East of England Radiotherapy Network:

Breast Protocol V3.0

Contents

1.0 Indications and patient population

This protocol covers treatment in the following situations:

- Adjuvant radiotherapy to the breast/chest wall - increases local control and survival for patients with invasive breast cancer [1-4]
- Adjuvant radiotherapy to the breast - increases local control for patients with ductal carcinoma in situ (DCIS) [5-7]
- Lymphatic Radiotherapy may be used for patients at higher risk of nodal recurrence - decreases breast cancer mortality and all case mortality [8]
- Radiotherapy boost to the tumour bed - increases local control in patients at higher risk of recurrence [9-11]
- Primary breast radiotherapy - may be considered for locally advanced tumours and for palliation.

1.1 Adjuvant Radiotherapy

1.1.1 Whole breast RT is indicated following breast conserving surgery +/- chemotherapy for invasive breast cancer or DCIS* (IG or HG). This includes patients following neoadjuvant chemotherapy (including those with pCR).

* N.B. Pleomorphic lobular carcinoma in situ (LCIS) is treated as per DCIS

1.1.2 Omission of radiotherapy may be considered in individual cases (while awaiting the results of the PRIMETIME study) for women who:

- Have had breast-conserving surgery for invasive breast cancer with clear margins (includes focal involvement of the anterior margin where the MDT agrees that there is no further tissue to surgical resect) **and;**
- Have a very low absolute risk of local recurrence (defined as women aged 65 and over with tumours that are T1N0, ER-positive, HER2-negative and grade 1 to 2) **and;**
- Are willing to take adjuvant endocrine therapy for a minimum of 5 years **and;**

- Will have regular mammograms for 10 years. Mammographic follow-up should take place annually for five years and ideally three yearly thereafter up to ten years. Patients are still eligible for the breast screening programme when >73 years, but they need to self-refer. [12-14]

1.1.3 If the multidisciplinary team (MDT) considers omitting radiotherapy after breast conserving surgery, a consultation is required to discuss risks and benefits with the patient [14].

1.1.4 Consider post-mastectomy RT following mastectomy/reconstruction +/- chemotherapy for invasive breast cancer where [15]:

- Involvement of 1 or more lymph nodes OR
- > 5 cm or T4 tumour OR
- Involved resection margins.

An additional scoring guide is contained within Appendix 1 and may be useful in identifying patients for post-mastectomy RT, where a resultant score is ≥3 [16].

1.1.5 Phyllodes Tumours:

- Benign/Borderline phyllodes – Surgery is usually excision only and adjuvant radiotherapy is not required.
- Malignant phyllodes – Surgery is usually mastectomy.
  Consider post-mastectomy RT to reduce local recurrence, RT is not shown to affect survival [17]. Where breast conserving surgery has been performed a tumour bed boost (10Gy in 5F) should also be considered [18].
  The standard of care is 50Gy in 25F over 5 weeks [17]. In exceptional circumstances, such as frailty or patient declining 5 weeks of radiotherapy then alternatives can be considered that are similar biologically to 50Gy in 25F. Examples include 42.5Gy in 16F over 3 weeks (Canadian hypofractionation trial) and for those who are very frail 30Gy in 5F once weekly over 5 weeks

(FAST trial). This requires full discussion with the patient regarding benefit, risk and uncertainties and documentation of a shared decision.

1.1.6 Partial breast radiotherapy may be considered following breast conserving surgery in patients with a low absolute risk of local recurrence where the following criteria are met [12]:

- Patients ≥ 50 years
- Invasive ductal type
- G1-2
- ≤ 30mm
- N0
- ER positive
- HER2 negative
- No LVI
- Minimum 1mm radial excision margins for invasive disease
- Visible tumour bed clips +/- post operative seroma for adequate on treatment verification, **and;**
- Have been advised to have adjuvant endocrine therapy for a minimum of 5 years.

OR

- Patients with co-morbidity/body habitus etc, precluding whole breast radiotherapy.

1.2 Lymphatic Radiotherapy

1.2.1 This is an area where further evidence is awaited and variations may exist locally, dependent upon the extent of surgery, individual patient risk factors and patient choice the following guidance will be considered.

1.2.2 Management of the cN0 axilla following primary surgery [12,14,19]. Summary in Appendix 2:

1.2.2.1 pN0, pN0(i+), pN1mi – no further local axillary treatment

1.2.2.2 For individual cases where nodal status is unknown, and cannot be confirmed, the risks and benefits of lymphatic radiotherapy should be considered by the multidisciplinary team and discussed with the patient.

1.2.2.3 pN1 – 1-2 macrometastases – further local axillary treatment may be omitted if **all** the following criteria are met:

- Patient is post-menopausal and will receive whole breast/chest wall radiotherapy and endocrine therapy,
- The tumour is T1, grade 1-2, ER positive, HER2 negative,
- The risks and benefits of no further axillary treatment are discussed with the patient.

1.2.2.4 All other patients require further axillary treatment: either surgery or radiotherapy. The risks and benefits of surgery versus radiotherapy may vary between individuals and will be discussed at multidisciplinary team meeting.

1.2.2.5 Axillary radiotherapy consists of levels 1-4 axillary nodes following a positive sentinel lymph node biopsy. This is relevant for those patients who have not had an axillary dissection and would have radiotherapy to levels 1-4 as per the AMAROS study [20].

1.2.2.6 For patients where radiotherapy to level 1-2 axillary nodes is offered these may be included within the tangential fields.

1.2.2.7 Treatment of the upper part of level 2 can also be as part of the undissected axilla. Ideally, the surgeon should mark the most superior part of the axillary dissection with a clip to aid RT planning.

1.2.2.8 Treatment of the supraclavicular fossa (SCF) (otherwise known as level 3 & 4 axillary nodes) should be considered for patients at high risk of recurrence, e.g. those with ≥ 4 nodes positive or pN1 where other high-risk features are present [21]. This is relevant for patients who have had a level 1-2 dissection and if found to have 4 or more nodes positive would recommend treating levels 3 and 4.

1.2.3 Internal mammary chain (IMN*) radiotherapy should be considered for [15,17,22-24]:

- All T4
- All N2-3
- N1 with central/medial disease and high-risk features present (e.g., unfavourable biology)
- Radiologically involved IMNs (ideally post downstaging with chemotherapy)

*N.B. The IMN is treated in conjunction with level 3 & 4 axillary nodes ±levels 1-2 depending on axillary surgery.

1.2.4 Radiotherapy to the axilla following neo-adjuvant chemotherapy (NACT) [25]. Summary in Appendix 3:

1.2.4.1 Patients with clinically and radiologically negative axilla, including negative axillary node histology if biopsy performed as per protocol and planned for NACT:

- After sentinel lymph node biopsy (SLNB) ypN0– no further local treatment to axilla
- Fibrosis in nodes is highly suggestive of previous nodal metastasis – axillary RT is recommended unless only 1 out of at least 2 SLNs shows fibrosis, and the MDT is reassured that baseline axillary imaging excludes macroscopic axillary disease.
- If any residual disease in SLNB after NACT (i.e., isolated tumour cells, micro/macrometastases) axillary lymph node dissection (ALND) is usually recommended as this may represent chemo-resistant disease.
- Radiotherapy can be considered for a few cases when the burden of disease in the axilla is low, and the patient has already met the criteria for upper axilla/ IMN treatment.

1.2.4.2 Patients with cN1 (biopsy proven) at presentation and planned for NACT:

- If positive node not marked, for ALND ± regional radiotherapy directed by final pathology findings.
- Consider level 3 & 4 (SCF) ± IMC radiotherapy if N1 with high-risk features, e.g., unfavourable biology and central/medial disease.
- If targeted axillary assessment after NACT is planned the positive node must be marked before NACT and 3 or more lymph nodes must be removed including marked node at targeted axillary assessment
- If ypN0, for axillary radiotherapy OR no further treatment of the axilla as part of a clinical trial/registration cohort study
- If ypN1, for ALND as there is no good evidence to support radiotherapy as an alternative to ALND in this setting.

