Southern District Health Board

An Introduction to Stereotactic Body Radiotherapy for Lung Cancer

Shaun Costello

KEEP CALM AND MAKE AN APPOINTMENT WITH YOUR GP

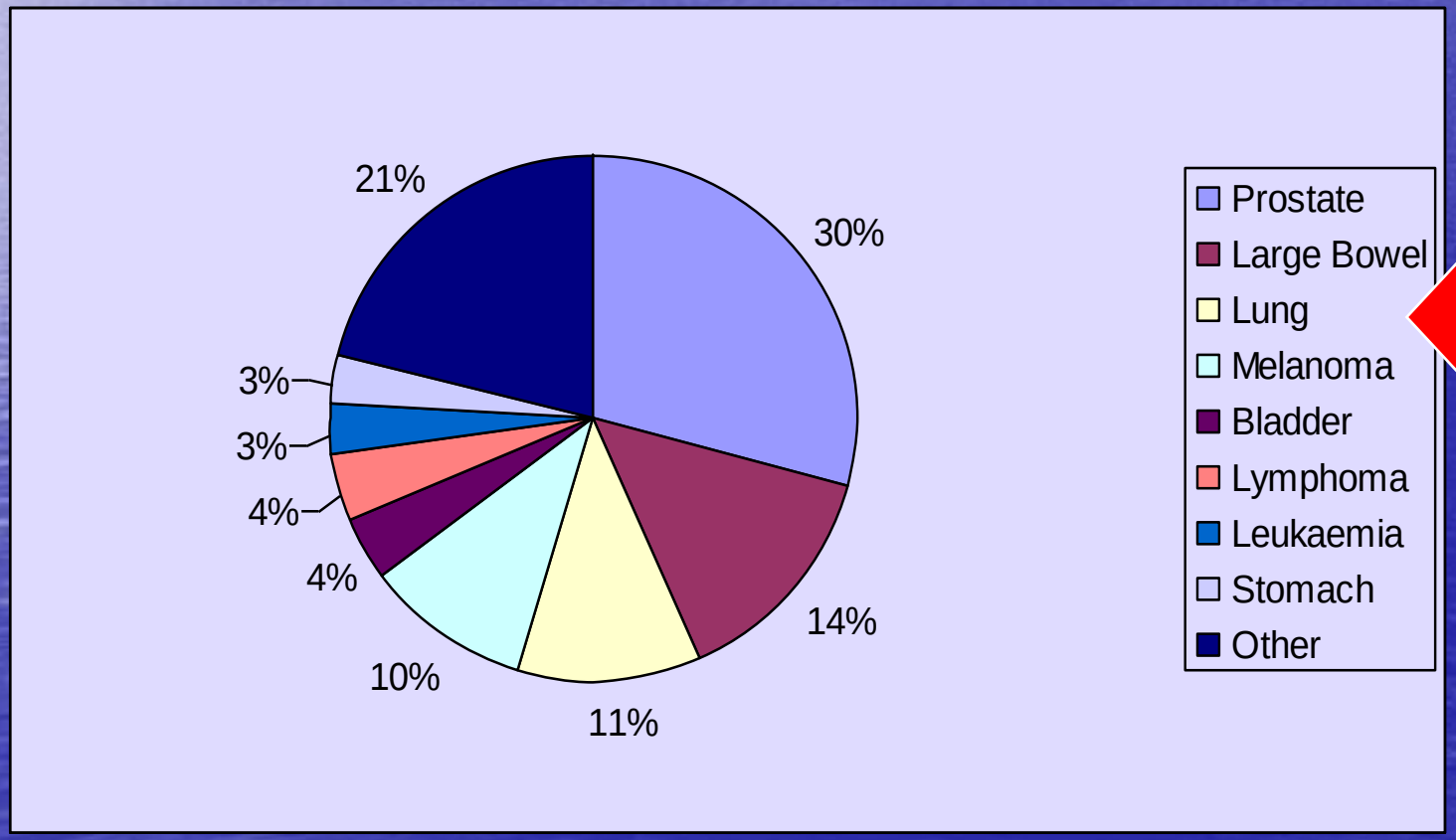
It's probably just a cold but if you've been coughing for more than 3 weeks, this could be a sign of lung cancer. Early diagnosis saves lives.

Freephone: 0800 358 7200
Monday to Friday, 9am to 5pm
info@roycastle.org
www.roycastle.org
England & Wales 1046854 • Scotland SCO37596

