTV= residual disease (consider all imaging and consult with neuroradiology if required)
- CTV = tumour + 0.5 cm margin + cavernous sinus (considering including superior part of sphenoid sinus / areas or uncertainty using pre-surgical scans)
- PTV = CTV + 3mm margin: Departments should aim to use a reduced PTV margin

11. Treatment Planning and Critical Organs

Dose metrics and constraints will depend upon pathology and prescription. The local consultant remains responsible and below charts are for guidance. Where critical OAR doses need to be exceeded, appropriate local consent/justification should be documented. Where the prescription dose is below organ tolerances, all attempts should be made to keep OAR doses as low as possible.

Seen appendix 1 for a sample plan assessment table and optimal constraints by dose/fractionation.

Optimal constraints are given however suggested planning priority (may vary according to disease):

1. Critical OARs (Brainstem optic pathways, spinal cord)
2. PTV coverage
3. Globes/cornea/larcrimal glands/cochlear
4. Hippocampus/pituitary.

12. Pre-Treatment/Treatment Verification and PTV

- Reduced PTV margins (e.g. 3mm) require sufficient on line imaging and immobilisation to prevent rotation of shoulders (e.g 9 point shell). For example, using 3D cone beam CT or Tomotherapy MVCT
- Each department should have local audit data to provide guidance on margins according to imaging / immobilisation with appropriate action levels.
- PTV margins of 5mm with reduced level of IGRT may be appropriate in selected cases.
- Local protocols must be available describing action levels and concomitant patient imaging doses.
- In Vivo dosimetry, as defined by local protocols, completed within first 3 fractions

13. On-treatment review

This will depend upon the disease site and service set up.

- Weekly review during treatment is required for most cases and this may be by clinician, clinical nurse specialist or specialist radiographer.
- Weekly full blood counts (FBCs), liver function tests (LFTs) and urea and electrolytes (U&Es) are required for patients having concomitant temozolomide.

14. Treatment Letter

- On completion of treatment a summary of the radiotherapy dose and toxicities experienced are documented.
- In addition, expected acute and late side effects are detailed with recommended treatments.

15. Significant Toxicities to consider

Significant, unavoidable or Frequently occurring Risks:	
Possible Early side Effects	Possible Late side Effects
Tiredness / Lack of energy	Effect on Memory /concentration
Hair Loss	Hearing loss
Headache	Worsening balance /dizziness
Skin Redness /soreness	Loss of Pituitary function (hormone deficiencies)
Sickness	• Potential early menopause
Seizures(epilepsy)	Damage to Vision
Swelling requiring increase in steroid dose	• Cataracts
Periods of increased sleepiness	• Dry /Red eye
Hearing loss during treatment	• Double vision
	• Loss of vision
	Nerve Damage
	• Facial Weakness /spasm
	• Altered Sensation on face/facial pain
	Risk of Stroke /Bleed
	Second tumour (including Cancer)
	Risk of swelling requiring steroids/surgical intervention
	Long term damage to brain (radionecrosis) causing potential disability/ weakness
	Seizures
	SMART (stroke-like Migraine attacks)

Please refer to RCR webpages for latest consent/toxicity information. The above list may not cover every risk and individual consultants must apply judgement.

16. Appendix 1: Guidelines for plan assessment sheets.

These are example and may not cover every scenario. Where the prescription dose is below organ tolerances, all attempts should be made to keep OAR doses as low as possible.

Dose = 60Gy in 30 fractions

		PTV60		PTV54		PTV50.4	
% Volume	**% Dose**	**Dose Required**		**Dose Required**		**Dose Required**	
99%	**>90%**	54.0		48.6		45.4	
95%	**>95%**	57.0		51.3		47.9	
50%	**=100%**	60.0		54.0		50.4	
5%	**<105%**	63.0		56.7		52.9	
2%	**<107%**	64.2		57.8		53.9	

ORGAN	CONSTRAINT (Gy)
PRV cord (max/1cc)	46/45
Brainstem	55
PRV Brainstem (surface dose)	60
Globes	40
PRV Chiasm	55Gy
PRV Optic nerves (Lt/Rt)	55
Brain (1cc)	<64
Brain (V54)	<33%
Cornea (Lt/Rt)	30
Lacrimal gland (mean)	<24
Lens (Lt/Rt)	6
PRV Contralateral Cochlear (Lt/Rt) (mean)	40
Pituitary (mean)	Record/ALARA
Contralateral hippocampus (mean) Or bilateral (if distant ipsilateral disease)	<10 D40%<12.2

Dose to 0.03cc accepted unless otherwise specified

Dose = 59.4Gy in 33 fractions

ORGAN	CONSTRAINT (Gy)
PRV cord (max/1cc)	46/45
Brainstem	55
PRV Brainstem (surface dose)	60
Globes	40
PRV Chiasm	55
PRV Optic nerves (Lt/Rt)	55
Brain (1cc)	<64
Brain (V54)*	<33%
Cornea (Lt/Rt)	30
Lacrimal gland (mean)	<24
Lens (Lt/Rt)	6
PRV Cochlear (mean – at least one side)	40
Pituitary (mean)	Record/ALARA
Contralateral Hippocampus (Lt/Rt) (Mean) Or bilateral (if distant ipsilateral disease)	<10 D40%<12.2

Dose to 0.03cc accepted unless otherwise specified

Dose = 54 in 30:

ORGAN	CONSTRAINT
PRV cord (max/1cc)	46/45Gy
Brainstem	54Gy
PRV brainstem	54Gy
Globes	40Gy
PRV Chiasm	54Gy
PRV Optic nerves (Lt/Rt)	54Gy
Cornea (Lt/Rt)	30Gy
Lacrimal gland (mean)	<24Gy
Lens (Lt/Rt)	6Gy
PRV Cochlear (mean –at last one side)	40Gy
Pituitary (mean)	Record/ALARA
Contralateral hippocampus (Lt/Rt) (mean) Or bilateral (if distant ipsilateral disease)	<10 Gy D40%<12.2

Dose to 0.03cc accepted unless otherwise specified

Dose = 40Gy in 15 fractions

ORGAN	CONSTRAINT
PRV cord (max/1cc)	40Gy
Brainstem	40Gy
PRV brainstem (surface dose)	41.2Gy
Globes	26.5Gy
PRV Chiasm	40Gy
PRV Optic nerves (Lt/Rt)	40Gy
Cornea (Lt/Rt)	30Gy
Lacrimal gland (mean)	<24Gy
Lens (Lt/Rt)	4.9Gy
PRV Contralateral Cochlear (Lt/Rt) (mean)	40Gy
Pituitary (mean)	Record

Dose to 0.03cc accepted unless otherwise specified

Dose = 45Gy in 25 fractions

ORGAN	CONSTRAINT
SpinalCord_PRV(0.03cc/1cc)	≤45Gy*
Brainstem	≤45Gy*
Brainstem_PRV (surface dose)	≤45Gy*
Eyes (Lt/Rt)	≤26.5Gy
PRV_Chiasm	≤45Gy*
PRV Optic nerves (Lt/Rt)	≤45Gy*
Corneas (Lt/Rt)	≤30Gy
Lacrimal gland (mean) (Lt/Rt)	<24Gy
Lens (Lt/Rt)	≤6Gy
PRV Contralateral Cochlear (Lt/Rt) (mean)	≤40Gy
Pituitary (mean)	Record
Hippocampus combined	D40%<12.2gy

Dose to 0.03cc accepted unless otherwise specified

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