1.3 Radiotherapy Boost

1.3.1 Tumour Bed Boost should be considered following whole breast radiotherapy for the following [9-11]:

- All patients < 50 years
- All patients > 50 years with higher risk pathological features (especially G3 and/or extensive intraductal component)

1.3.2 Risk factors:

- Tumour size > 3 cm
- Oestrogen receptor negative/Triple negative disease
- Extensive lymphovascular space invasion
- Involved, or close surgical margins
- Poor response to systemic therapy, or where treatment was stopped prematurely.

1.3.3 It is assumed that the multidisciplinary team have considered the tumour to be completely excised; otherwise, a boost should be considered.

1.3.4 Consider omitting a boost when the tumour bed is challenging to localise post oncoplastic surgery and risks of a larger boost volume are considered to outweigh possible benefit.

1.3.5 The initial pre-treatment pathology should be used to assess the need for a boost in those patients receiving neo-adjuvant systemic therapy.

1.3.6 A boost may also be given to any area of high risk, e.g., where macroscopic disease is present or known involved lymph nodes which are not amendable to surgery.

1.3.7 It is reasonable to consider a 48Gy in 15F simultaneous integrated boost (with or without nodal radiotherapy) based upon the 5-year primary endpoint results of IMPORT High [26].

1.3.8 A hypofractionated sequential boost can be added to whole breast radiotherapy as indicated.

1.3.9 A photon boost (conformal or VMAT) is the preferred technique, but occasionally it will be necessary to use a sequential electron or mini-tangential photon boost following whole breast irradiation. Such situations include the absence of tumour bed clips, oncoplastic surgery causing uncertainty in defining the tumour bed or individual patient anatomy.

1.4 Primary (Palliative) Breast Radiotherapy

1.4.1 Primary radiotherapy may be used for locally advanced tumours that are considered inoperable.

1.4.2 Tangential fields as for a radical treatment or a direct orthovoltage or electron field may be used to try to achieve local control. Fractionations are chosen to suit the type of patient and tumour.

1.5 Breast Re-irradiation

1.5.1 Patients presenting with isolated locoregional disease in the breast may have a prolonged disease-free survival and even cure after salvage treatment. Salvage treatment would routinely consist of surgery where possible and may involve re-irradiation.

1.5.2 Where re-irradiation is being considered, patients should be assessed face to face with a breast examination, skin assessment and assessment of late toxicity from their primary radiotherapy treatment.

1.5.3 All patients being considered for re-irradiation should be discussed in the breast radiotherapy MDT.

1.5.4 An α/β ratio of 2 should be used for brachial plexus in radiobiology calculations.

1.5.5 Shared decision making should be recorded in the patient's electronic notes with details of possible benefits, risks and uncertainties including small risk of radionecrosis. The expected clinical benefit of re-irradiation should outweigh the potential toxicity.

1.5.6 There is no randomised evidence underpinning re-irradiation and guidance comes from small series and expert opinion [27].

1.5.7 The following general principles should be considered:

- Within field relapse <2 years from first radiotherapy suggests relative radioresistance and irradiation is less likely to be beneficial
- There should be full evaluation of the previous irradiation course, guiding subsequent treatment planning. This includes estimating "worse-case scenario" equivalent doses in 2Gy daily fractions to dose limiting organs at risk such as brachial plexus.
- Small series suggest that moderate hypofractionation schedules such as 40Gy in 15F over 3 weeks can be repeated to breast tissue, 2Gy fractions may be needed if the brachial plexus is an organ at risk.

- Effort should be made to reduce the re-irradiated volume and doses to normal tissues.
- Careful evaluation of other potential contributors to poor tolerance for re-irradiation, such as patient related factors (comorbidities, performance status) and treatment-related factors (systemic treatment) is required.
- Care should be taken to avoid potential toxicity by avoiding excessive local cumulative radiation doses and/ or overlapping field junctions, and re-irradiation of organs at risk such as brachial plexus or lymphatics.
- It is recommended patients are followed up to monitor for late toxicity.

1.5.8 Refer to the RCR Clinical Oncology Principles of reirradiation (2024) [28] for further guidance.

1.6 Adjuvant treatment eligibility

1.6.1 Exclusion criteria

- Not suitable for immobilisation required to deliver radiotherapy.

1.6.2 Adjuvant TDM1

- It is recommended to complete adjuvant breast radiotherapy +/- regional lymph nodes before starting adjuvant TDM1 [29]
- Concurrent TDM1 in the adjuvant setting should be avoided where possible due to the increased risk of toxicity but may be considered by the multi-disciplinary team for individual patients considered to have high-risk disease.

1.6.3 Essential information required pre-radiotherapy:

- Histology
- MDT outcome
- New patient clinic letter from the IR(ME)R referrer
- Radiotherapy referral
- Consent

- In the instance of contralateral breast irradiation, the previous radiotherapy treatment plan must be reviewed to prevent overlap.

2.0 Localisation

Localisation	Notes	
Position	Supine	Prone positioning can be considered for individual patients where suitable immobilisation can be achieved
Arm/ head/ thorax position	Arm(s) abducted	Pay attention to avoid chin dropping into nodal RT fields. Consider wire to mark scar.
	Head straight	
	Sternum straight	
Immobilisation and supports	Breast Board / Wing Board	Head rest Arm/elbow support Wrist support
	Knee Block	
	Foot Stocks	If required
	If this position cannot be achieved other positions will be investigated	
Organ pre-requisites	Heart	Breath hold technique to be offered to all patients who have been referred for: • Left breast +/- nodes • Bilateral breast +/- nodes • IMC
Contrast	Consider for IMC or contoured nodes	
CT acquisition	Slice thickness:	2-3mm
	Sup Scanning limits	C3 (or hard palate for nodal RT)
	Inf Scanning limits	2.0cm inf of lung

3.0 Dose prescription

Intent	Dose (Gy)/F	F/week	Comments
a. Whole Breast RT	**26/5**	**5**	**Standard of care for breast RT without nodal RT**
	40-40.05/15	5	**Standard of care for breast + nodal RT** or if simultaneous integrated boost is required. Consider 40Gy in 15F for people with invasive breast cancer having whole breast RT, without regional lymph node irradiation, after breast-conserving surgery when they: • Have a diagnosis that increases sensitivity to RT, **or;** • Have any other factor that could mean having RT over 3 weeks is more acceptable (such as high BMI or fibromyalgia). [12]
	28.5–30/ 5	1	Patients with poor performance status/ co-morbidity
b. Chest Wall and breast reconstruction	**26/5**	**5**	**Standard of care for chest wall/breast reconstruction RT without nodal RT**

Intent	Dose (Gy)/F	F/week	Comments
b. Chest Wall and breast reconstruction (cont.)	40-40.05/15	5	**Standard of care for chest wall/breast reconstruction + nodal RT** Used in conjunction with nodal RT or if simultaneous integrated boost is required. Consider 40Gy in 15F for people when they: • Have had implant-based reconstruction; • Have a diagnosis that increases sensitivity to RT, **or;** • Have any other factor that could mean having RT over 3 weeks is more acceptable (such as high BMI or fibromyalgia). [12] N.B. There is no biological reason patients with immediate reconstruction should have a higher risk of normal tissue toxicity/capsular contracture with this fractionation. However, the RCR consensus 2021 recommended that centres may wish to audit their practice for this cohort, based upon the very small numbers within FAST-Forward. [30]
	28.5–30/ 5	1	Patients with poor performance status/ co-morbidity
c. Malignant Phyllodes	**50/25**	**5**	**Standard of care**
	42.5/16	5	For frail patient or those declining 5 weeks RT. N.B. should include full discussion with patient regarding benefit, risk and uncertainties and documentation of a shared decision
	28.5–30/ 5	1	FAST trial. Patients with poor performance status/ co-morbidity

