East Midlands Radiotherapy Operational Delivery Network

Radiotherapy Protocol for the management of BREAST Cancer

This is radiotherapy protocol for the East Midlands RT Operational Delivery Network (ODN).
Tumour sites are: Breast

Document revision History

Version Number	Date	Document History.
0.01	03/02/2023	Initial Draft by Priyesh Mistry
0.02	31/07/2023	Reviewed and amended with KD
0.03	11/10/2023	Changes following 1st Network review. In attendance: A.Aleksic, K.Das, W.Ali, K.Johnson, K.Kancherla, R.Vijyan
0.04	11/23	Changes following planning and physics departmental (UHL/UHDB/NUH) feedback in person with PM
0.06	02/2024	Changes following feedback regarding planning section from M.Cowen
0.06	23/04/2024	Reviewed by Radiotherapy planning team. In attendance: D.Holmes, L.Martins. V. M-Smith, J. Sutton Updated draft shared to planning team for any further comments
0.07	27/09/2024	Reviewed and ratified at ECAG
1.0	October 2024	Uploaded to Sharepoint
V1.1	March 2025	KD/PM- References improved as per Dec 2024 NOG action

1. Treatments to include

- Whole breast Radiotherapy
- Partial breast Radiotherapy
- Chest wall (+/- Reconstruction) Radiotherapy
- Nodal irradiation
- Tumour bed boost
- Special cases

2. Indications for treatment

Adjuvant Radiotherapy

2.1. Whole breast radiotherapy

Breast conserving surgery with clear margins for:

- Invasive carcinoma
- DCIS with high risk
- DCIS with intermediate risk (Reference VNPI to guide decision)
- Encysted papillary carcinoma
- Pleomorphic lobular carcinoma in situ

2.2. Partial Breast Radiotherapy [20] [15]

For patients that meet all the following criteria

- Breast conserving surgery for invasive cancer
- Age ≥ 50 Years
- Tumour ≤ 30mm
- Grade 1 and 2 disease
- Minimum of 1mm radial margins
- Node negative
- ER positive HER negative

Exclusion criteria

- Classical Lobular carcinoma
- Lymph-vascular invasion

-Patients should be advised to have adjuvant endocrine therapy

2.3. Omission of RT Only

Omission of RT only

- NICE 2018 guidance [3] recommends to consider omitting radiotherapy in women who have a very low absolute risk of local recurrence (defined as women aged 65 and over with tumours T1N0, ER-positive, HER2-negative and grade 1-2) willing to take adjuvant endocrine therapy for a minimum of five years.

2.4. Chestwall radiotherapy (+/- Reconstruction) [21]

- 4 or more LN +ve
- Involvement of deep margin or skin
- All tumour > 5 cm
- Consider RT if any of
  - size > 3cm
  - LN +ve
  - Grade 3
  - Lympho-vascular invasion

2.5. Nodal Irradiation [1]

Consider supraclavicular fossa radiotherapy (SCF) treatment:

- N2/N3 (≥ 4 lymph nodes positive)

1-3 lymph nodes positive in patients with good performance score and other poor prognostic features in patients such as grade 3 disease, T3/4 tumours, lymph vascular invasion and extra capsular spread. Consider if grade 2 and high risk features

Consider Internal mammary chain nodal radiotherapy:

- T4 and/or N2-N3
- Intermediate risk of recurrence (that is, 1–3 axillary macrometastases and central/medial disease, who have been recommended locoregional irradiation

Axillary node radiotherapy

- Axillary surgery not possible
- Consider in selected patients with macroscopic metastases following sentinel node biopsy where further axillary treatment (axillary surgery or axillary radiotherapy) is required.

Individualised treatment as per MDT discussion and patient choice. Axillary lymph node clearance preferred in patients who present with macroscopic disease in the axilla including bulky disease.

2.6. Tumour Bed Boost Radiotherapy [1]

- Age ≤ 50 years
- Grade 3
- Extensive intraductal component
- Positive margins and close resection margins of <1mm where no further surgical excision is possible in invasive disease.

