Lung Radiotherapy Treatment Clinical Protocol

1) Purpose/Scope

To provide current guidelines on the treatment of non-small cell and small cell cancer of the lung with radiotherapy.

The guidance in this document applies to patients receiving radiotherapy with both radical and palliative intent.

These guidelines apply to non-SABR and non-trial patients:
- For SABR Guidelines, please refer to a separate document.

2) Indications for treatment

2.1 Radical radiotherapy

- PS 0, 1, 2 and selected 3.
- Stage I and II medically inoperable or refusing surgery & not suitable for SABR.
- Stage IIIA, IIIB with small bulk localised disease not considered fit for chemotherapy. Selected stage IV with resected oligometastatic disease.
- Lung function sufficient with respect to the overall volume to be irradiated.

2.1.1 Concurrent chemoradiotherapy: (+/- adjuvant immunotherapy)

- Histologically proven, surgically unresected Stage IIB, IIIA and IIIB NSCLC or SCLC
- WHO PS 0-1, and selected PS2
- Adequate lung function - FEV 1 ≥ 1.0, DLCO ≥ 40%
- Adequate pulmonary, cardiac, and renal function to tolerate chemo radiotherapy.
- Disease volume which can safely be encompassed in a radical radiotherapy volume.
- Patients with IIIA and IIIB NSCLC that is PDL-1 positive, and have received concomitant chemoradiotherapy, are eligible for adjuvant durvalumab.

2.1.2 Sequential radiotherapy

- PS 0-2, but concern regarding ability to tolerate concurrent chemoradiotherapy based on comorbidity, frailty, or disease volume.
- Adequate pulmonary, cardiac, and renal function to tolerate both chemotherapy and radiotherapy.
- Disease volume that can safely be encompassed in a radical radiotherapy volume.

2.1.3 Post-operative (adjuvant) radiotherapy (PORT)

- Involved surgical margins. The decision to treat R1 resection will depend on site and discussion with operating surgeon.
- Lung function sufficient with respect to the overall volume to be irradiated.
- Tracheal tumour

*Some of these patients may receive prior adjuvant chemotherapy

2.2 Palliative radiotherapy

2.2.1 High dose

- PS 0-2
- Locally advanced, non-metastatic disease not amenable to radical radiotherapy
- Thoracic symptoms predominate.
- Patients not suitable for or not wishing SACT.
- Reasonable life expectancy where higher dose treatment considered for achievement of survival benefit.

2.2.2 Low dose

- Poor performance status patients not fit for SACT.
- Limited life expectancy but should exceed one month.
- Symptoms amenable to palliation with radiotherapy
- Patients with good performance status and stage IV disease who decline SACT or whose symptoms merit radiotherapy prior to commencement of SACT.

3) Peer Review

- All target volume delineation for radical plans should be prospectively peer reviewed prior to planning with thoracic oncologist.
- Peer review process and outcomes should be documented and audited.

4) Pre-treatment Information required for Radical Radiotherapy

- Clinical evaluation with reference to extent of disease which should be radically treatable, i.e.: stage IIIB or lower.
- Performance status
- Pulmonary function tests usually demonstrating FEV1 ≥ 1 litre, DLCO ≥40%
- Diagnostic imaging usually including CT thorax / abdomen and PET-CT
- Brain imaging to exclude metastatic disease, ideally MRI.
- Histological confirmation of lung cancer, + further staging information from EBUS if appropriate. In some circumstances treatment without histological confirmation may be appropriate following full discussion at MDT and with patient.
- Consider all patients receiving radical chemoradiotherapy for prophylactic treatment of pneumocystis jiroveci pneumonia (PJP) during or after their treatment if they are thought to be at risk, e.g. lymphocyte count <0.6x109/L or patients on steroids for more than four weeks. Treatment should continue until lymphocyte count>0.6x109/L or for a minimum of six weeks radiotherapy.

5) Consent

The use of the National Radiotherapy consent forms, developed by the Royal College of Radiologists, is recommended – click here to access the site-specific national consent forms.

6) Localisation

6.1 Imaging for planning:

6.1.1 Radical treatments:

- All patients should ideally have a planning CT scan with either 4DCT or some form of motion management.
- IV contrast should be used unless precluded by poor renal function.

6.1.2 Palliative treatments:

- Patients to have CT scan. 4DCT may be considered for high dose palliative treatments.
- Consider iv contrast unless precluded by poor renal function.