Intent	Dose (Gy)/F	F/week	Comments
d. Partial breast RT	**26/5**	**5**	**Standard of care for partial breast RT**
	40-40.05/15	5	Consider 40Gy in 15F for people with invasive breast cancer having partial breast RT, without regional lymph node irradiation, after breast-conserving surgery when they: • Have a diagnosis that increases sensitivity to RT, **or;** • Have any other factor that could mean having RT over 3 weeks is more acceptable (such as high BMI or fibromyalgia). [12]
	28.5–30/ 5	1	Patients with poor performance status/ co-morbidity
e. Primary (Palliative) breast/chest wall RT	40-40.05/15 to microscopic disease & 48-51/ 15 to macroscopic disease	5	**(**N.B. care must be taken to ensure that dose is kept to ≤ 60 Gy EQD2 in the region of the brachial plexus) May also be considered for nodal recurrence volumes where RT to the breast/chest wall is not indicated
	28.5–30/ 5	1	Patients with poor performance status/ co-morbidity
	26/5	5	Nodal RT (not including IMN) can be considered in the primary RT setting for patients with poor performance status/ co-morbidity.
	24/4	1	Patients with poor performance status/ co-morbidity
	36/6	1	Patients with poor performance status/ co-morbidity
	20/5	5	
	8/1	1	Patients with poor performance status/ co-morbidity
	Local palliative fractionations may be used on an individual patient basis.		
f. SCF	40-40.05/15	5	**Standard of care for breast + nodal RT**
	26/5	5	Can be considered for patients with significant co-morbidities

Intent	Dose (Gy)/F	F/week	Comments
g. SCF & Axilla	40-40.05/15 Where a post axilla field is required, 34.04 is prescribed to 85% of SCF dose at mid-plane	5	**Standard of care for breast + nodal RT**
	26/5	5	Can be considered for patients with significant co-morbidities
h. IMC	40-40.05/15	5	**Standard of care for breast + nodal RT**
i. Radiotherapy Boost – tumour bed or LN macroscopic disease	48/15	5	**Simultaneous Integrated Boost (SIB) generally combined with whole breast RT i.e. 40Gy/15F to whole breast with 8Gy/15F to tumour bed + 5mm delivered simultaneously over 15F** (N.B. care must be taken to ensure that dose is kept to ≤ 60 Gy EQD2 in the region of the brachial plexus)
	13.335/ 5	5	**Sequential hypofractionated boost** (N.B. care must be taken to ensure that dose is kept to ≤ 60 Gy EQD2 in the region of the brachial plexus)
	12/4	5	**Sequential hypofractionated boost** (N.B. care must be taken to ensure that dose is kept to ≤ 60 Gy EQD2 in the region of the brachial plexus)
	10/5	5	**Standard of care for patients with malignant phyllodes**
	6/1	1	Patients with poor performance status/ co-morbidity following a 1/week WBRT regimen

4.0 Target volumes

Use standard nomenclature as per AAPM

https://www.aapm.org/pubs/reports/RPT_263.pdf

4.1 Whole Breast/ Chest Wall

4.1.1 Coverage of the whole breast PTV (PTVwb) is defined by virtual simulation, aided by surgical clips. Generally, a field based PTV; 5 mm within the patient's surface, 5 mm from the posterior field edge and lung/chest wall interface, and 10 mm from the superior and inferior field edges. Delineation of the PTVwb may also be aided by the use of AI software, such as M-Vision to define the whole breast tissue (CTVwb) for review before applying margins of 5-10mm to generate a field-equivalent PTVwb.

4.1.2 After wide local excision, fields should cover the remaining ipsilateral breast tissue including the deep fascia.

4.1.3 Post mastectomy fields should cover the deep fascia, subcutaneous tissues, and any remaining ipsilateral breast tissue.

4.1.4 If the skin is considered the target organ (e.g., 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 [31].

4.1.5 Tangential fields with non-divergent posterior border are considered standard treatment although alternatives, including VMAT, may be used where necessary.

4.1.6

Usual field borders:	
Superior	SSN, or as near as possible, to cover breast tissue with 10mm margin
Inferior	10-15mm inferior to breast tissue (or contralateral breast, if mastectomy)
Medial	Midline. Field borders should avoid crossing onto the contralateral breast.

Lateral	10mm lateral to breast tissue (usually the mid-axillary line)

4.1.7 Field borders may be modified as appropriate to give required coverage of the tumour bed (as per section 4.3.2) and/or sparing of OARs.

4.1.8 The heart should be routinely excluded from the radiotherapy field.

4.1.9 Ipsilateral lung depth should be minimised within OAR tolerance and aim to be less than 20mm.

4.1.10 It may be necessary to exceed these limits if borders are not achievable or if there is a compromise between target coverage and OAR sparing.

4.1.11 Where bilateral breast irradiation is required, overlap of the tangential fields in the midline must be prevented by leaving an appropriate gap, e.g., 10-15mm.

4.2 Partial Breast

4.2.1 Tumour bed CTV (CTVtb) = Tumour bed, including outer part of surgical clips + post-surgical change.

4.2.2 Tumour bed should be localised using all available imaging and clinicopathological information.

4.2.3 Partial Breast CTV (CTVpb) = CTVtb + 15mm

4.2.4 The CTVpb is bound by 5mm from skin surface and should not extend beyond the pectoral fascia posteriorly. Where the pectoral fascia is not visible, then it should be no more that 5mm from the ipsilateral lung/chest wall interface.

4.2.5 The CTVpb may be modified according to biological/anatomical constraints and should not extend radially beyond the edges of the visible/palpable breast.

4.2.6 Partial breast PTV (PTVpb) = CTVpb + 10mm

4.2.7 The PTVpb is bound by 5mm from skin surface but unmodified posteriorly.

4.2.8 In order to ensure that the PTVpb does not extend outside of the PTVwb a reduction in medial and lateral margins may be used. This is not considered to impact quality or safety of treatment delivery based on the use of tangential fields.

4.2.9 Coverage of the partial breast PTV is defined by virtual simulation.

4.2.10 The heart should be excluded from the fields if possible and the maximum lung depth should not exceed 2cm (as IMPORT Low planning pack)[32].

4.3 Whole Breast with Regional Node Irradiation (RNI)

4.3.1 Where available, AI software, such as M-Vision, can be utilised to generate CTV contours based upon the ESTRO consensus guidelines ready for clinical review and approval, prior to applying appropriate PTV margins [33].

4.3.2 Whole breast CTV (CTVwb) – to be defined according to ESTRO guidance.

ESTRO consensus guideline on target volume delineation for elective radiation therapy of early-stage breast cancer.

ESTRO Guidance - R Lumpectomy

4.3.3 Chest wall CTV (CTVcw) - to be defined according to ESTRO guidance.

ESTRO consensus guideline on target volume delineation for elective radiation therapy of early-stage breast cancer.

ESTRO Guidance - L Mastectomy

4.3.4 Where immediate reconstruction has occurred following mastectomy the CTVcw will be defined according to ESTRO guidance.

ESTRO consensus guidelines for target volume definition in the setting of post-mastectomy radiation therapy after immediate implant-based reconstruction for early breast cancer.

4.3.5 Internal mammary nodes CTV (CTVimn) - to be defined according to ESTRO guidance.

ESTRO consensus guideline on target volume delineation for elective radiation therapy of early-stage breast cancer.

4.3.6 Axillary nodes CTV (CTVaxilla) - to be defined according to ESTRO guidance.

ESTRO consensus guideline on target volume delineation for elective radiation therapy of early-stage breast cancer.

4.3.6 Supra-clavicular nodes CTV (CTVscf) - to be defined according to ESTRO guidance.

ESTRO consensus guideline on target volume delineation for elective radiation therapy of early-stage breast cancer.

OR

4.3.7 Tangential fields with non-divergent posterior and superior borders for breast and direct anterior SCF field matched to tangents to cover axillary nodes levels 1-4 as required.