THE ROY CASTLE LUNG CANCER FOUNDATION
Research • Prevention • Support

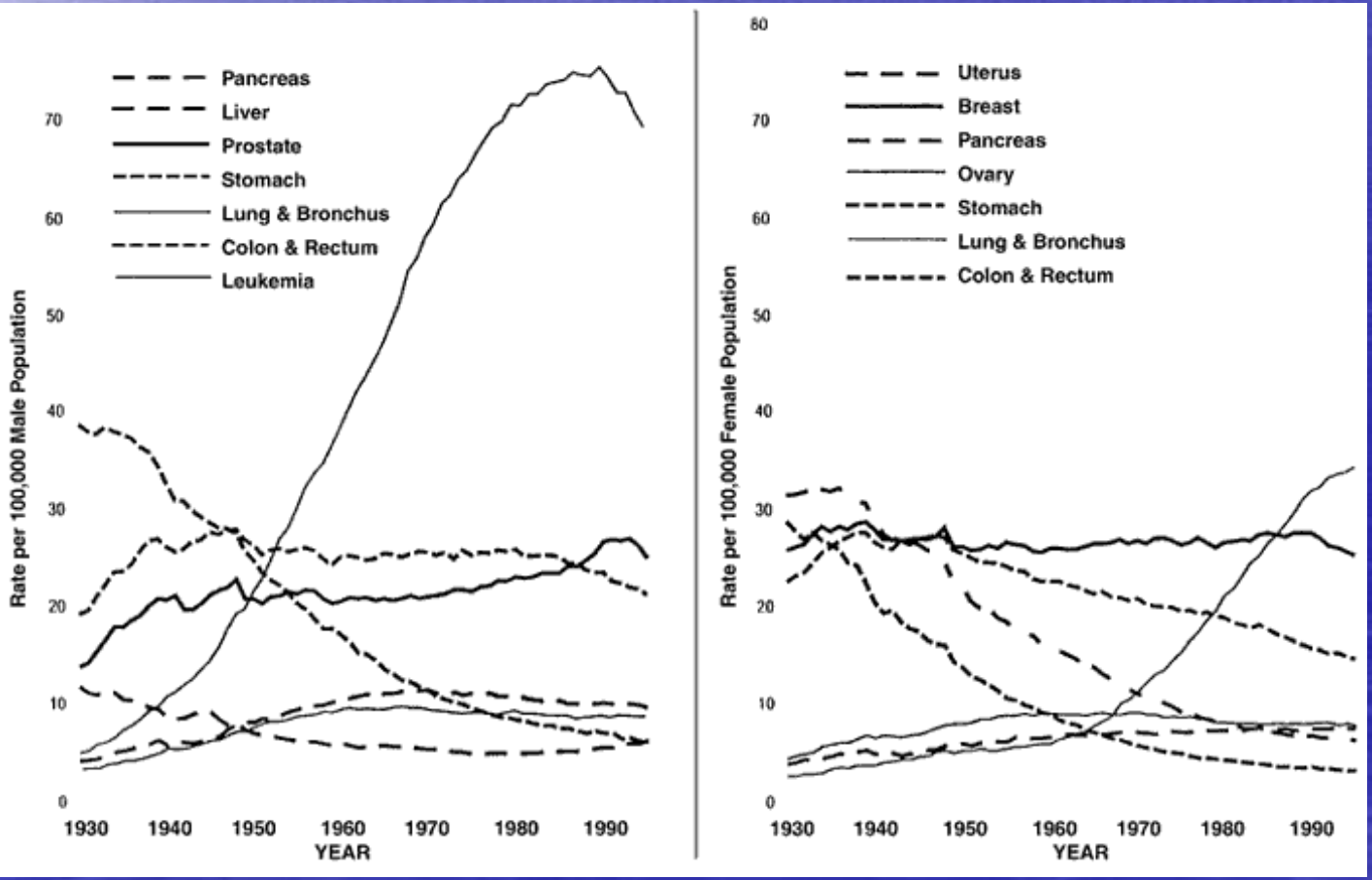
Epidemiology

Cancer Incidence -men



Epidemiology

Cancer Mortality



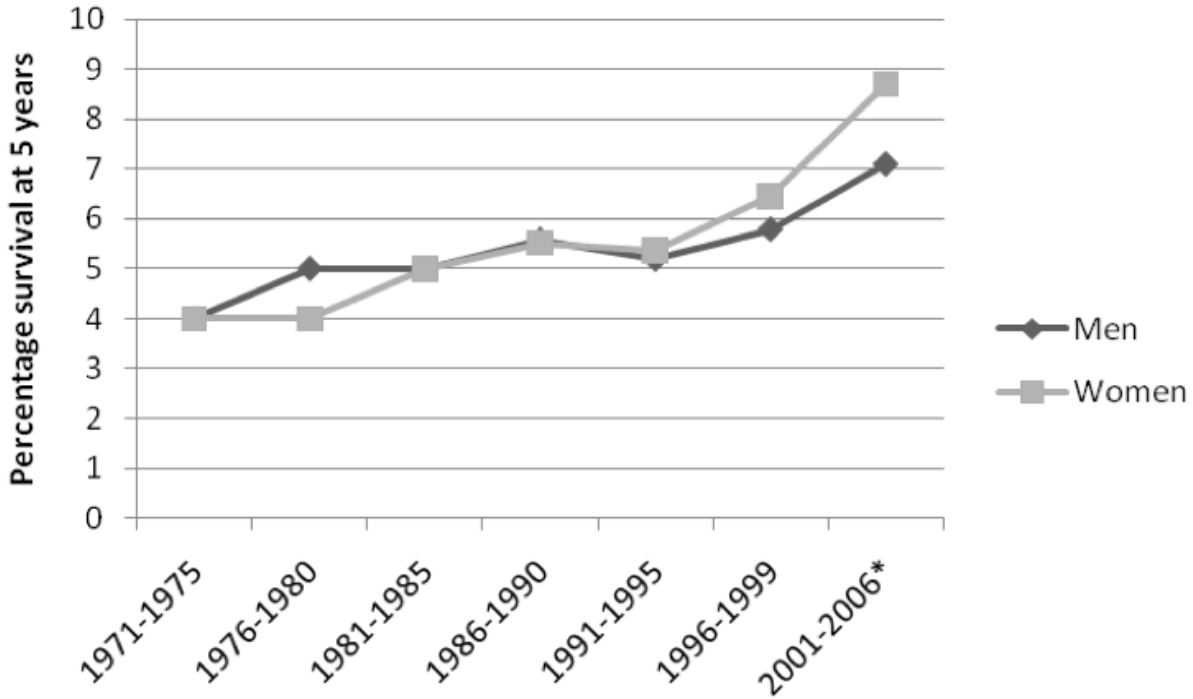
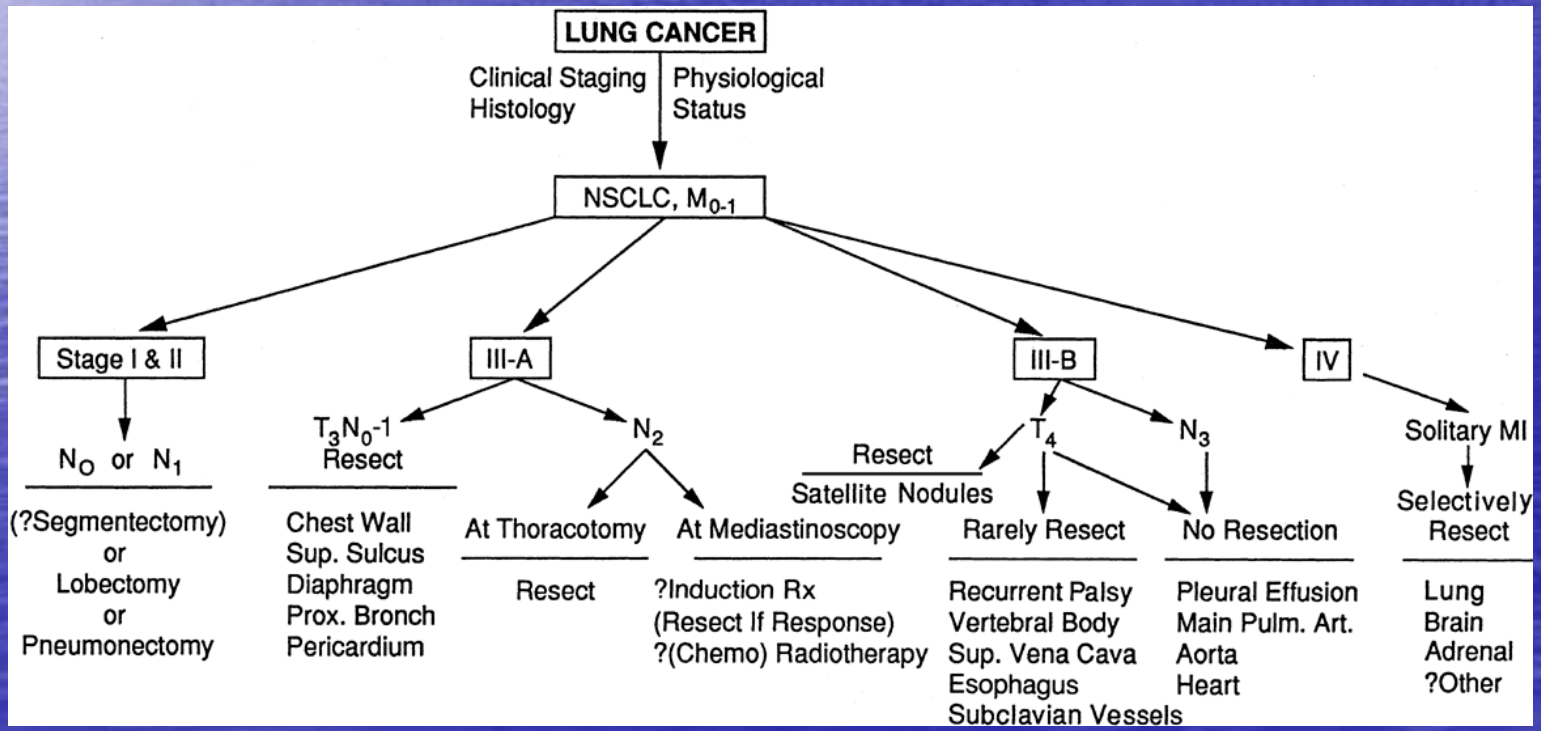


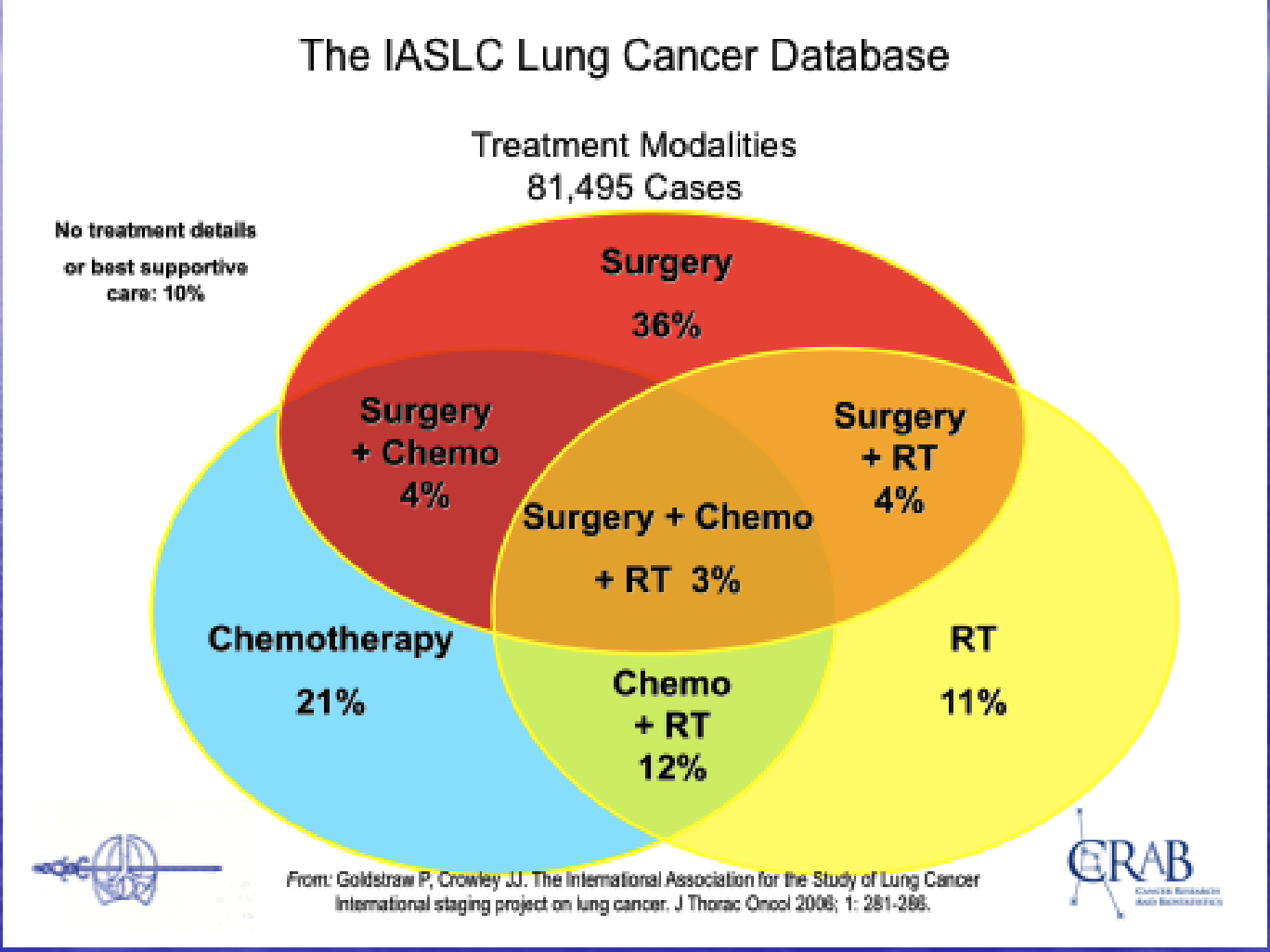
Figure 19: Five year survival data over time. Reproduced with kind permission of Cancer Research UK.