Consider boost in cases of DCIS with positive margins that cannot be re-excised to be discussed on a case by case basis in the MDT meeting (Meena et al, 2017) [2]

2.7. Considerations

DIBH

- All left sided breast cancers [1]
- Right sided breast cancer where the left has been irradiated in DIBH
- Consider right sided cancer in a large breast to reduce the amount of liver in the field
- Internal mammary chain lymph nodes in both left and right sided disease [1]

- Consider for right sided breast treatment where SCF and/or axilla are to be treated

Bilateral Breast/Chestwall treatment

- Simultaneous or sequential as per local practice
- DIBH recommended for both sides
- If for nodal radiotherapy on one or both sides, treatment with VMAT/Rapidarc simultaneous (40gy in 15#) should be considered
  -Alternatively: Matched tangents with a central gap

2.8. NACT

Neoadjuvant chemotherapy (NACT)

- Base the indication for adjuvant radiotherapy on the pre NACT clinical staging
- Pre NACT node positive (includes post NACT residual nodal disease and pathological evidence of previous nodal involvement)

3. Investigations Required

- Histological confirmation of malignancy
- Diagnostic/staging imaging to include:
  -CT chest/abdomen/pelvis (if indicated)
  -MRI (if indicated)

Review of clinical history to include:
-Previous radiotherapy
-History and examination, PS
Special Circumstances to consider:
-Chronic conditions or disease that affects radiosensitivity
-Ongoing medication that may affect response to radiotherapy
-Patients with an ICD (RCR ICD GUIDANCE) [4]

4. Information given to patients

- General radiotherapy booklet
- Site specific treatment leaflet including long term side effects

5. Consent

- By IR(ME)R Practitioner at new patient / planning clinic
- By Entitled IR(ME)R Operator under delegated authority at new patient / planning clinic

6. Trials Open

- Consider current trials open in any of the radiotherapy centres in the East Midlands.
  [EMRTN TRIALS TRACKER LINK]
- If a patient is being treated in a clinical trial then the Trial Protocol overrides the departmental protocol.

7. Position and immobilisation

All patients will be CT scanned as per local protocol and should consider including the following:

- Appropriate scan levels incorporating the treatment area and OAR
- Suitable breast/thorax patient immobilisation utilising incline as appropriate
- Patients should be supine with their arm(s) above their head
- Consideration should be taken into account to reduce treatment collision risk (i.e. width between elbows and incline) in line with local planning and treatment restrictions
- Radio-opaque markers to delineate breast tissue, scars and disease
- Use of IV contrast if required, as per local protocol

8. Planning

Target volumes: Use ESTRO contouring atlas as a guide[5]

Breast & Chest wall
Routine outlining is not required. Fields are defined based on the patients anatomy using virtual simulation and a pseudo PTV is created. Breast/chest wall are outlined when RapidArc/VMAT is required (due to patient anatomy or treatment include nodes) RapidArc/VMAT may be used to treat any SCF/Axilla/IMLN patients according to local practice. RapidArc/VMAT may also be used to treat breast only patients and should be decided on case by case basis. CTV_WB: Whole breast CTV includes the soft tissues of the whole breast from 5 mm below the skin surface down to the deep fascia, excluding muscle and underlying rib cage. PTV as per local practice. CTV_CW: Chest wall CTV is from skin flaps and includes the soft tissues down to the deep fascia, excluding underlying muscle and rib cage. PTV as per local practice

Partial breast [15]
GTV = clips + surgical changes PB_CTV = GTV + 15mm margin bound 5mm from skin surface and 5mm from lung/chest wall interface but should not extend into pectoral fascia nor beyond visible breast tissue PB_PTV = PB_CTV + 10mm PB_PTV_DVH = PB_CTV + 10mm bound 5mm from skin surface and 5mm from lung. Also, bound 5mm from field boundary, only after acknowledgement and justification from clinician Field = PB_PTV + 7-10mm

Tumour Bed Boost
Aim to treat surgical bed using surgical clips as guidance if appropriate. Add PTV and fields as per local practice (consider IMPORT methodology for guidance[11]). Take consideration if patient is in DIBH for boost treatment. Boost volume is treated either with photons as part of simultaneous integrated boost or sequentially with photons/electrons. Dose constraints should account for boost and ideally should be planned together, but may be planned separately (i.e. Treatment with SIB is preferable)

SCF
To include level 3 + level 4 nodes. The nodal areas are outlined by the consultant or advanced practitioner. PTV and field are placed as per local practice. Alternatively, centers may use fields based on anatomical land marks but need to ensure that the nodal areas are covered

Axilla:
Level 1 & Level 2 nodes need to be included. The nodes are outline and PTV and fields are placed as per local practice. If not for VMAT/Rapidarc: The volume is covered by a direct anterior field matched with the breast tangents. It is expected that the part of this volume is covered by breast tangent and part of the volume by the axillary field. Alternatively, centers may use a wide breast tangent to treat the axilla

SCF & Axilla:
Volumes to include SCF and axilla as above and PTV and fields as per local practice. If not for VMAT/Rapidarc: Alternatively fields based on anatomical landmarks to cover the nodal areas may be used. Shielding to cover humeral head.