6.2 Motion management:

All patients having radical treatment should ideally have some form of motion management. For the majority of patients where the tumour motion is less then 1cm, 4DCT is recommended. For patients with lower lobe tumours and a high degree of tumour motion the use of techniques such as Activated Breathing Control (ABC) or abdominal compression should be considered.

7). Volume Definition

Radical
GTV/ITV, CTV/cITV, PTV

GTV/ITV	Using information from available imaging and bronchoscopy findings etc. To cover all visible primary tumour and involved nodes. Contour with reference to diagnostic and planning imaging available using mediastinal and thoracic windows.
CTV/cITV	GTV + 5mm margin (irrespective of histology), modified to respect anatomical boundaries. In the absence of invasion of surrounding structures consider editing off vertebrae. If uncertain do not edit. Where induction chemotherapy has been used, CTV should attempt to encompass the entire pre-chemo involved lymph node region. The degree to which the pre-chemo tumour volume is encompassed is the clinician's discretion.
PTV	**3D Planning:** 5-10mm axially and 10-15mm sup/inf **4D Planning:** cITV+5-10mm in all planes (assuming daily CBCT verification), guided by local audit

Any deviation from standard margins or modification to 3D margins should be documented.

Radical Postoperative
GTV, CTV, PTV

GTV	Not usually defined
CTV/cITV	From operative findings and histology report to include involved nodes and positive margins. Discuss the target volumes with a thoracic surgeon, ideally the one who has performed the surgery.
PTV	**3D Planning:** 5-10mm axially and 10-15mm sup/inf **4D Planning:** ITV+5-10mm in all planes (assuming daily CBCT verification), guided by local audit

Palliative
GTV, CTV, PTV

GTV	from planning scans, +/- chest X-ray to include visible tumour and involved lymph nodes
CTV	not usually defined.
PTV	GTV+10-15mm
Field borders	GTV + appropriate margin (which may include mediastinum and adjacent lymph nodes). (10-20mm)
Field Sizes	Most palliative radiotherapy can be safely and effectively delivered within a 12x12cm^2 field with a single fraction, but larger field sizes may be considered. For bigger volumes consider if more advanced planning technique is appropriate, whether all disease should be covered to achieve palliation or if radiotherapy should be used at all.

8) Dose and Fractionation

Radical NSCLC

- CHART: 54Gy in 36# over 12 days (x3/day)
- 55Gy/20#
- 60-66Gy/30-33#
- 50-60Gy/15# for small volume disease not amenable to SABR (not with concomitant chemotherapy)
- Post operative: 54-60Gy in 1.8-2Gy per fraction treated or 50Gy in 2.5Gy per fraction (adjuvant post-operative with R1 / R2 pathology or extracapsular nodal disease) (ASTRO guidelines 2015) For R2 disease dose should be a minimum of 60Gy.

Radical SCLC

- 45Gy/30#/bd fractionation - concurrent
- 66Gy/33# - concurrent
- 40Gy/15#- sequential

Palliative

- 36-39Gy/12-13#
- 30Gy/10#
- 20Gy/5#
- 16-17Gy/2#
- 8-10Gy / 1#
- 6-8Gy re-treats or bleeding

PCI for SCLC

- 25Gy/10#
- 20Gy/5#

9) Organs at Risk

Aim for the use of standard nomenclature as per the Global Harmonization Group consensus guidelines:
https://www.thegreenjournal.com/action/showPdf?pii=S0167-8140%2820%2930294-2

Lung-GTV	Each lung should be contoured separately on lung windowing. Contour the whole lung, from the apex to the diaphragm including all inflated and collapsed lung. Exclude the proximal bronchial tree and trachea. Combine the left and right lung and subtract the GTV from their combination by Boolean operation.