SURGERY -NSCLC

- Wedge resection / Lobectomy / Pneumonectomy



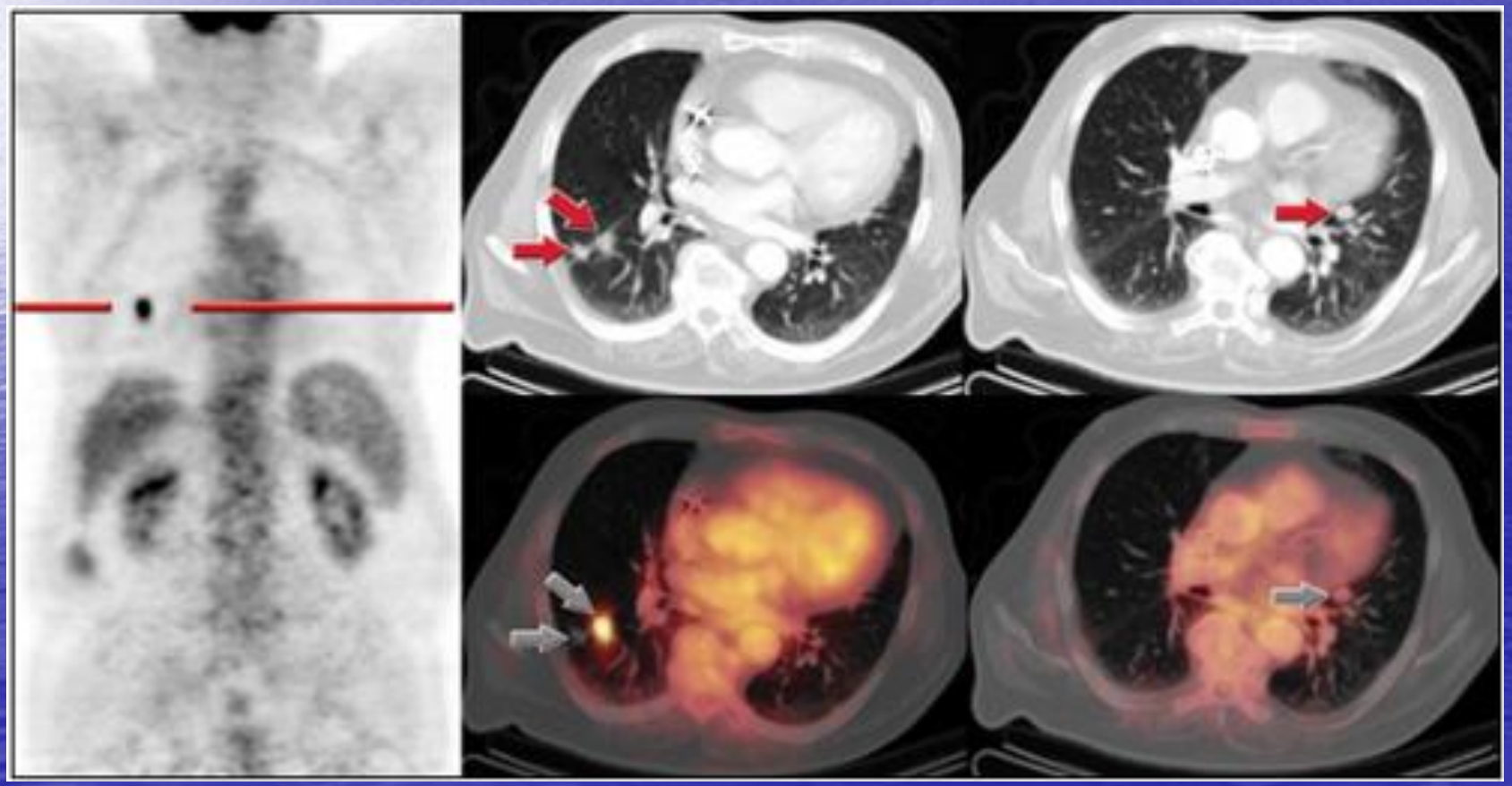
Treatment modalities



Overview

- 3.5 year survival Southland: 3.5% (2005)
- 3.5 year survival Otago: 11.3%
- 5 year survival (NZ): 10.2%
- 5 year survival (AUS): 14.5%
- 5 year survival (US): 15%

PET-CT combined imaging

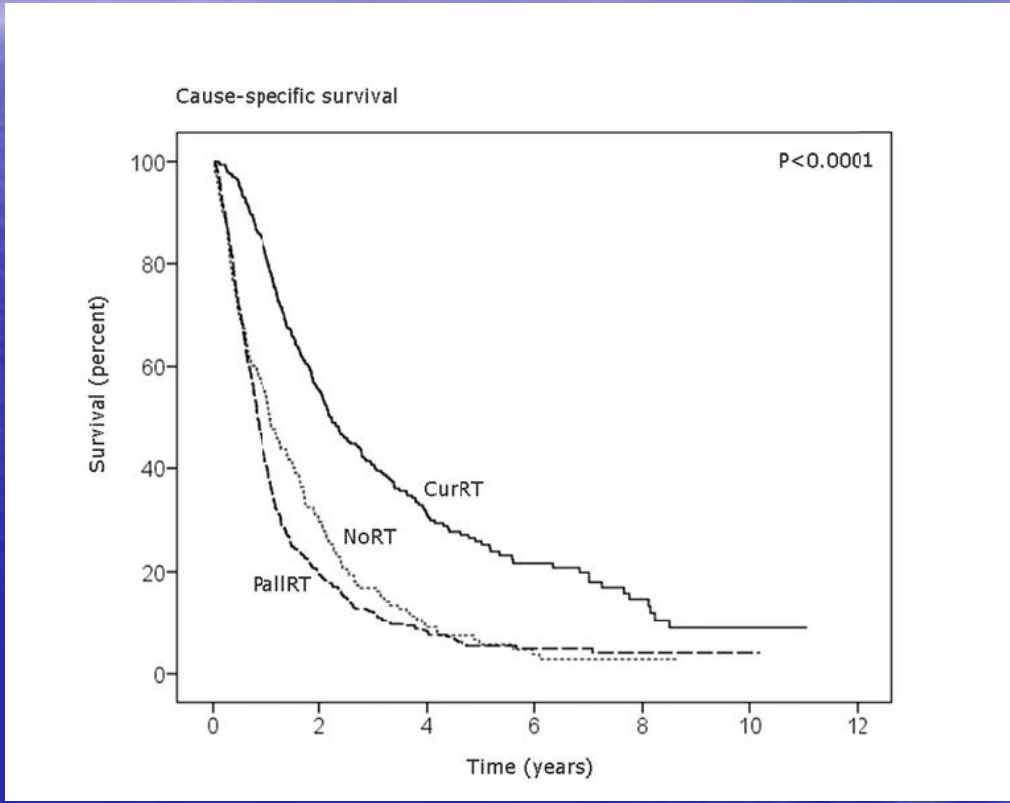


PET-CT

- at SUV of 2.5:
- sensitivity 97%
- specificity 78% (granulomatous/inflammatory)
- higher false negative rate when lesion small (<8mm)
- also false negatives in BAC, well differentiated neuroendocrine tumours

Conventional Therapy and Outcome

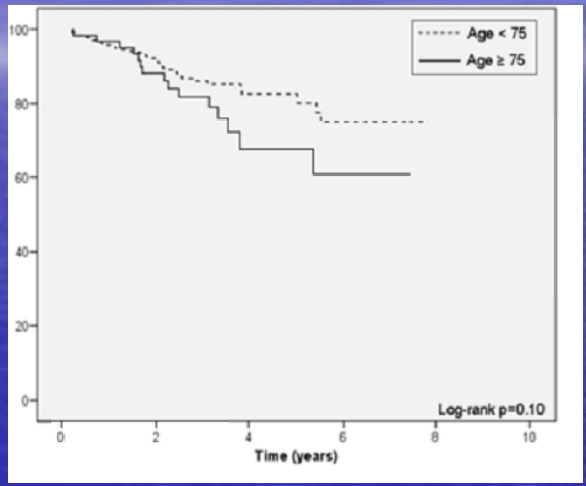
- Surgery five-year overall survival rates in the range of 60-70%
- Radiotherapy five-year overall survival rates in the range of 10-30%
- Local recurrence rate 6 – 70% with doses up to 84 Gy



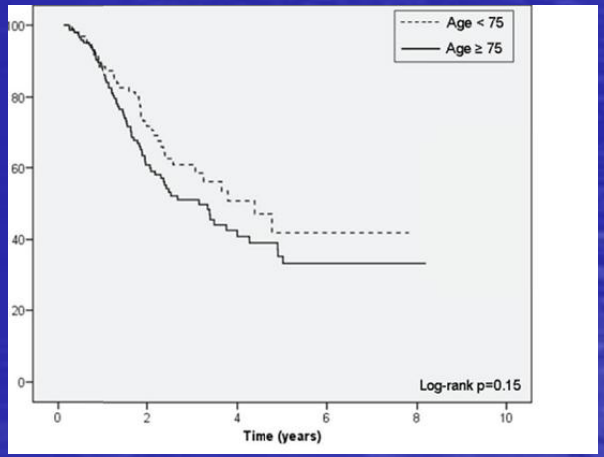
Why develop the service?

- 1 in 7 new cases of cancer
- 22% of all cancer deaths
- 80% of patients have non-small cell lung cancer (NSCLC),
- 20% have early-stage disease (AJCC Stage I, TNM Stage T1-2N0M0)
- Lung cancer is more common in elderly patients and smokers who a for a proportion of patients with early stage NSCLC surgery is too risky