IMLN:
Internal mammary nodes and SCF nodes CTV is outlined by Consultant or by trained advanced practitioner. Breast / chest wall CTV is also outlined. PTV used as per local practice. IMLN, SCF & Breast/Chest wall PTV is treated by VMAT/Rapidarc If not for VMAT/Rapidarc : Deep breast tangents can be considered if more appropriate.

9. Bolus

If the skin is considered the target organ (known skin involvement, inflammatory disease or where risk of recurrence at skin surface is considered to be high) bolus will be prescribed for all fractions. Bolus thickness will be decided based upon treatment plan dosimetry. N.B. In this situation, bolus may be removed towards the end of treatment if there is a marked acute skin reaction

10. OAR: Organs at risk & dose contraints

OAR to be outlined by planning staff and approved by responsible clinician. OAR to be included: Heart, Lung- ipsilateral and contralateral, contralateral breast (VMAT), spinal cord (VMAT) **Dose constraints for OAR are generally prioritised over the target coverage constraints. The volume of lung and heart treated should be reduced by MLC shielding.**

Dose objectives for PTV'S

- **Treatment plans should be prescribed as per the local protocol for breast planning**
- **Local protocols should also decipher decisions regarding PTV cropping.**

Breast	V95% ≥ 95% (optimal) V95% ≥ 90% (mandatory) D0.5cc ≤ 110% (mandatory)
Boost	V95% ≥ 95% (optimal) V95% ≥ 90% (mandatory) V107% ≤ 2% (mandatory)
SCF, Axilla, IMLN	V90% ≥90% (optimal) V80% ≥ 80% (Mandatory)

- This protocol has referenced several protocols for the OAR constraints. Other protocols that may incorporate tighter constraints (e.g. ESTRO guidance [16]) may also be used

  Local protocols can be adapted to incorporate any of the clinically acceptable guidance protocols as per departmental preference

Dose constraints	Tangents									VMAT/RAPIDARC		
Dose	26Gy in 5# / 28.5Gy in 5#			40GY in 15#			40GY in 15# / 48Gy in 15#			40GY in 15#		
	Breast / Chestwall / Partial breast (Based on FAST FORWARD trial) [13]			Breast / Chestwall / Partial breast + Specified Nodes (Based on IMPORT HIGH) [11]			Breast / Chestwall / Partial breast + Specified Nodes + Boost (Based on UK RCR Consensus 2016 & Import HIGH) [11] [12]			Breast / Chestwall / + Specified Nodes +/- Boost (Based on UK RCR Consensus 2016 & Import HIGH) [11] [12]		
OAR	Dose	Mandatory constraint	Optimal Constraint	Dose	Mandatory constraint	Optimal Constraint	Dose	Mandatory constraint	Optimal Constraint	Dose	Mandatory constraint	Optimal Constraint
Heart	V6.5Gy	≤ 5% mandatory	-	V10Gy	≤ 10%	≤ 5%	V10Gy	≤ 10%	≤ 5%	Mean	-	<2Gy (Right sided)
	V1.3GY	≤30% mandatory	-									
	Mean Dose	-	<2Gy	V2Gy	-	< 30%	V2Gy	-	< 30%	-	-	-
	-	-	Complete shielding of the heart	Mean dose	≤2Gy	-	Mean dose	≤2Gy	-	-	-	-
Heart (IMC)	-	-	-	-	-	-	-	-	-	V17Gy	≤10%	≤10%
										Mean [9]	≤6Gy	≤4Gy
Ipsilateral lung (Non IMC)	V7.8Gy	≤17%	≤15%	V18Gy	<15%	<10%	V18Gy	<15%	<10%	V12Gy	-	≤25.0%
				Mean	-	<6Gy				V18Gy	<30%	-
Ipsilateral lung + SCF	-	-	-	V18Gy	-	≤30%	-	-	-	-	-	-
Ipsilateral lung (IMC)	-	-	-	-	-	-	-	-	-	V17GY	≤35.0%	-
										Mean	-	≤ 13.0Gy Optimal
Contralateral breast	-	-	-	-	-	-	-	-	-	Mean	≤3.5Gy	≤1.5Gy if>40year ≤1Gy if ≤40 years
Contralateral lung	-	-	-	-	-	-	-	-	-	Mean	≤4.0GY	≤3.5Gy [9]