Heart + A_Pulm	The whole heart should be outlined on mediastinal windowing to the extent of the pericardial sac. The cranial border is at the cranial aspect of the pulmonary artery (best viewed in the coronal section), and the caudal extent at the apex of the heart where the left ventricle blends with the diaphragm. Both pulmonary arteries should be fully contoured above the main bronchus.
Spinal Cord	The spinal canal should be contoured according to its inner limits using bone windowing. It should be outlined on slices which include or are within 20mm of the PTV in the superior and inferior directions. Alternatively, the spinal cord can be contoured with a PRV margin depending on the local protocol (3-5mm).
Brachial Plexus	The brachial plexus originates at the spinal nerve root foramina C5, C6, C7, C8 and T1 and terminates at the medial limit of the second rib. Identify and outline the vertebral bodies of C5, T1 and T2. On the coronal view, identify and outline the anterior and middle scalene muscles. Use a 5mm diameter paint brush to extend from the neural foramina to the space between the anterior and middle scalene. On slices in which the neural foramina is not visible, outline the space between the anterior and middle scalene muscles. C8, T1 and the main trunk of the brachial plexus can be contoured using the subclavian and axillary vessels as a surrogate for identifying the location of the brachial plexus. This neurovascular complex will be contoured starting proximally at C7 and following along the route of the subclavian artery ending after the neurovascular structures cross the second rib.
Oesophagus	The oesophagus should be contoured on mediastinal windowing to include all muscle layers out to the fatty adventitia. Contour from the lower edge of the cricoid cartilage to the gastro-oesophageal junction.

10) Organs at Risk Constraints

Structure Name	Constraint	Optimal	Mandatory
For 55Gy/20#			
Lung-GTV	V18Gy	<30%	<35%
Lung Dmean		<15Gy	<20Gy
Contralateral Lung	V5Gy	<60%	
Brachial Plexus	D0.1cc		55Gy
Oesophagus	D0.1cc Dmean	<32Gy	<105%
Spinal Canal	D0.1cc	<40Gy	<44Gy
Spinal Cord + PRV	D0.1cc	<40Gy	<44Gy
Heart + A_Pulm	D100% D67% D33%	<36Gy <44Gy <57Gy	
For 60-66Gy/30-33#			
Lung-GTV	V20Gy		<35%
Lung Dmean		<18Gy	<20Gy
Contralateral Lung	V5Gy	<60%	
Brachial Plexus	D0.1cc		<65Gy
Oesophagus	D0.1cc Dmean	<34Gy	<65Gy
Spinal Canal	D0.1cc	<46Gy	<50Gy
Spinal Cord + PRV	D0.1cc	<46Gy	<50Gy
Heart + A_Pulm	D100% D67% D33% D20%	<44Gy <52Gy <59Gy <40Gy	
For 60Gy/15#			
Lung-GTV	V17.4Gy		<35%
Contralateral Lung	V5Gy		<60%
Spinal Canal	Max point		35Gy
Oesophagus	Max point 5.0cc 10.0cc		50Gy <48Gy <45Gy
Brachial Plexus	Max point		50Gy
Heart	Max point 10.0cc		63Gy <57Gy
Trachea	Max point 10.0cc		63Gy <57Gy
Great Vessel	Max point 10.0cc		63Gy <57Gy
Stomach	Max point 5.0cc 10.0cc		50Gy <48Gy <45Gy
Spinal Canal + 5mm	Max		<38Gy
Cardiac Vessels	Max		<63Gy
Chest wall	Max		<63Gy
Skin	Max		<50Gy
For 45Gy/30#			
Lung-GTV	V20Gy		<35%
Contralateral Lung	V5Gy	<60%	
Oesophagus	D0.1cc		<105%
Spinal Canal	D0.1cc		<40Gy
Heart + A_Pulm	V45Gy	<30%	

	V22.5Gy	<50%	
For 40Gy/15#			
Lung-GTV	V20	Aim for <25%in high-risk patients	<30%
Oesophagus			
Spinal Canal			<40Gy
Heart	V40Gy	<30%	

11) Verification

Daily CBCT should be undertaken for radical treatment.
MV pre-treatment image or 2D kV imaging daily, if CBCT unavailable.
Please refer to the Network Verification guidelines for more details

12) On-treatment review

Patients undergoing radical radiotherapy should have regular review during treatment to assess and manage toxicity.

13) Follow up

There is no evidence to guide frequency of subsequent follow-up, the following represents a general recommendation which can be tailored as necessary to individual patient circumstances. As an example, follow-up could be based on:

- Year 1-3: 3-6 monthly follow-ups with imaging.
- Year 3-5: 6-12 monthly follow-up with imaging.
- Consider discharge at 5 years if disease free.

Patients who have had radical radiotherapy are at risk of fragility fractures of the vertebrae which may be visible on routine post-treatment imaging.

References

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