Usual field based SCF borders	
Superior	1.25cm above the most superior aspect of the subclavian artery (approximately superior aspect of clavicle). Where a PTVscf exists, superior field edge is PTV + 5mm
Inferior	Matches superior border of the tangential fields without overlap
Medial	Lateral to the vertebrae, near the medial aspect of the clavicle. Avoid spinal cord. Where a PTVscf exists, medial field edge is PTV + 3-5mm
Lateral	Medial border of the pectoralis minor (approximately two-thirds along the clavicle and through the coracoid process). Where a PTVscf exists, lateral field edge is PTV + 5mm. The lateral border may be adjusted for individual patient anatomy and depending on the level of axillary surgery completed, to avoid the surgical field and reduce the risk of lymphoedema.

4.3.8 If mid-axillary dose <80%, 10MV or a post axilla field may be considered.

Usual field based SCF and post-axilla borders	
Ant SCF + Axilla	
Superior	1.25cm above the most superior aspect of the subclavian artery (approximately superior aspect of clavicle). Where a PTVscf exists, superior field edge is PTV + 5mm
Inferior	Matches superior border of the tangential fields without overlap
Medial	Lateral to the vertebrae, near the medial aspect of the clavicle. Avoid spinal cord. Where a PTVscf exists, medial field edge is PTV + 3-5mm
Lateral	Lateral edge of pectoralis minor + 3cm (approximately halfway through the head of humerus). Consider extending to the lateral edge of head of humerus dependent on patient anatomy. Shield the head of humerus.

Post Axilla	
Superior	Parallel to the inferior aspect of the clavicle.
Inferior	To match the SCF and axilla field edge
Medial	Along angle of ribcage. Usually includes approximately 5mm of lung.

Lateral	Approximately halfway through the head of humerus. Consider extending to the lateral edge of head of humerus dependent on patient anatomy. Consider shielding as appropriate.

4.3.9 Whole breast PTV (PTVwb) - CTVwb + 5-10mm as per departmental guidelines

4.3.10 Chest wall PTV (PTVcw) – CTVcw + 5-10mm as per departmental guidelines

4.3.11 Internal mammary nodes PTV (PTVimn) - CTVimn + 5-10mm as per departmental guidelines

4.3.12 Axillary nodes PTV (PTVaxilla) – CTVaxilla + 5-10mm as per departmental guidelines

4.3.13 Supra-clavicular nodes PTV (PTVscf) - CTVscf + 5-10mm as per departmental guidelines. As per Fast Forward Lymphatic RT QA Pack, where there is concern about the dose to midline structures a 5mm margin or less may be considered [34].

4.3.14 Where a structure is cropped from an OAR for planning purposes an Opt structure should be created for each individual PTV (e.g., PTVwb Opt = PTVwb cropped 5mm from ipsilateral lung).

4.4 Radiotherapy Boost

4.4.1 Tumour bed CTV (CTVtb) = Tumour bed, including outer part of surgical clips + post-surgical change. Clips related to axillary surgery will be ignored.

4.4.2 Tumour bed should be localised using all available imaging and clinicopathological information.

4.4.3 Nodal boost CTV (CTVn) = Visible involved nodes on RT planning CT, or region of known pre-NACT involvement on staging investigations.

4.4.4 Tumour bed PTV (PTVtb) = CTVtb + 5-10mm as per departmental guidance.

4.4.5 Tumour bed PTV DVH (PTVtbDVH) = For reporting purposes, it is recommended that the PTVtb is cropped 5mm inside skin surface (where this does not affect CTVtb coverage) and along lung / chest wall /organ interface.

4.4.6 Nodal boost PTV (PTVn) = CTVn + 5mm

4.4.7 For **electron boosts**, where a CT-planned method is not possible, information below will be used to localise the target volumes:

- Pre-operative imaging
- Surgical note
- Palpation of surgical cavity
- Information of depth of tumour bed from CT planning scan
- If tumour bed visible on ultrasound, localise maximum dimension, centre of tumour bed and the skin-chest wall depth.

NB surgical scar may be placed away from the tumour bed.

4.5 Primary (Palliative) radiotherapy

4.5.1 For treatment with tangential fields, the PTVwb will be defined as per adjuvant whole breast radiotherapy (section 4.2).

4.5.2 Where treatment is planned using a direct orthovoltage or electron field, the target volume will be defined through clinical examination and/or RT planning CT.

5.0 Organs at risk

5.1 Aim for the use of standard nomenclature as per Global Harmonization Group consensus guidelines [35].

5.2 Details of organs at risk required for delineation should be guided by the relevant constraints table in Section 6.0.

Description
Contralateral Breast (Breast_L or Breast_R as appropriate)
Heart
Ipsilateral Lung (Lung_L or Lung_R as appropriate)
Contralateral Lung (Lung_L or Lung_R as appropriate)
Oesophagus
Ipsilateral Head of Humerus (HOH_L or HOH_R as appropriate)
Ipsilateral Brachial Plexus (Brachial Plexus_L or Brachial Plexus_R as appropriate) - Consider outlining where a boost is planned to a PTV situated <1cm from the subclavian/axillary artery. Consider using the Global Harmonization Group guidelines to guide delineation.  Appendix A. Supplementary data

5.3 Where available, AI software, such as M-Vision, can be utilised to generate OAR contours ready for clinical review and approval.

6.0 Constraints

6.1 Whole breast / Chest wall / Partial Breast – Tangents alone (26Gy/5F)

(Based on Fast Forward and Pre-operative Breast radiotherapy COVID19)				
Organ at Risk / PTV	**Dose in %**	**Dose in Gy**	**Mandatory Constraint**	**Optimal Constraint**
Ipsilateral Lung	V30%	V7.8Gy	≤17%	≤ 15%
Heart*	V25%	V6.5Gy	≤ 5%	-
	V5%	V1.3Gy	≤25%	-
	Mean Dose		-	<2Gy
	-		-	Completely shield the heart (as clinically achievable)
PTVwb/pb**	V95%	V24.7Gy	≥90%	≥95%
	V105%	V27.3Gy	≤7%	≤5%
	V107%	V27.82Gy	≤2%	-
	D50%		25-27Gy	-
	Dmax(0.1cc)		≤110%	-

Body-PTVwb/pb	V107%	V27.8Gy	-	≤2cc
	Dmax(0.1cc)		≤110%	-

* If Heart only mentioned in the Organ at Risk column tolerances apply for both Left & Right sided tumour.

** PTVwb name is used for both Whole Breast and Chest walls.

6.2 Breast + SCF + Boost (26Gy/5F)

±Sequential Photon Boost as listed (Based on Fast Forward nodal sub study and RCR 5F COVID-19 Guidelines)				
Organ at Risk / PTV	**Dose in %**	**Dose in Gy**	**Mandatory Constraint**	**Optimal Constraint**
Ipsilateral Lung	V30%	V7.8Gy	≤ 25%	≤ 15%
Heart	-		-	ALARA
PTVwb-PTVtb	10Gy/5F		-	V36Gy < 5%
	12Gy/4F		-	V38Gy < 5%
	13.335Gy/5F		-	V39.335Gy ≤ 5%
	D50%		-	26 – 28.6Gy
PTVtb	V95%		≥95%	-
Body-PTVs	V112%	V29.12Gy	-	≤2cc
	Dmax(0.1cc)		≤110%	
Contralateral Breast	Mean dose		1Gy	0.2Gy

6.3 Breast / Chest wall – Tangents alone (28Gy/5F)

(Based on FAST Trial)				
Organ at Risk / PTV	**Dose in %**	**Dose in Gy**	**Mandatory Constraint**	**Optimal Constraint**
Ipsilateral Lung	-		-	Max lung depth < 2cm
Heart (Left & Right sided tumour)	-		-	Completely shield the heart (as clinically achievable)
PTVwb/pb	V95%	V27.08Gy	≥90%	≥95%
	V105%	V29.93Gy	≤7%	≤5%

	V107%	V30.5Gy	≤2%	-
	Dmax(0.1cc)		≤110%	-
Body-PTVwb/pb	Dmax(0.1cc)		≤110%	D2cc ≤ 107%