Additional OAR for consideration	
OAR	**Dose considerations (Report only or as per local practice)**
Brachial plexus [8]	**Dose to 0.10cc less than 42Gy**
Left anterior descending artery (LAD) [18]	**Less than 12Gy total dose (0.8 Gy per fraction) IMC etc.**
Thyroid [17]	**V30Gy< 50%**
Trachea	**D0.1cc<33Gy** **D0.1cc<30Gy + 5mm (PRV)**
Oesophagus [14]	**V17<15%** **mean<11Gy**
Spinal cord dose	**12-14Gy for IMC treatments with VMAT**
Head of humerus [8]	**V40Gy < 1cc**

11. Dose Fractionations [1]

Breast/Partial Breast/Chest wall /Reconstruction

- 26Gy in 5 fractions over 1 wk
- 28.5Gy in 5 fractions over 5 wks for frail patients[12]
- 40Gy in 15 fractions over 3 wks (for patients requiring breast boost only)

Breast/Chest wall plus nodes (SCF, Axilla, IMLN)

- 40GY in 15 fractions over 3wks
- 26GY in 5 fractions for frail patients, excluding patients needing IMLN[6]

Breast Boost

- 13.35Gy in 5# or 12GYin 4# (Hypofractionated boost) (Grade C). Sequential following 26Gy in 5# or 40GY in 15#**;** whichever dose schedule is used, should be equivalent to 16GY in 8#
- 15# in SIB (Simultaneous integrated). 48Gy to boost volume and 40Gy to rest of the breast (Grade A)

12. Palliative Intent

- Bespoke treatment to palliate locally advanced and metastatic disease to achieve local tumour control and symptom control
- Medically inoperable breast cancer
- Conformal Radiotherapy is the primary choice of planning technique for palliative patients. However IMRT/VMAT Radiotherapy will be considered where it is justifiably, patient appropriate and also in circumstances where constraints/targets cannot be achieved through conformal Radiotherapy

Dose Fractionations: [1]

- **20Gy in 5#**
- **26Gy in 5#**
- **40Gy in 15#**
- **30GY-36GY over 5-6 weeks**
- **8Gy in 1#**

10. Treatment

- Final pre-treatment, Physics and 1st day checks should be carried out as per local protocol.
- These should ideally cover or take into account the following:
  -Monitoring and managing Radiotherapy delays to ensure patients start treatment according to national guidelines
  -Checking plan approval status and parameters as per local protocol
  -All prior preparatory and required patient information is available
  -Imaging requirements for the planned treatment are adequate according to patient plan and local protocol
  -Any prior In vivo dosimetry has been performed as per local protocol.
- During treatment:
  -Any other monitoring as specified in the local protocol should be performed e.g. dietician review, weight checks, weekly blood counts.
  -On treatment imaging as per local protocols
- For gaps in treatment follow local policy which should take into account the RCR policy[19]
- On treatment and follow up reviews as per local protocols.
- SGRT is recommended for the treatment of breast patients and should be used as per local protocol.
  -Where SGRT is not available alternative motion management should be considered.

11. Late effects

- Late effects will have been discussed as part of the initial discussions and counselling by the treating clinician and is dependent on the radiotherapy target volumes

- If available, details of the local department's late effects clinic should be provided at the appropriate interval following completion of Radiotherapy.

12. Peer Review [22]

- Peer Review will enable clinicians to provide high quality treatments despite potentially limited referrals. Documenting peer review is essential as per RCR Recommendation 10 + 11.
- In order to meet the RCR standards the review will cover patient selection, prescription and target / OAR delineation. For some cases it may be necessary to review the final treatment plan also.
- The reviewee must provide the reviewer with all relevant clinical information to peer review, which may include demographics, diagnosis and details of proposed treatment. Any relevant clinical tests or images must also be provided (see Table 1 above).
- Responsibility for the patient will remain with the clinician under whom the patient receives their care. If a peer review does not occur, whatever the reason may be, it is that clinician's responsibility to address this.

13. Glossary

Abbreviation	Definition
#	Fraction (i.e. Fractions of treatment)
3DCT	Three dimensional computed tomography (standard CT scan)
CBCT	Cone Beam computed tomography
ChemoRT	Chemotherapy with Radiotherapy
CT	Computed tomography
CTV	Clinical target volume
DCIS	Ductal carcinoma insitu
EMRTN	East Midlands Radiotherapy Network
ESTRO	European society for Radiotherapy and Oncology
GTV	Gross tumour volume
Gy	Gray (unit of measure for radiation dose)
ICD	Internal Cardiac device
ICRU	International commission on radiation units and measurements
IMC	Internal mammary chain
IMN/IMLN	Internal mammary nodes / Internal mammary lymph nodes
IMRT	Intensity modulated radiotherapy
IR(ME)R	*Ionising Radiation (Medical Exposure) Regulations*
ITV	Internal target volume
LAD	Left Anterior Descending Artery
MDT	Multi-disciplinary team
MLC	Multi lead collimator
MRI	Magnetic resonance imaging
NACT	Neo adjuvant chemotherapy
NOG	Network oversight group
OAR	Organs at risk
PB	Partial Breast
PET (PET-CT)	Positron emission tomography (Positron emission tomography – computed tomography)
PRV	Planning organ at risk volume
PS	Performance status
PTV	Planning target volume
RCR	Royal college of radiologists
RT	Radiotherapy
SCF	Supraclavicular fossa
SGRT	Surface Guided Radiotherapy
SIB	Simultaneous integrated boost
U+E	Urea and electrolytes
VMAT	Volumetric modulated arc therapy
WB	Whole breast