Curative Surgery



Curative radiothrapy



Inclusion / Exclusion Criteria

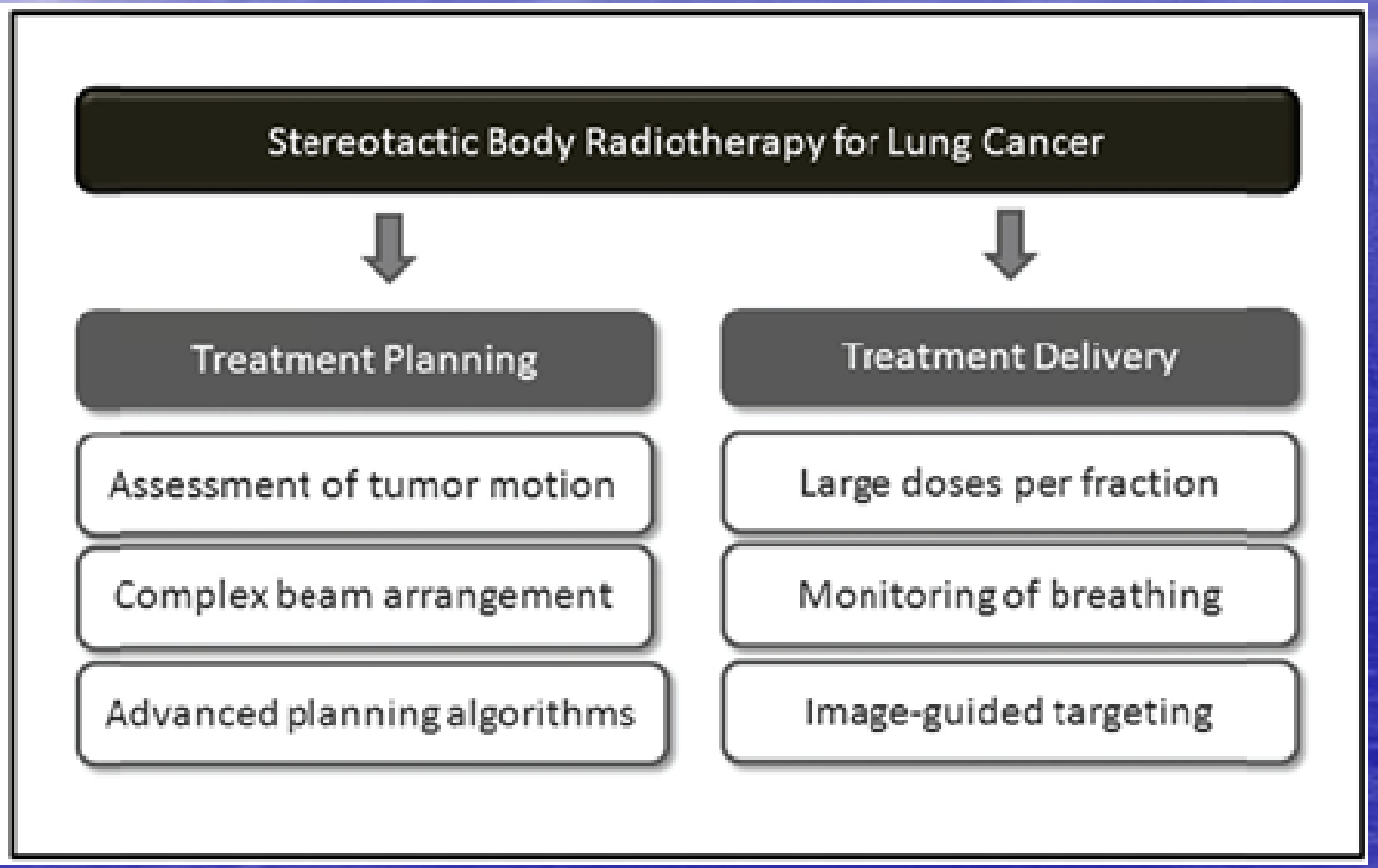
Inclusion Criteria

- MDT confirmed diagnosis of NSCLC based on findings of positive histology, positive PET scan and growth on serial CT scan.
- Clinical stages of: T1 N0 M0
  T2 (≤5cm) N0 M0
  T3 (≤5cm) N0 M0
- Not suitable for surgery because of medical co-morbidity, lesion is technically inoperable or patient declines surgery after surgical assessment.
- WHO performance status 0-2.
- Peripheral lesions outside a 2cm radius of main airways and proximal bronchial tree. This is defined as 2cm from the bifurcation of the second order bronchus e.g. where the right upper lobe bronchus splits

Exclusion Criteria

- Any tumour that is not clinically definable on the treatment planning CT scan e.g. surrounded by consolidation or atelectasis.
- Significant overlap with previous radiotherapy fields
- Advanced interstitial lung disease

Basic Requirements



Motion Control

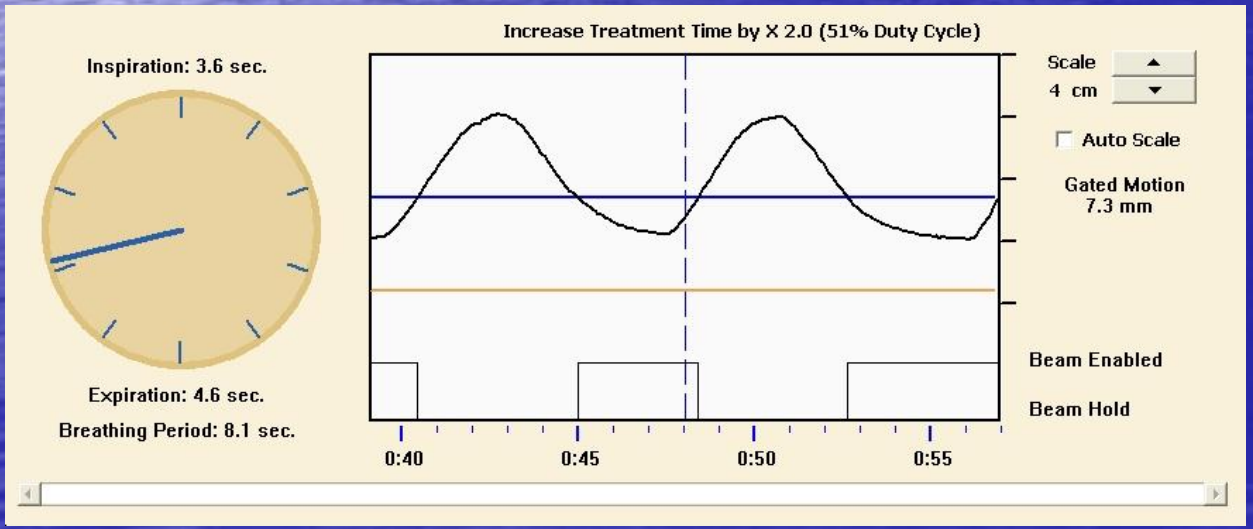
- Motion Restriction to reduce tumour motion (to <1cm), by using one of the following methods
  - Abdominal compression
  - Respiratory gating
  - Coached respiration or Active Breathing Control (ABC)

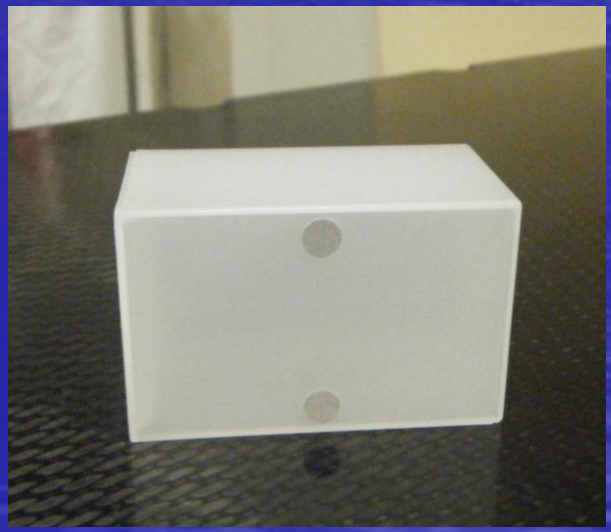
- Accounting for motion in RT planning:

Provided that the dose conformity, dose spillage and OAR constraints can be met the whole motion envelope may be included in the ITV and the patient treated whilst breathing normally.

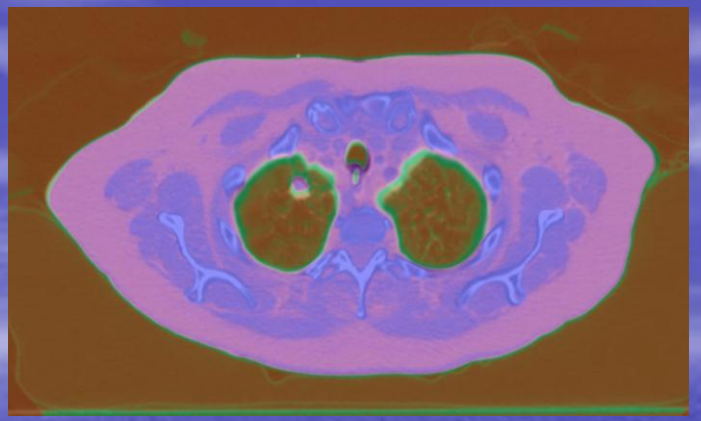
Gated Planning CT Method

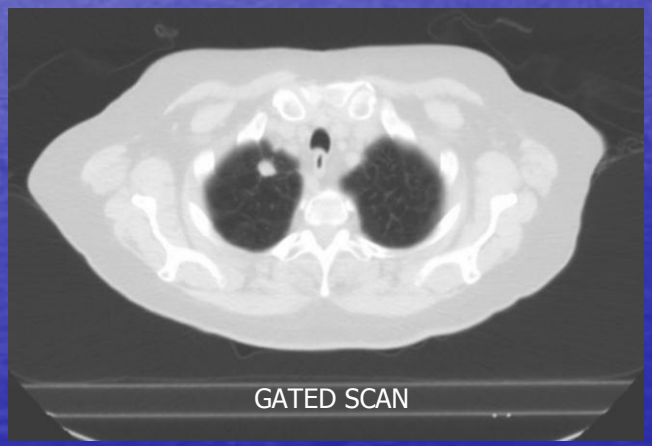
- Patient positioning
- Gated CT scan process