6.4 Whole breast / Chest wall / Partial Breast – Tangents alone (40Gy/15F)

(Based on Import HIGH)				
Organ at Risk / PTV	**Dose in %**	**Dose in Gy**	**Mandatory Constraint**	**Optimal Constraint**
Ipsilateral Lung	V45%	V18Gy	≤15%	≤10%
	V30%	V12Gy	-	≤25%
	Mean dose		-	< 6Gy
Heart* (Left sided tumour)	V32.5%	V13Gy	≤ 10%	≤ 2%
	Mean dose		<3Gy	≤2.5Gy
Heart* (Right sided tumour)	V12.5%	V5Gy	-	≤ 6%
	Mean dose		-	≤ 1.7Gy
PTVwb/pb	V95%	V38.048Gy	≥90%	≥95%
	V105%	V42.05Gy	≤7%	≤5%
	V107%	V42.85Gy	≤2%	≤2cc
PTVwb/pb	D50%		39.05-41.05Gy	-
	Dmax(0.1cc)		≤110%	-
Body-PTVwb/pb	Dmax(0.1cc)		≤110%	-
	V107%	V42.8Gy	≤2%	≤2cc

***** Completely shield the heart on tangent plan as clinically achievable.

6.5 Whole breast / Chest wall / Partial Breast + Boost + SCF (40Gy/15F)

± Sequential Photon Boost as listed or Simultaneous Integrated Boost (48Gy/15F) (Based on Import HIGH)				
Organ at Risk / PTV	**Dose in %**	**Dose in Gy**	**Mandatory Constraint**	**Optimal Constraint**
Ipsilateral Lung	V45%	V18Gy	≤15% (≤30% where SCF included)	≤10%

	V30%	V12Gy	-	≤25%
	Mean dose		-	< 6Gy
Contralateral Lung	V6.25%	V2.5Gy	≤15%	≤3%
	Mean dose		-	< 1Gy
Heart* (Left sided tumour)	V32.5%	V13Gy	≤ 10%	≤ 2%
	Mean dose		<3Gy	≤2.5Gy
Heart* (Right sided tumour)	V12.5%	V5Gy	-	≤ 6%
	Mean dose		-	≤ 1.7Gy
Contralateral Breast	Mean dose		< 1.5Gy	≤ 0.5Gy
PTVwb/pb	V95%	V38.048Gy	≥90%	≥95%
	V105%	V42.05Gy	≤7%	≤5%
	V107%	V42.85Gy	≤2%	≤2cc
	D50%		39.05-41.05Gy	-
	Dmax(0.1cc)		≤110%	-
PTVtb	V95%		≥95%	-
PTVscf	Where the SCF is contoured please refer to Table 6.6.1 for dose constraints (as per NHSE)			
Body-PTVwb/pb	Dmax(0.1cc)		≤110%	-
	V107%	V42.8Gy	≤2%	≤2cc
	D2cc (on sum plan of tangents and SCF)		≤112%	-
Body	Dmax(0.1cc)		≤110%	-
PTVwb-PTVtb	For 16Gy/8F		V56Gy ≤ 5%	Median dose 40-44 Gy
	For 12Gy/4F		V52Gy ≤ 5%	
	For 10Gy/5F		V50Gy ≤ 5%	
	For 13.335Gy/5F		V53.335Gy ≤ 5%	
	For 48Gy/15F (SIB)		V48Gy ≤5%	

***** Completely shield the heart on tangent plan as clinically achievable.

6.6 Whole breast / Chest wall (50Gy/25F)

6.6.1 This dose and fractionation is recommended for malignant phyllodes. The ODN Task and Finish Group acknowledge that further guidance is awaited, and the OAR table will be added in a future version if required based on upcoming recommendations. In the interim, OAR doses should be assessed using the 40Gy/15F tables as the increased dose per fraction should ensure that doses are safe.

6.7 Regional node irradiation

Assess the plan sum of PH1 ± photon boost using the following table, except where stated otherwise.

Whole Breast / Chest wall + Specified nodes (40Gy/15F) ± Boost

± Sequential Photon Boost as listed or Simultaneous Integrated Boost (48Gy/15F) (Based on Danish Guidelines & UK RCR Consensus 2016 & Import HIGH)				
Organ at Risk / PTV	**Dose in %**	**Dose in Gy**	**Mandatory Constraint**	**Optimal Constraint**
PTVwb (PH1 only)	V95%	V38.048Gy	-	≥95%
	V90%	V36Gy	≥ 90%	-
	V107%	V42.85Gy	<2%	-
	V105%	V42.05Gy	<7%	<5%
PTVwb (PH1 only)	Dmax 0.5cc		≤ 44.055Gy	-
	D50%		39.05 -41.05 Gy	-
Individual nodal volume PTV (PH1 only)	V80%	V32.04Gy	≥ 80%	≥90%
	V90%	V36.045Gy	-	≥ 90%
	V107%	V42.85Gy	≤ 2%	≤ 1%
	Dmax(0.1cc)		≤44Gy	-
	D50%		39.05 -41.05 Gy	-
PTV IMC	V80%	V32.04Gy	>90%	
PTVtb	V95%		≥95%	-
Ipsilateral Lung	V42.5%	V17Gy	≤ 35%	-
	Mean dose		-	≤13Gy
Ipsilateral Lung (non-IMC)	V30%	V12Gy	-	≤ 25%
		V18Gy	<30%	-

	Mean dose		-	≤13Gy
Contralateral Lung	Mean dose		≤ 4Gy	≤1Gy
Heart	V42.5%	V17Gy	≤10%	-
Heart	Mean dose		<6Gy	<4Gy
Heart (non-IMC)	Mean dose		<4Gy	<2.5Gy
Contralateral breast	Mean dose		≤ 3.5Gy	≤1.5Gy if >40year ≤1Gy if ≤40 years
Contralateral breast (non-IMC)	Mean dose		<1.5Gy	<1Gy
Oesophagus [36]	V42.5%	V17Gy	-	≤ 15%
	Mean dose		-	<11Gy
HOH+5mm	V100%	V40Gy	-	≤1.0cc
Ipsilateral HOH	Mean dose			≤20Gy
PTVwb-PTVtb	For 16Gy/8F		V56Gy ≤ 5%	Median dose 40-44Gy
	For 10Gy/5F		V50Gy < 5%	
	For 12Gy/4F		V52Gy ≤ 5%	
	For 13.335Gy/5F		V53.335Gy < 5%	
	For 48Gy/15F (SIB)		V48Gy ≤5%	
Body-PTVs	V107%	V42.85Gy	≤2cc	≤2%
	Dmax(0.1cc)		≤44.055Gy	

Brachial Plexus (if contoured)	Dmax(0.1cc)	Care should be taken to ensure that dose is kept ≤60Gy EQD2	≤42Gy

7.0 Planning process/ technique

Region of Interest	Technique
Whole Breast / Chest Wall RT or Partial Breast RT	RT planning CT as per departmental guidelines DIBH should be offered for all left/bilateral treatments. Tangential fields using IMRT, or conformal RT as required. For chest wall ± reconstruction, bolus to be considered and prescribed at field localisation.
Whole Breast/Chest Wall + SCF/Axilla	As above. If using a direct MLC defined axillary field, this should shield the humeral head or the humeral head PRV, based on risk of recurrence (See: ESTRO Guidelines [33]).
Whole Breast / Chest Wall + Regional Nodes	RT planning CT as per departmental guidelines DIBH should be offered for all treatments. Contrast may be considered to aid volume delineation. VMAT or; IMRT with widened tangential fields to cover the IMN (MLCs utilised inferiorly to limit the field) and a direct anterior field to cover axilla L1-4 as required, or; Where available, tomotherapy can be considered for patients who cannot breath-hold.
Tumour Bed Boost	VMAT SIB, or; Sequential boost delivered using a conformal technique. Electrons or mini-tangential fields are an acceptable alternative if a conformal/VMAT boost is not clinically appropriate.
Primary (Palliative) Whole Breast / Chest Wall RT	RT planning CT as per departmental guidelines Simple tangential field arrangements using IMRT, or conformal RT as required.