14. References

[1]
- https://www.rcr.ac.uk/media/br2aqgpd/03-breast-cancer-radiotherapy-dose-fractionation-fourth-edition.pdf

[2]
- https://jamanetwork.com/journals/oncology/articlepdf/2613411/jamaoncology_moran_2017_oi_160109.pdf

[3]
- https://www.nice.org.uk/guidance/ng101/evnce/evidence-review-h-breast-radiotherapy-pdf-4904666613

[4]
- https://www.rcr.ac.uk/sites/default/files/mgmt_cancer_patients_receiving_radiotherapy_cardiac_implanted_electronic_device_sep2015.pdf

[5]
- ESTRO consensus guideline on target volume delineation for elective radiation therapy of early stage breast cancer - Radiotherapy and Oncology (thegreenjournal.com)

[6]
- https://www.rcr.ac.uk/system/files/publication/field_publication_files/bfco21.pdf

[7]
- Bartelink H, Horiot J-C, Poortmans P, Struikmans H. Recurrence Rates after Treatment of Breast Cancer with Standard Radiotherapy with or without Additional Radiation. The New England Journal of Medicine 2001:10

[8]
- Yan M, Kong W, Kerr A, Brundage M. The radiation dose tolerance of the brachial plexus: A systematic review and meta-analysis. Clinical and Translational Radiation Oncology 2019;18:23–31. https://doi.org/10.1016/j.ctro.2019.06.006.

[9]
- Ranger A, Dunlop A, Hutchinson K, Convery H, Maclennan MK, Chantler H, et al. A Dosimetric Comparison of Breast Radiotherapy Techniques to Treat Locoregional Lymph Nodes Including the Internal Mammary Chain. Clinical Oncology 2018;30:346–53. https://doi.org/10.1016/j.clon.2018.01.017.

[10]
- RCR. Prospective treatment of breast cancer: UK consensus. 2016.

[11]
- IMPORT High. IMPORT HIGH Planning_pack_version_4 0_final_23052013.pdf 2013.

[12]
- https://www.rcr.ac.uk/media/g2qg4yra/rcr-publications_postoperative-radiotherapy-for-breast-cancer-hypofractionation-rcr-consensus-statements_may-2021.pdf

[13]

- https://www.icr.ac.uk/media/docs/default-source/default-document-library/fast-forward-planning-pack.pdf?sfvrsn=b5052169_0
  [14]
- Yaney, A. et al. (2021). Dosimetric parameters associated with radiation-induced esophagitis in breast cancer patients undergoing regional nodal irradiation. 155: 167-173
  [15]
- Coles CE, Griffin CL, Kirby AM *et al*. Partial-breast radiotherapy after breast conservation surgery for patients with early breast cancer (UK IMPORT LOW trial): 5-year results from a multicentre, randomised, controlled, phase 3, non-inferiority trial. *Lancet* 2017; **390**(10099): 1048–1060. doi:10.1016/S0140-6736(17)31145-5
  [16]
- https://www.thegreenjournal.com/article/S0167-8140(14)00524-6/fulltext
  [17]
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5454600/
  [18]
- https://www.redjournal.org/article/S0360-3016(22)00332-7/abstract
  [19]
- https://www.rcr.ac.uk/media/z5jgmrhd/rcr-publications_the-timely-delivery-of-radical-radiotherapy-guidelines-for-the-management-of-unscheduled-treatment-interruptions-4th-edition_january-2019.pdf
  [20]
- https://www.rcr.ac.uk/our-services/all-our-publications/clinical-oncology-publications/postoperative-radiotherapy-for-breast-cancer-uk-consensus-statements/
  [21]
- NCCN Guidelines Version 3.2025 Invasive Breast Cancer, Page 15
  [22]
- https://www.rcr.ac.uk/media/bpvngu2n/rcr-publications_radiotherapy-target-volume-definition-and-peer-review-second-edition-rcr-guidance_october-2022.pdf