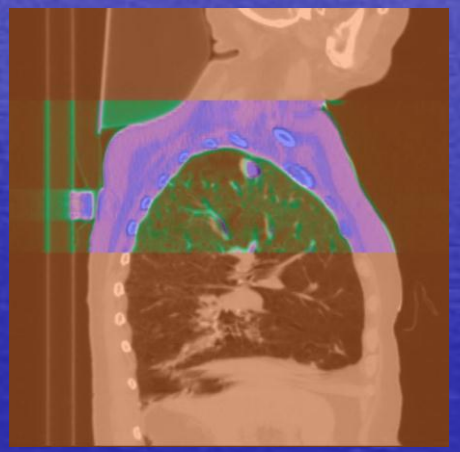


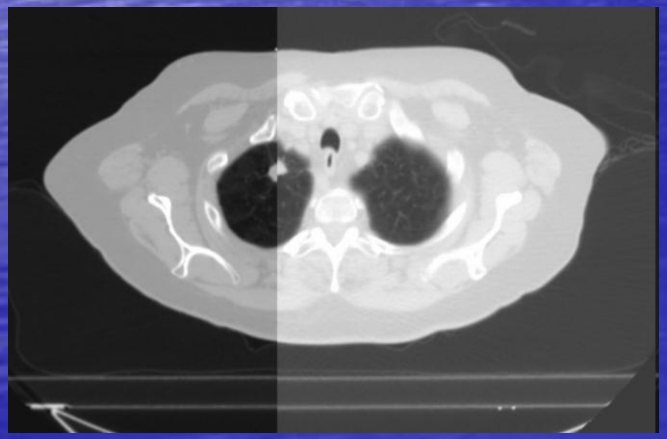


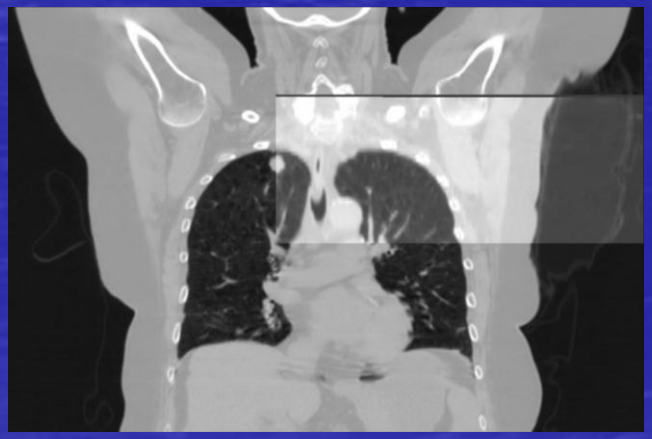
Free Breathing & Gated CT Fusion

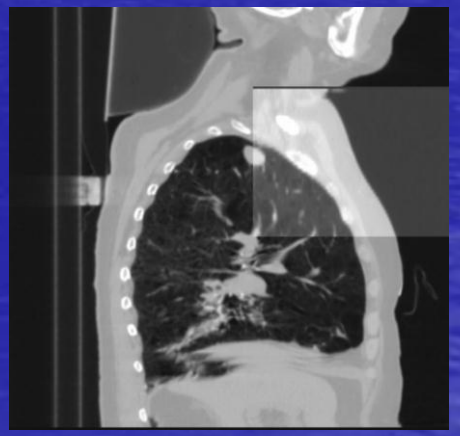












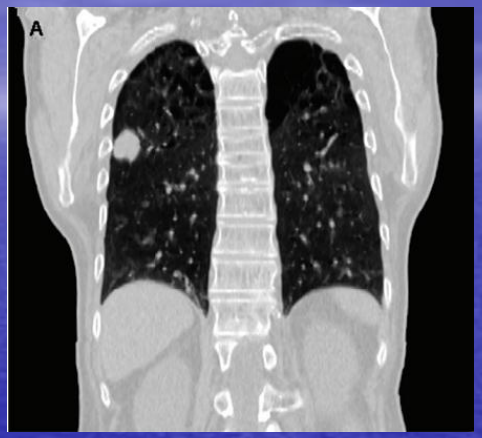
Voluming

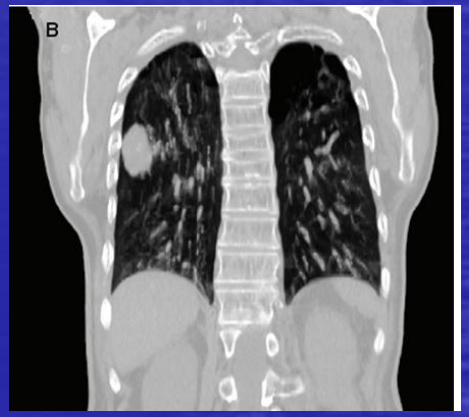
- GTV = CTV = Visible tumour on CT using Lung settings
- ITV developed using 4D CT either:

maximum intensity projection scan

maximum inspiratory and expiratory scans

contoured on all 10 phases of a 4DCT scan



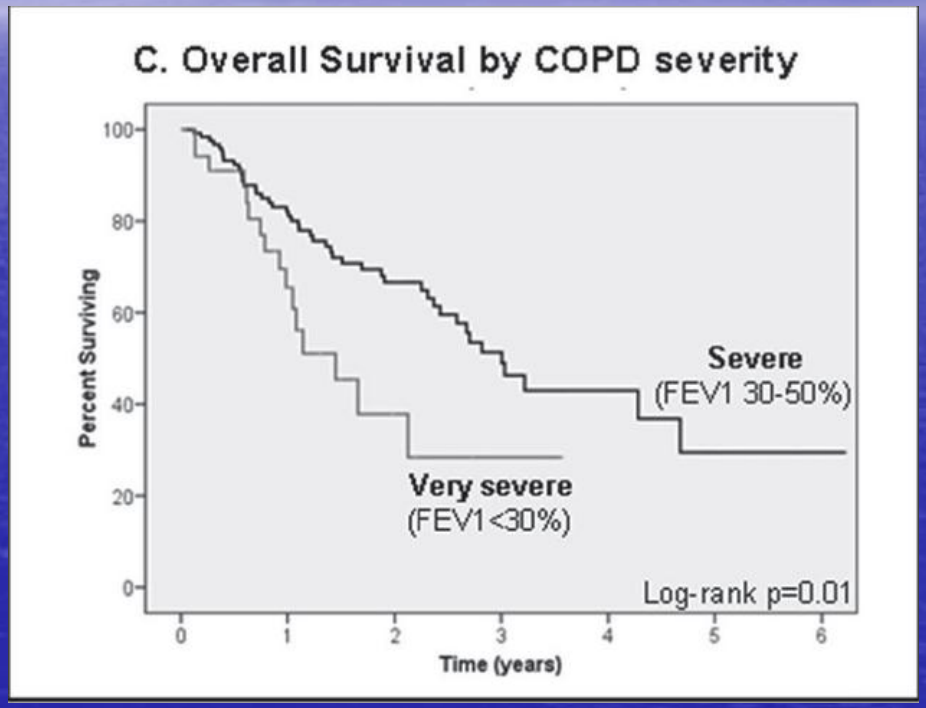


Contouring

CTV contouring for each respiratory phase

Organs at Risk

- Spinal cord
- oesophagus
- brachial plexus
- heart
- trachea and proximal bronchial tree
- skin



Dose Prescription

- Wide variation in dose prescription
- Some prescriptions are dictated by perceived tolerance doses
- Doses as high as 6000 c Gy in 2000 c Gy fractions have been used

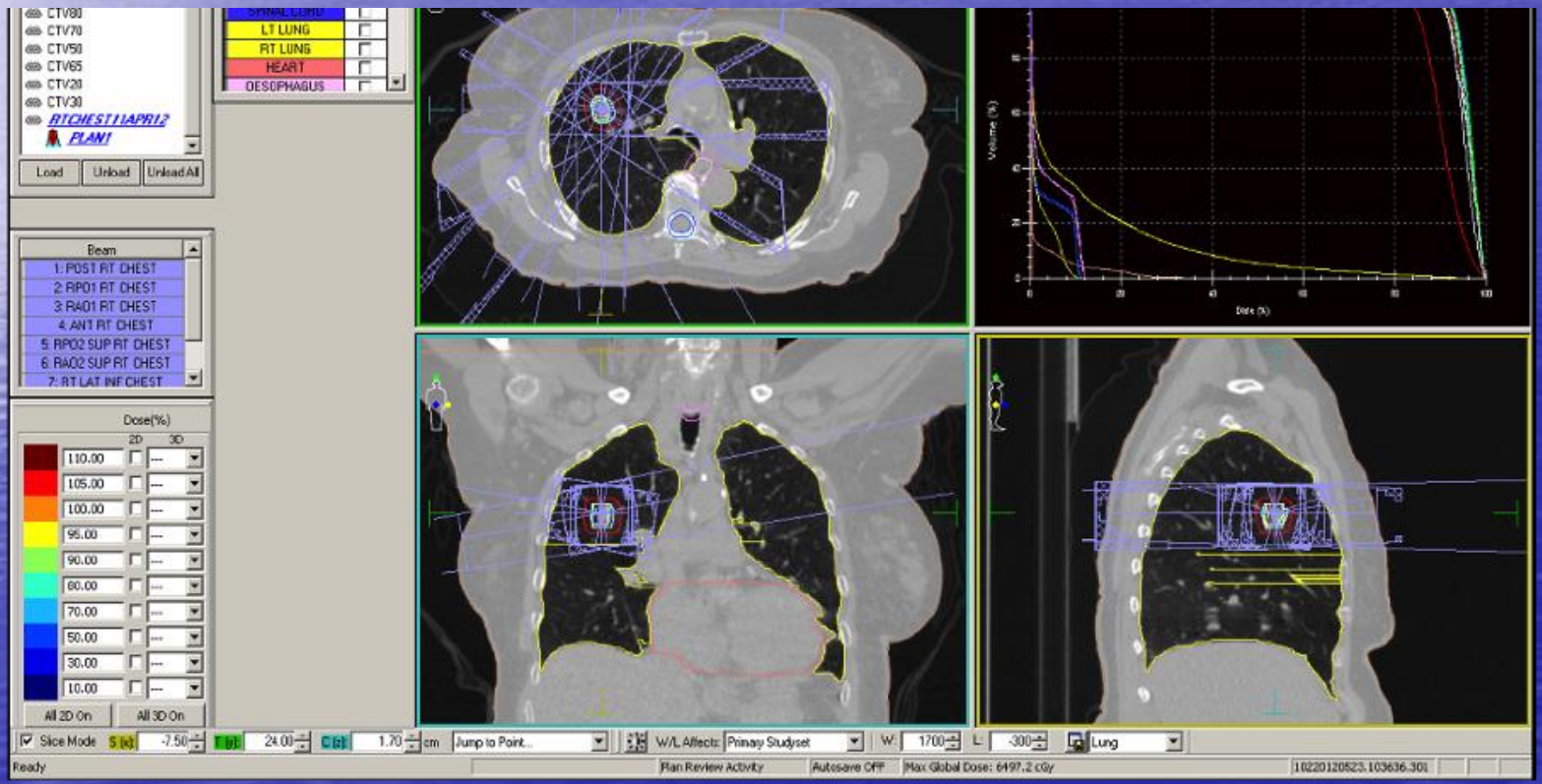
Standard Fractionation

- 18Gy x 3 fractions as a standard dose fractionation
- 12Gy x 5 fractions or 11Gy x 5 fractions as a conservative dose fractionation
- 40 hours minimum between fractions