8.0 Peer Review / Contour QA

8.1 As per RCR radiotherapy target volume definition and peer review guidance, second edition (2022) [37], prospective peer review should occur in cases where considerable individual judgement is required including:

- All individualised volumes, e.g., contoured regional nodes.
- Any protocol-specified volume that does not conform to the department protocol.
- Any protocol-specified volume defined within a new protocol where the volume is different to that used previously. Prospective review should continue until adequate audit shows that the new protocol is being followed appropriately.
- Palliative treatments where volume definition is as complex as for curative or adjuvant cases. Examples include re-treatments and where high doses are used.
- All peer-reviewed volumes where major changes (for example, changes affecting the likelihood of cure or locoregional disease control) have been recommended. The revised volumes should be subject to further peer review to ensure compliance with the recommended changes.

8.2 For other situations a QA programme should be in place to assess quality of volume delineation. Departments should have an agreed programme for retrospective audit of volumes. For example, 10% of volumes could be randomly selected and audited at a peer review meeting.

8.3 As random errors in a complex process are unpredictable, including some of these volumes in prospective peer review is recommended.

8.4 Retrospective audit of volumes should be performed for:

- Protocol-specified volumes that are defined according to protocol, e.g., tumour bed boost or PBI.
- Routine palliative radiotherapy treatments.

- Techniques where fields are defined according to a protocol rather than volumes, e.g., 2FB or 3FB.

9.0 Target Verification

Modality	Frequency	Match point	Additional information
Tangents (inc. PBI RT) - MV/kV pair	Daily online	Chest wall, spine & soft tissue. Checking clip coverage if present. Checking lung depth and heart position as appropriate.	
Tangents + nodes (inc. IMC) – MV/kV pair or kV/kV pair or CBCT	Daily online	Chest wall, spine & soft tissue. Focussing on clavicle. Checking clip coverage if present. Checking lung depth and heart position as appropriate.	
Photon tumour bed boosts - KV/KV pair	Daily online	Clips	
Electron Tumour Bed Boost	Daily	Light field beam view	

10.0 Side Effects

10.1 Possible early/ short-term side-effects	
Expected (50% - 100%)	**Management (if appropriate)**
Tiredness	Increase fluid intake Gentle exercise Rest as needed
Temporary hair loss in treatment area	
Common (10% - 50%)	**Management (if appropriate)**
Skin soreness, itching and colour changes in the treatment area	Skin care advice as per SCoR Radiation Dermatitis Guidelines 2020 [38]
Less common (Less than 10%)	**Management (if appropriate)**
Breast/chest wall/ axilla discomfort	Analgesia

Breast swelling	
Change in breast texture	
Rare (Less than 10%)	**Management (if appropriate)**
Sore throat	Analgesia Dietary advice Mouthwash
Skin blistering	Dressings
Pneumonitis	Steroids
Specific risks associated with some breast RT	**Management (if appropriate)**
Oesophagitis	Dietary advice Peptic suspension Analgesia
Nausea	Anti-emetics

10.2 Possible late or long-term side-effects

Common (10-50%)	**Management (if appropriate)**
Skin colour change in the treatment area including lighter, darker, or pinker	
Subtle changes to breast appearance including change to breast size, shape, and texture	
Breast/ chest wall/ axilla discomfort including aching and shooting pains	For complex chest wall pain management consider referral back to surgical team or for scar release massage where available.
Worsened cosmetic outcome after reconstruction surgery	
Less common (Less than 10%)	**Management (if appropriate)**
Marked change to breast appearance including change to breast size, shape, and texture	
Breast/ chest wall swelling	

Shoulder stiffness	Give people who are going to have radiotherapy for breast cancer instructions and information on upper limb exercises before their treatment begins. Identify those at high-risk, e.g. planned radiotherapy to the axilla or supraclavicular nodes. Refer to physiotherapy department for individual assessment and treatment if they report a persistent reduction in arm and shoulder mobility.
Lymphoedema of the arm	Ensure that people with breast cancer who develop lymphoedema have prompt access to a specialist lymphoedema service.
Rare (Less than 1%)	**Management (if appropriate)**
Telangiectasia	
Rib fracture	
Fibrosis of underlying lung	
Increased risk of heart disease	
Brachial plexopathy	
Second malignancy	

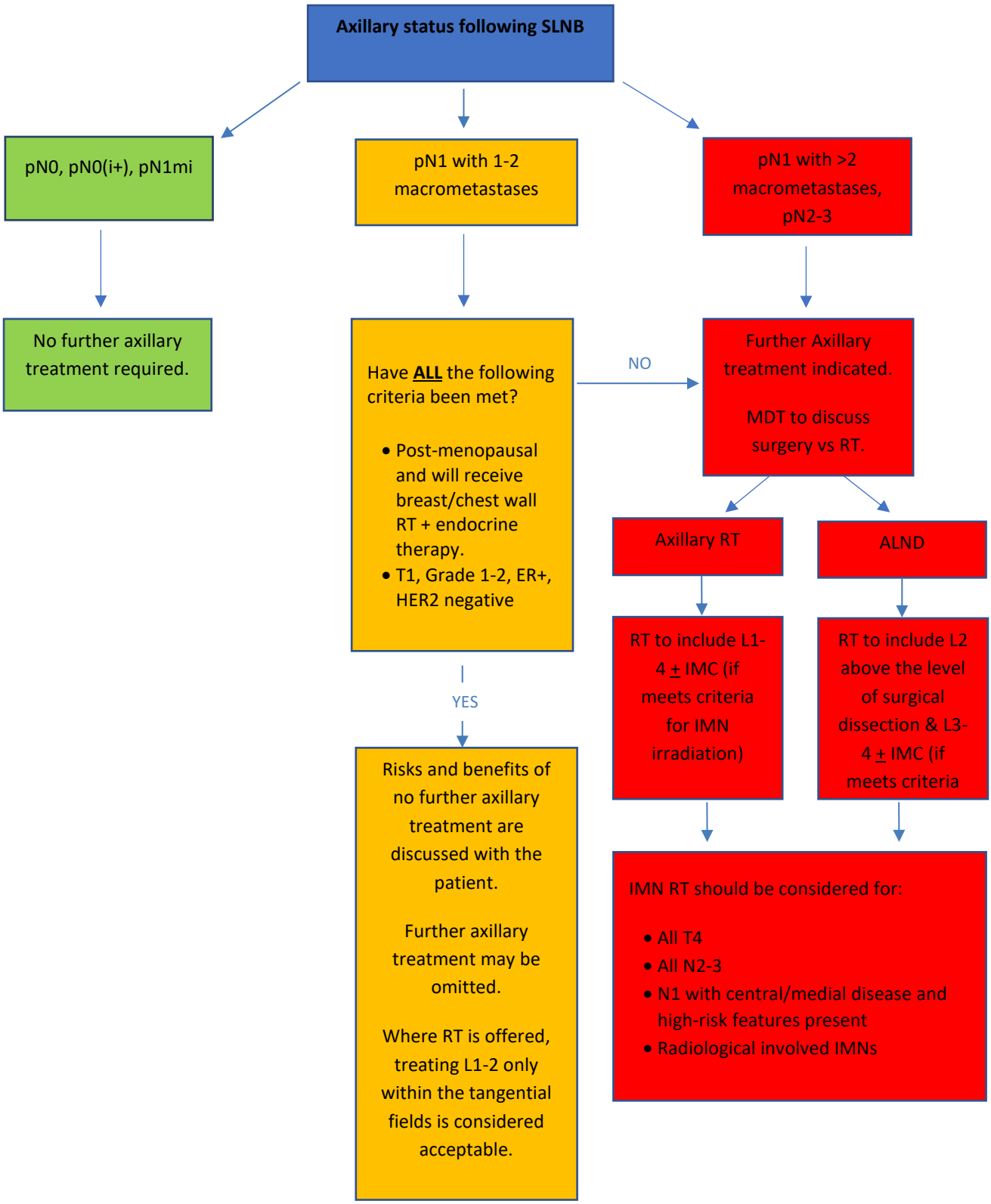
11.0 Appendix

11.1 Appendix 1: Decision aid for post-mastectomy radiotherapy

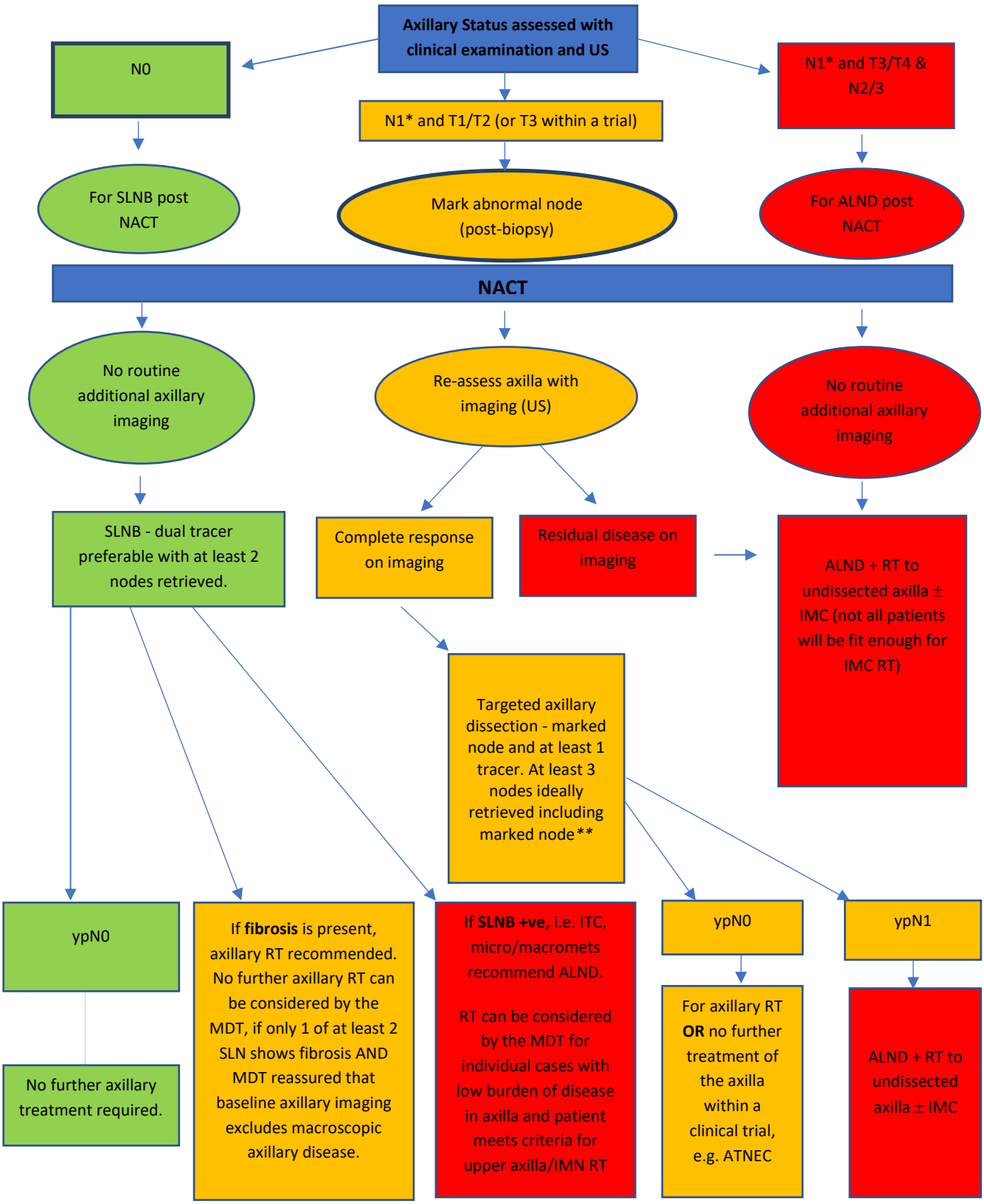
The decision aid may be useful in identifying patients for post-mastectomy RT, where a resultant score is ≥3 [16].

Score	3	2	1
Nodes	≥ 4	1-3 or fibrosis post neo-adjuvant chemotherapy	Lymphovascular space invasion (LVSI) or micro-metastases
Size	>5cm		3-5cm
Other	male		Grade 3

11.2 Appendix 2: Decision aid for management of the cN0 axilla following primary surgery.



11.3 Appendix 3: Decision aid for neo-adjuvant management of the axilla



*N1 (1-3 nodes involved).

** if no clipped node identified in the post op histology, this is concordant if there is fibrosis. If no clipped node and no fibrosis in the post op histology - discuss level I axillary clearance

12.0 References

1. Clarke, M., et al. (2005). *Effects of radiotherapy and of differences in the extent of surgery for early breast cancer on local recurrence and 15-year survival: an overview of the randomised trials.* Lancet, 366(9503): p. 2087-106.
2. Overgaard, M., et al. (1999). *Postoperative radiotherapy in high-risk postmenopausal breast-cancer patients given adjuvant tamoxifen: Danish Breast Cancer Cooperative Group DBCG 82c randomised trial*. Lancet, 353(9165): p. 1641-8.
3. Overgaard, M., et al., (1997). *Postoperative radiotherapy in high-risk premenopausal women with breast cancer who receive adjuvant chemotherapy.* Danish Breast Cancer Cooperative Group 82b Trial. N Engl J Med, 337(14): p. 949-55.
4. Ragaz, J., et al. (1997). *Adjuvant radiotherapy and chemotherapy in node-positive premenopausal women with breast cancer*. N Engl J Med, 337(14): p. 956-62.
5. Fisher, B., et al. (1998). *Lumpectomy and radiation therapy for the treatment of intraductal breast cancer: findings from National Surgical Adjuvant Breast and Bowel Project B-17*. J Clin Oncol,16(2): p. 441-52.
6. Bijker, N., et al. (2006). *Breast-conserving treatment with or without radiotherapy in ductal carcinoma-in-situ: ten-year results of European Organisation for Research and Treatment of Cancer randomized phase III trial 10853--a study by the EORTC Breast Cancer Cooperative Group and EORTC Radiotherapy Group*. J Clin Oncol, 24(21): p. 3381-7.
7. Houghton, J., et al. (2003). *Radiotherapy and tamoxifen in women with completely excised ductal carcinoma in situ of the breast in the UK, Australia, and New Zealand: randomised controlled trial.* Lancet, 362(9378): p. 95-102.
8. Early Breast Cancer Trialists' Collaborative Group (EBCTCG) (2023). *Radiotherapy to regional nodes in early breast cancer: an individual patient data meta-analysis of 14 324 women in 16 trials.* Lancet, 402(10416): p.1991-2003.
9. Poortmans PM, et al. (2009). *Impact of the boost dose of 10 Gy versus 26 Gy in patients with early stage breast cancer after a microscopically incomplete lumpectomy: 10-year results of the randomised EORTC boost trial.* Radiother Oncol, 90(1): p.80-5
10. Bartelink et al. (2007). *Impact of a higher radiation dose on local control and survival in breast-conserving therapy of early breast cancer: 10-year results of the randomized boost versus no boost EORTC 22881-10882 trial.* J Clin Oncol, 25(22): p.3259-3265.
11. Jones HA, et al. (2009). *Impact of pathological characteristics on local relapse after breast-conserving therapy: a subgroup analysis of the EORTC boost versus no boost trial.* J Clin Oncol, 27(30): p.4939-47.