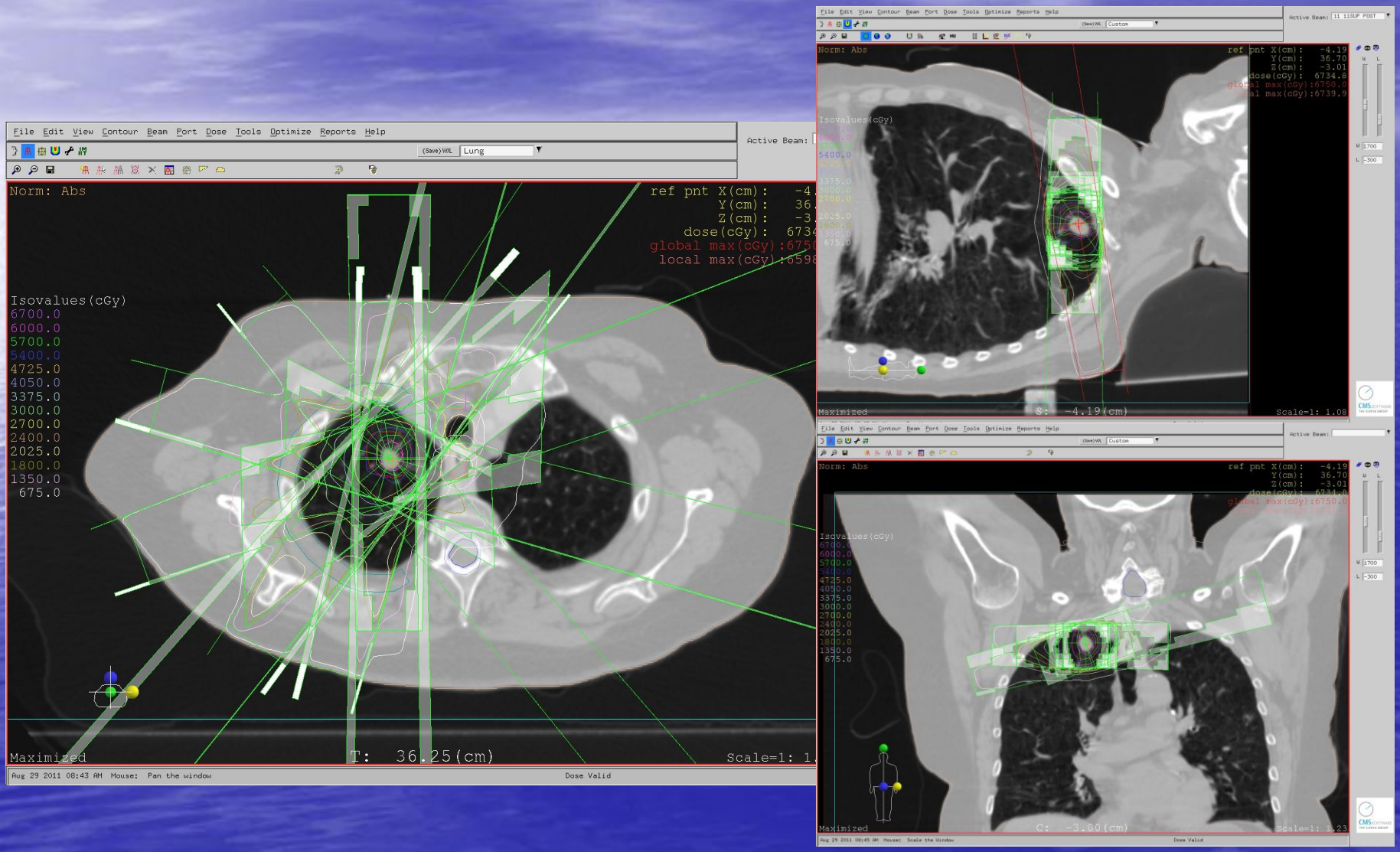
Tolerance Doses

Organ	Volume	Three Fraction Regime		Five Fraction Regime	
		Tolerance	Minor Deviation	Tolarance	Minor Deviation
Spinal cord	Any point	18 Gy	> 18 to 22 Gy	25 Gy	> 25 to 28 Gy
Oesophagus	1 cm^3	24 Gy	> 24 to 27 Gy	27 Gy	>27 to 28.5Gy
Ipsilateral Brachial Plexus	1 cm^3	24 Gy	> 24 to 26 Gy	27 Gy	> 27 tp 29 Gy
Heart	1 cm^3	24 Gy	> 24 to 26 Gy	27 Gy	> 27 to 29 Gy
Trachea, Ipsilateral Bronchus	1 cm^3	30 Gy	> 30 to 32 Gy	32 Gy	> 32 to 35 Gy
Lungs - GTV	V20			<10%	N/A

Stereotactic Lung Plan

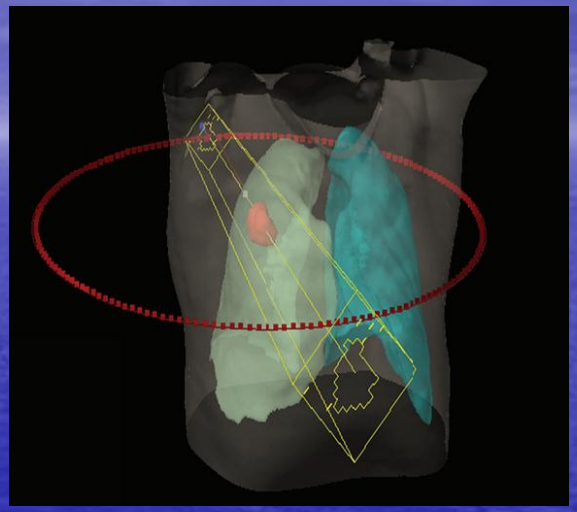


Plan Evaluation



Treatment Delivery

- Modern linac with CBCT and precision couching
- Rapid ARC or VMAT capable
- Gating Technology

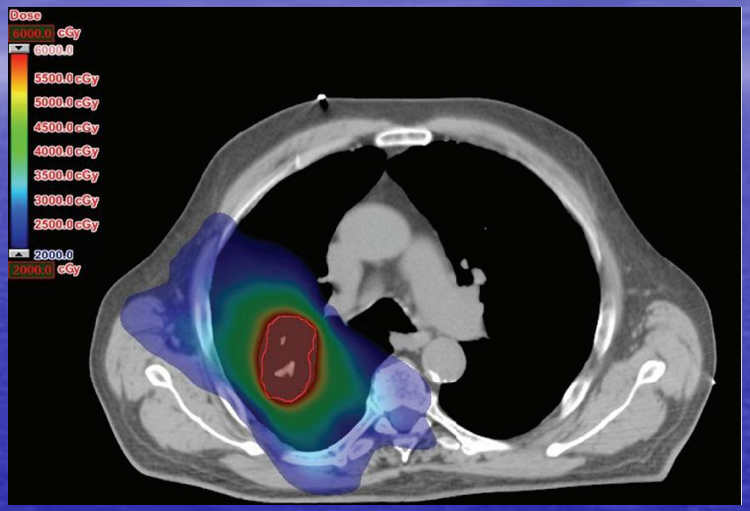


VMAT

(Table 2 continued)

Hypofractionated Stereotactic Treatments

Treatment Site	Authors	Dose per Fraction	Modalities Reported	Treatment times* in minutes (mean or range, unless specified)
Lung	Verbakel et al (33)	7.5 – 18 Gy	RapidArc	4.5 – 11
			3D-CRT	11– 13
	Hodge et al (61)	12 Gy	Tomotherapy	22