12. NICE Guideline 2024. *Early and locally advanced breast cancer: Diagnosis and management [NG101]*
13. Kunkler IH, et al. (2023). *Breast-Conserving Surgery with or without Irradiation in Early Breast Cancer.* N Engl J Med, 388(7): p.585-594.
14. RCR 2016. *Postoperative radiotherapy for breast cancer: UK consensus statements*
15. EBCTCG (Early Breast Cancer Trialists' Collaborative Group) (2014). *Effect of radiotherapy after mastectomy and axillary surgery on 10-year recurrence and 20-year breast cancer mortality: meta-analysis of individual patient data for 8135 women in 22 randomised trials.* Lancet, 383(9935): p.2127-35.
16. Mukesh MB, et al. (2014). *The Cambridge post-mastectomy radiotherapy (C-PMRT) index: A practical tool for patient selection.* Radiother Oncol, 110(3): p.461-6.
17. Gnerlich, J. L. et al. (2014). *Utilization of radiotherapy for malignant phyllodes tumors: analysis of the National Cancer Data Base, 1998-2009*. Annals of surgical oncology, *21*(4): p.1222–1230.
18. Barth, R. J., Jr, Wells, W. A., Mitchell, S. E., & Cole, B. F. (2009). *A prospective, multi-institutional study of adjuvant radiotherapy after resection of malignant phyllodes tumors.* Annals of surgical oncology, *16*(8): p.2288–2294.
19. Association of Breast Surgery 2015. *Association of Breast Surgery consensus statement: Management of the malignant axilla in early breast cancer*
20. Donker, M. et al. (2014). *Radiotherapy or surgery of the axilla after a positive sentinel node in breast cancer (EORTC 10981-22023 AMAROS): a randomised, multicentre, open-label, phase 3 non-inferiority trial.* Lancet Oncol,15(12): p.1303-1310.
21. Recht, A., et al. (2001). *Postmastectomy radiotherapy: clinical practice guidelines of the American Society of Clinical Oncology*. J Clin Oncol,19(5): p. 1539-69.
22. Poortmans PM, et al. EORTC Radiation Oncology and Breast Cancer Groups. (2015). *Internal Mammary and Medial Supraclavicular Irradiation in Breast Cancer.* N Engl J Med, 373(4): p.317-27
23. Whelan TJ, et al. MA.20 Study Investigators. (2015). *Regional Nodal Irradiation in Early-Stage Breast Cancer.* N Engl J Med, 373(4): p.307-16.
24. Thorsen LB, et al. (2015). *DBCG-IMN: A Population-Based Cohort Study on the Effect of Internal Mammary Node Irradiation in Early Node-Positive Breast Cancer*. J Clin Oncol. 2015 Nov 23. [Epub ahead of print]
25. Ghandi et al. (2019) *Axillary surgery following neoadjuvant chemotherapy: Multidisciplinary Guidance from the Association of Breast Surgery, Faculty of Clinical Oncology of The Royal College of Radiologists, UK Breast Cancer Group, National Coordinating Committee for Breast Pathology and British Society of Breast Radiology*. Clinical Oncology, 31 (2019): p. 664-668

26. Coles CE, et al. on behalf of the IMPORT Trial Management Group. (2023). *Dose-escalated simultaneous integrated boost radiotherapy in early breast cancer (IMPORT HIGH): a multicentre, phase 3, non-inferiority, open-label, randomised controlled trial.* Lancet, 401(10394): p.2124-2137.
27. Kaidar-Person et al. *Re-irradiation and Hyperthermia in Breast Cancer.* Clinical Oncology, 30 (2018): p.73-84
28. RCR (2024). *Clinical Oncology Principles of reirradiation*.
29. Meattini I, et al. on behalf of the Consensus Panellist Group. (2024). *International multidisciplinary consensus on the integration of radiotherapy with new systemic treatments for breast cancer: European Society for Radiotherapy and Oncology (ESTRO)-endorsed recommendations*. Lancet Oncol, 25(2):e73-e83.
30. RCR (2021). Postoperative radiotherapy for breast cancer: Hypofractionation. RCR consensus statements
31. Kaidar-Person O, et al. (2021). *A Delphi study and International Consensus Recommendations: The use of bolus in the setting of postmastectomy radiation therapy for early breast cancer*. Radiother Oncol, Volume 164: p115-121
32. Coles CE, et al. on behalf of the IMPORT Trialists' Group. (2017). *Partial breast radiotherapy after breast conservation surgery for early breast cancer: 5 year outcomes from the IMPORT LOW (CRUK/06/003) phase III randomised controlled trial*. Accepted by The Lancet, 13th April, 2017
33. Offersen BV, et al. (2016). *ESTRO consensus guideline on target volume delineation for elective radiation therapy of early-stage breast cancer, version 1.1*. Radiother Oncol, 118(1): p.205-8.
34. ICR (2016). *Guidelines to outlining, planning and delivery of lymphatic radiotherapy for FAST-Forward trial patients Lymphatic RT QA Pack v. 1.1 July 2016*
35. Mir, R. et al. (2020). *Organ at risk delineation for radiation therapy clinical trials: Global Harmonization Group consensus guidelines*. Radiotherapy and Oncology, 150(1): p. 30-39
36. Yaney A, et al. (2021). *Dosimetric parameters associated with radiation-induced esophagitis in breast cancer patients undergoing regional nodal irradiation*. Radiotherapy and Oncology, 155: p.167–173
37. RCR (2022). *RCR radiotherapy target volume definition and peer review guidance, second edition (2022)*
38. SCoR (2020). *Radiation Dermatitis Guidelines for Radiotherapy Healthcare Professionals*.

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14.0 Amendment History

A record of changes in this document

Date	Updated version number	Previous version number	Page Number/ Section (updated version)	Details
8.8.22	V1.0			New Document
16.3.23	V2.0	V1.0	3 / 1.1.2	Addition to clarify focal involvement of anterior margin (highlighted)
			4 / 1.1.4	Amended to be post-mastectomy RT. Nodal burden specified.
			6 / 1.2.2.5 & 1.2.2.8	Clarification statements added for axillary RT
			16 / 3.0 (d)	Removal of poor performance status for 40Gy/15F
			17 / 3.0 (i)	10Gy in 5F boost specified for malignant phyllodes
			20/ 4.3.7 & 4.3.8	SCF/axilla field borders amended to reflect ESTRO guidance.
			21 / 4.3.13	Reference added for FF Nodal Study for SCF PTV medial margin
			22 / 5.0	Reference added for standard OAR nomenclature
			22 / 5.2	Ipsilateral HOH added to table.
			23-28 / 6.2, 6.4 & 6.7	Inclusion of 12Gy/4F sequential boost. Removal of NHSE metric for PTVwb in 6.7. Removal of NHSE metric for heart in 6.4 and 6.7.
			27 / 6.5.1	Noted that 50Gy/25F tolerance table will be added in a future version
			27-28 / 6.7	Addition of a Brachial Plexus tolerance
			29-30 / 8.1 – 8.3	Peer review section updated to reflect new RCR guidance released in 2022
			36/10.0	Addition of NICE guidance in long-term effects for lymphoedema and shoulder stiffness.

07/01/25	V3.0	V2.0	3 / 1.1.2	Mammogram wording adjusted to reflect RCR consensus statements 2016
			5 / 1.1.6	Inclusion criteria updated to reflect NICE guidance 2024
			11 / 1.5.8	Addition of RCR Clinical Oncology principles of reirradiation
			13 / 3.0	Repetition removed
			17 / 4.1.1 & 19/ 4.3.1 & 22 / 5.3	Updated to reflect potential use of AI software
			22 / 5.2	Addition of Global Harmonization Group guidelines
			23 / 6.1 & 24 / 6.3	Heart optimal constraint for tangents alone amended to 'completely shield heart (as clinically achievable)'
			23 / 6.2	Contralateral breast constraints updated
			24 / 6.4	Separate 40Gy/15F tangents/PBI constraint table included
			26 / 6.6.1	Wording updated
			26 / 6.7	Heart mean dose updated. Individual nodal volume PTV coverage constraint updated. Body-PTVs constraint updated.
			31 / 10.2	Late effect table updated to include onward referral for complex chest wall pain management
			32 / 11.1	Wording updated