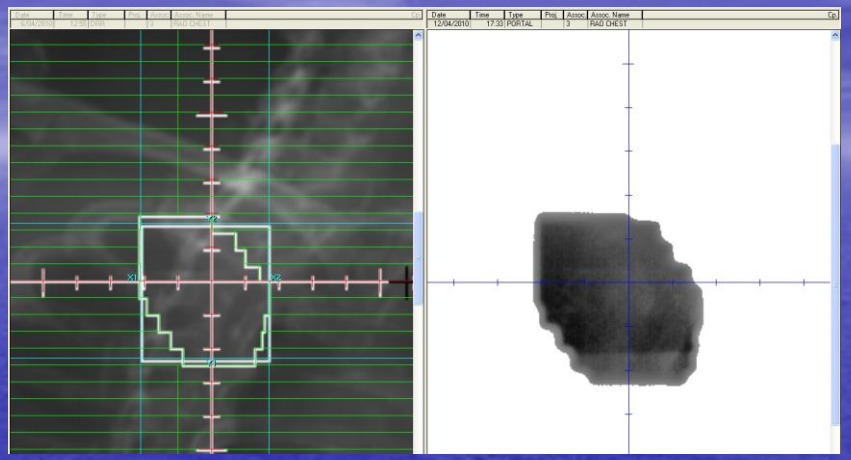


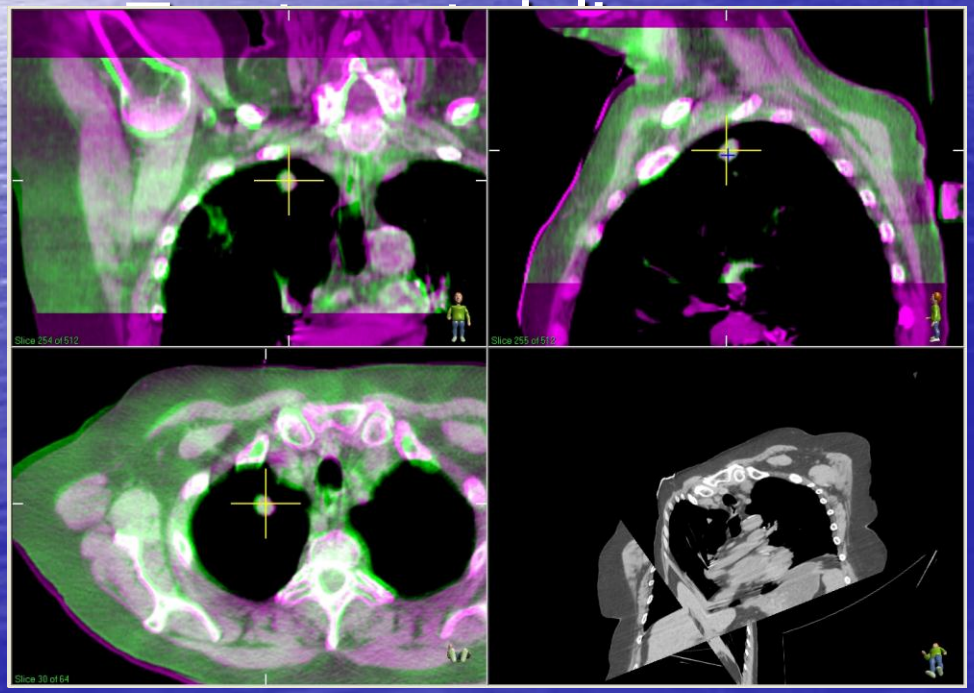
Potential Advantages of Arc Therapies

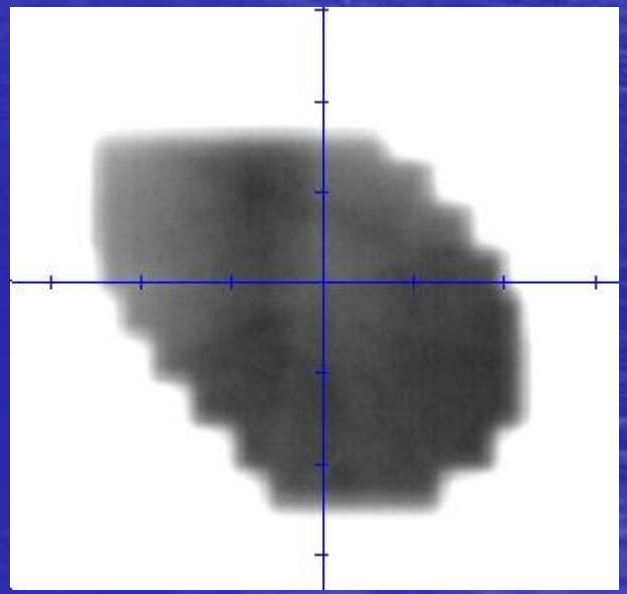
1. Improved dose distributions. Using arc techniques, the target can be treated from all angles, negating the issue of beam angle selection when using fixed beams.
2. Improved treatment times. Treatment times may be fastest with 'volumetric' arc techniques that treat the whole target volume at once.
3. Decreased monitor unit requirements due to improved efficiency, which can result in a lower dose to normal tissues.

Treatment Imaging and Localisation

- Set-up reproducibility
- Breathing evaluation
- CBCT match







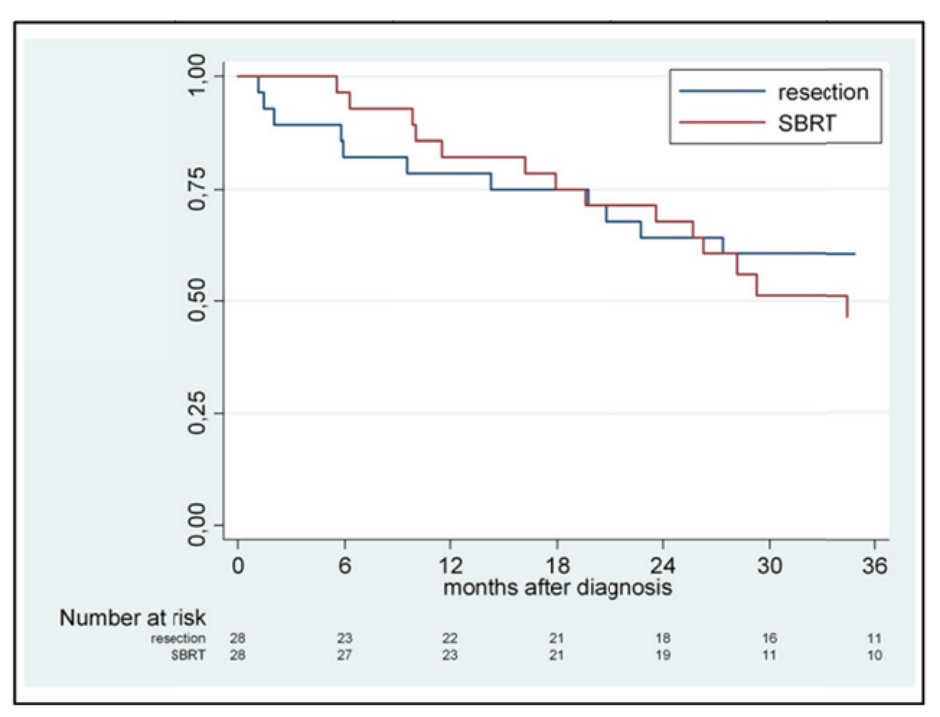
SBRL Outcomes and Fractionation

Study	Patient Numbers	Schedule	BED ($\alpha/\beta = 10$)	Median FU (months)	Actuarial local control	Survival
Baumann et al, 2006 [15]	138	30-48 Gy in 2-4 #	60-120 Gy	33	85% (3 yr)	52% 3 year 26% 5 year
Lagerwaard et al, 2007 [16]	197	3 x 20Gy 5 x 12 Gy	180 Gy 132 Gy	12	94% (2 yr)	64% 2 year
Nagata et al, 2005 [17]	45	4 x 12 Gy	106 Gy	30	98% (2 yr)	72% 3 year
Nyman et al, 2006 [18]	45	3 x 15 Gy	113 Gy	43	80% (crude)	55% 3 year 30% 5 year
Onishi et al, 2007 [9]	257	18-75 Gy in 1-22 #	Miscellaneous	38	84% (5 yr BED > 100) 37% (5 yr BED <100)	71% 5 year 30% 5 year
Timmerman et al, 2006 [11]	70	3 x 20 Gy 3 x 22 Gy	180 Gy 211 Gy	18	96% (2 yr)	55% 2 year
Wulf et al, 2001 [19]	50	50-60 Gy in 5-10 #	Miscellaneous	36	94% (crude)	21% 2 year
Lagerwaard 2008 [53]	206	60 in 3, 5 or 8 #	Miscellaneous	12	68%	64%

Results (over 75 years)

- 120 matched patients
- 60 surgery 60 SBRT
- 47% SBRT group has pathology

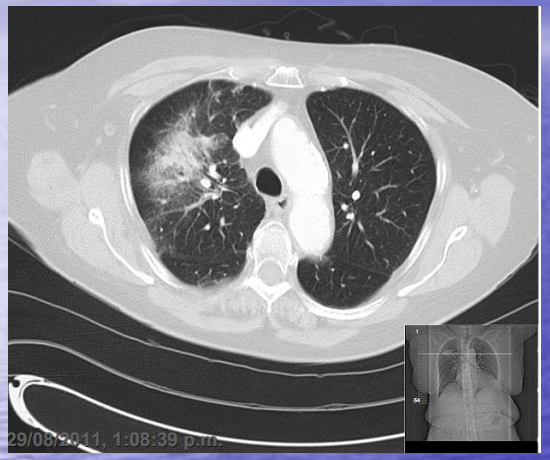
- No difference between Surgery and SBRT
- 1 yr surgery 78% SBRT 82%
- 3 yrs surgery 61% SBRT 47%



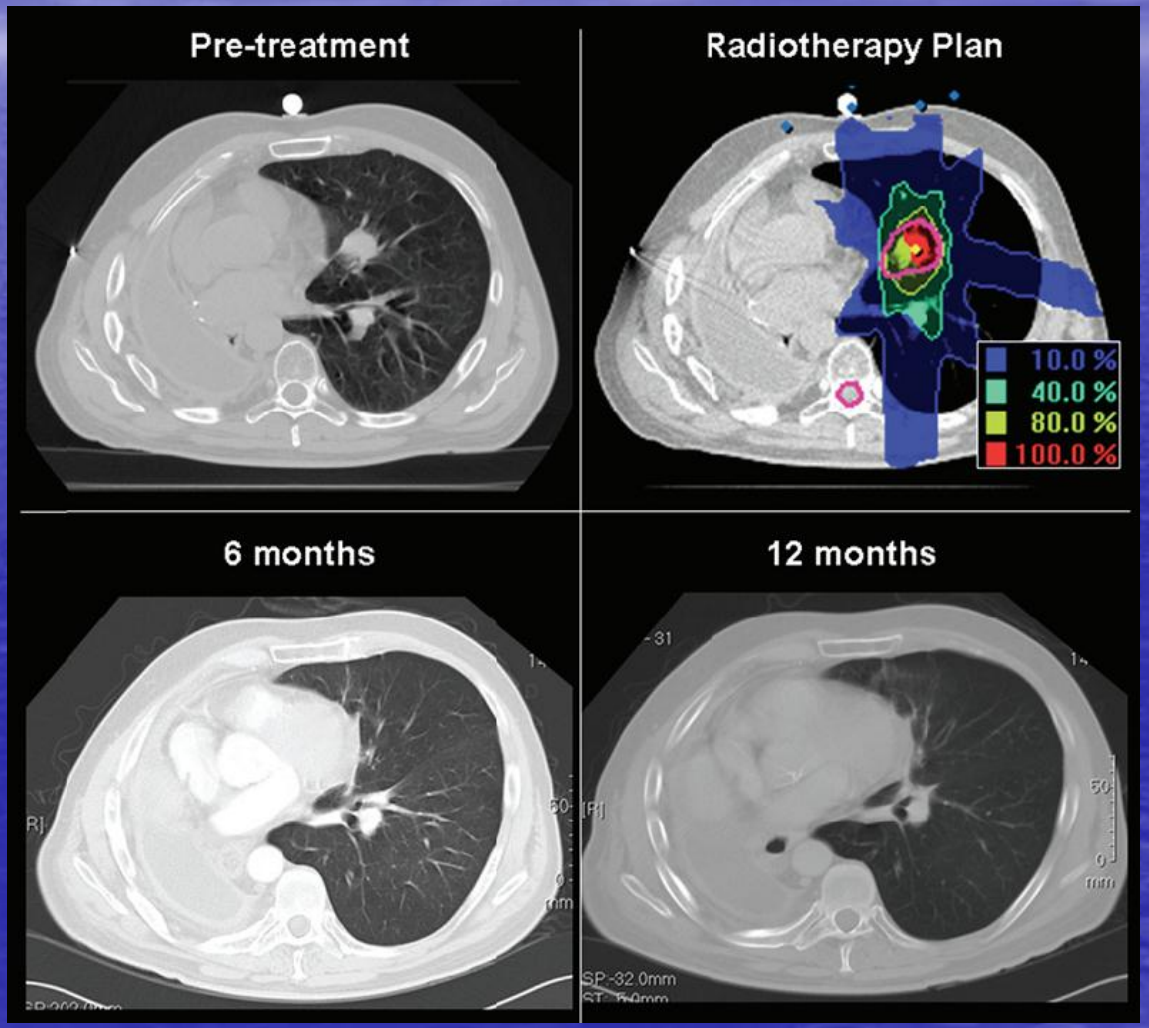
Treatment Toxicity & Cases to Date

- Treated 20 patients to date
- Generally well tolerated
- Minimal side effects
- Follow up to date
- Long term follow up

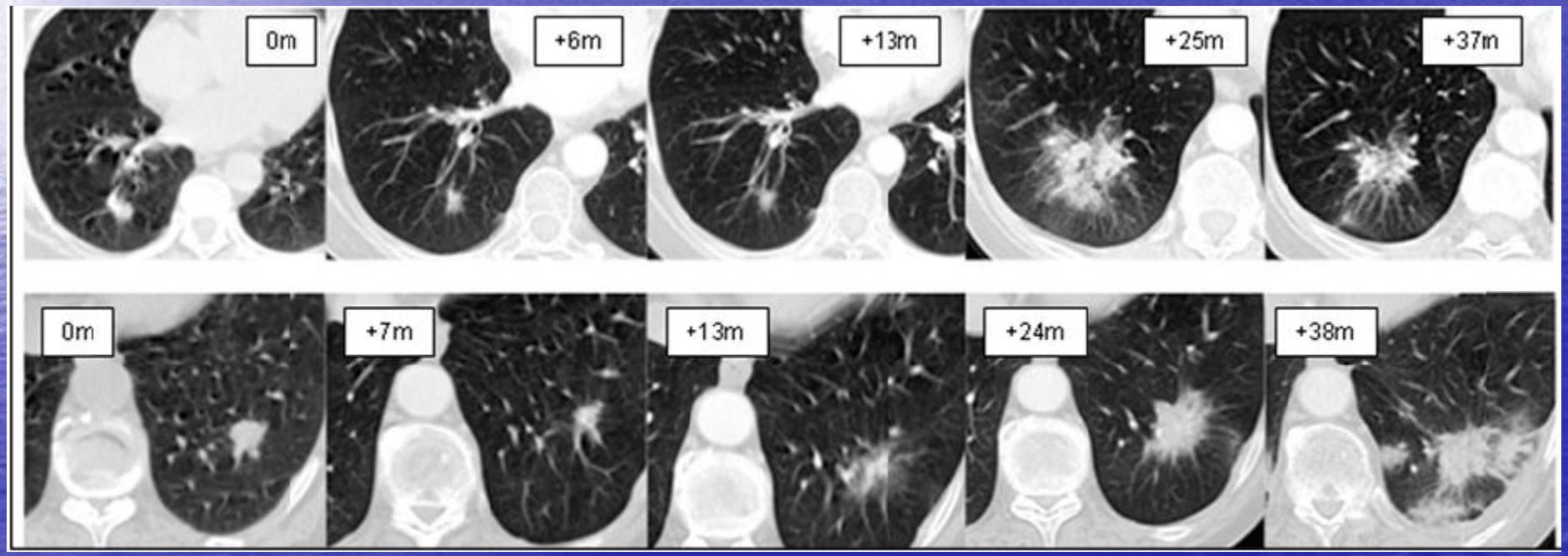
Outcomes



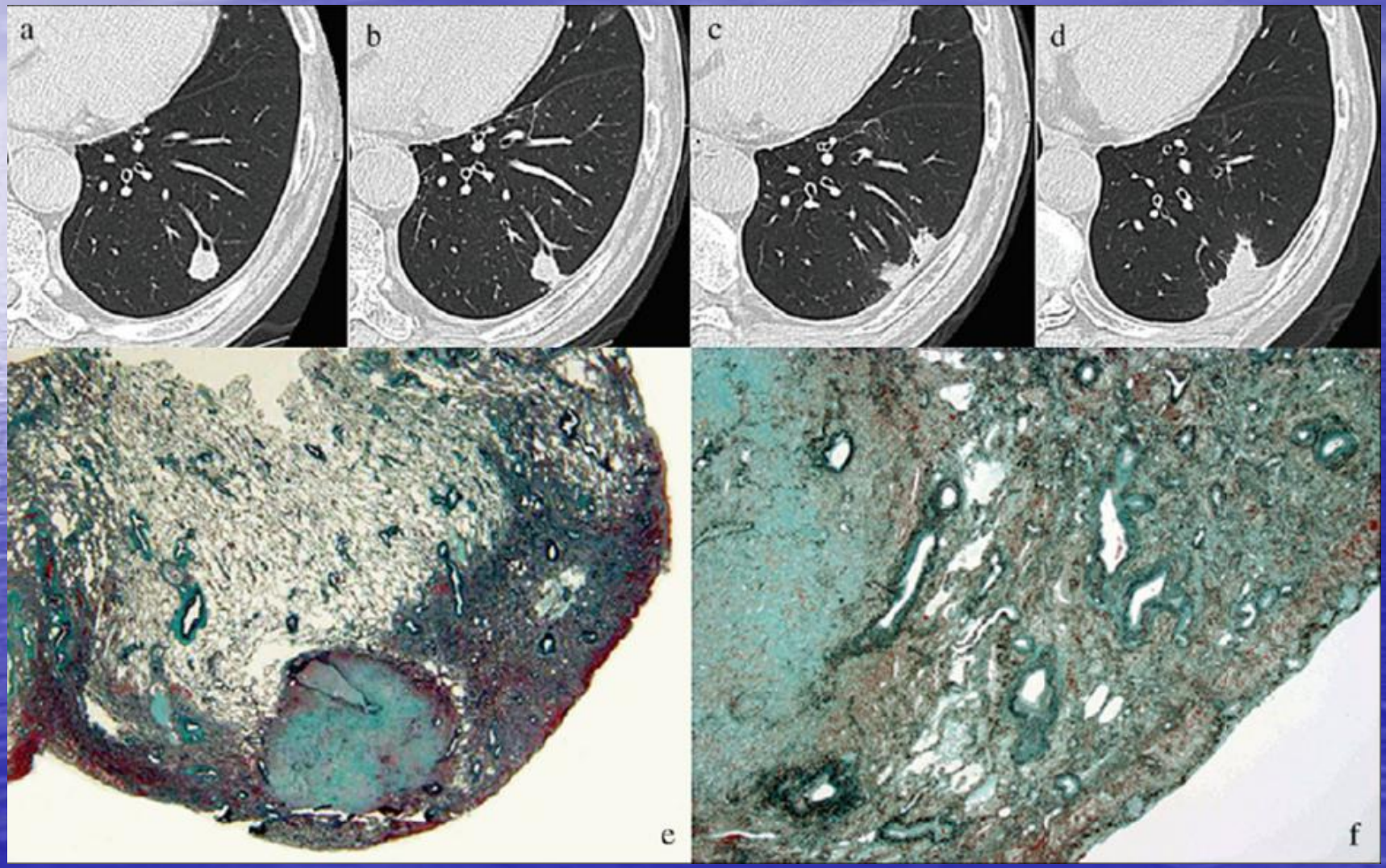

CLD8390
Snitt: 5 mm
29/08/2011, 1:08:38 p.m.


Pre-treatment
Radiotherapy Plan
10.0 %
40.0 %
80.0 %
100.0 %
6 months
12 months
SP:-32.0mm

Change over time



Long term Outcomes



Other targets

- Brain (malignant and non malignant)
- Spine
- Liver
- Pancreas
- Prostate
- Lung metastasis

Conclusion

- SBLT for Lung is practical and feasible
- SBLT outcomes rival those of wedge resection of lung
- SBLT is the treatment of choice for non operative candidates
- SBLT is a cost effective intervention


DOCTOR, I'M NOT A TALL WELL
17"