

Stereotactic radiotherapy (SBRT)

High-precision image-guided RT characterized by:

- 4D target definition
- Accurate patient positioning
- Multiple non-coplanar RT beams

allowing for:

- Steep dose-gradients
- Hypofractionation (3-8x)
- High biological effective dose

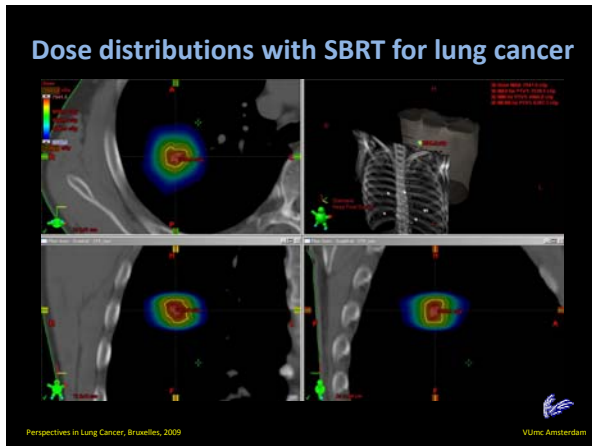
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Dose distributions with SBRT for lung cancer

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Does biological dose matter ?

Total Dose	Reference	BED Gy10	NTD, Gy 2-Gy Fractions ¹	Estimated Progression-free Survival at 30 Mo. (Assuming No Hypoxia)
Conventional fractionation	—	(Fig. 1.1)	—	—
60 Gy, 30 fractions	—	124	90	100%
70 Gy, 35 fractions	—	184	131	34%
SBRT	—	(Fig. 1.2)	—	—
48 Gy, 4 fractions	(8)	106	83	34%
45 Gy, 3 fractions	(7)	113	84	95%
48 Gy, 3 fractions	(7)	135	104	90%
60 Gy, 3 fractions	(3)	194	143	39%
69 Gy, 3 fractions	(3)	229	190	>99%

BED, biologically equivalent dose; NTD, normalized total dose in 2-Gy fractions; SBRT, stereotactic body radiation therapy; NSCLC, non-small cell lung cancer; Th, thorax; Td, total dose; LQ, linear-quadratic.


Fowler et al. 2005

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- ### SBRT for lung cancer at VUmc
- Standard treatment for Stage IA-B NSCLC since early 2003
 - Medically inoperable, or patients refusing surgery
 - Tumor size ≤6 cm
 - Pathological confirmation OR new/growing ¹⁸F-DG-PET positive lesions
 - Prospective data collection on tumor control, toxicity, QoL
 - Follow-up 3-monthly during the first year; 6-monthly intervals thereafter
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SBRT delivery at VUmc



- Target definition using 4D CT scans
- Novalis Linear accelerator
- Online patient positioning and monitoring
- 8-12 non-coplanar beams
- During quiet respiration
- No fixation frames
- Treatment duration 25-45 min.

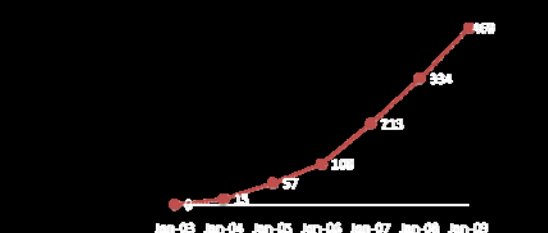
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Use of 'risk-adapted' SRT protocols

- **T1 tumors**, without extensive contact with chest wall or mediastinum
 - 3 x 20 Gy; 3 fx/week (BED 180 Gy)
- **T1 tumors** in broad contact with thoracic wall or mediastinum, and **T2 tumors**
 - 5 x 12 Gy; 3 fx/week (BED 132 Gy)
- **Tumors adjacent to pericardium or hilus**
 - 8 x 7.5 Gy; 3 fx/week (BED 105 Gy)

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Patient 'accrual' for SBRT NSCLC at VUmc



Date	Number of Dutch centers performing lung SBRT
Jan-03	0
Jan-04	1
Jan-05	2
Jan-06	5
Jan-07	8
Jan-08	334
Jan-09	669

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Patient characteristics

Patients	402*
Gender	
Male	241 (60%)
Female	161 (40%)
Median age	74 Years
Stage	
T1 NO M0	249 (62%)
T2 NO M0	153 (38%)
Pathological confirmation	
Yes	139 (35%)
No	263 (65%)
WHO class	
0-1	251 (62%)
2-3	151 (38%)
Charlson co-morbidity score (age-adjusted)	
≤ 4	24 (6%)
5-6	131 (33%)
≥ 7	247 (61%)

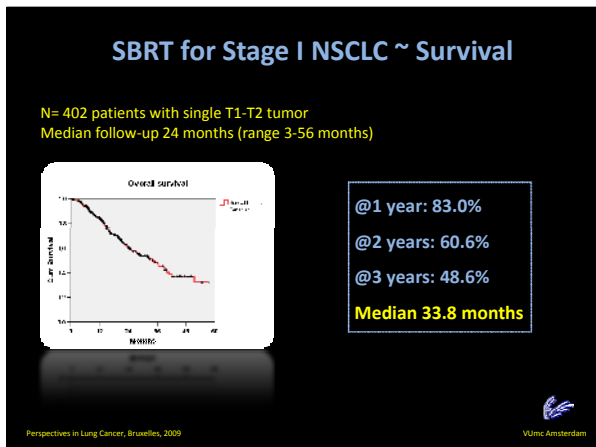
* Only patients with single tumors included

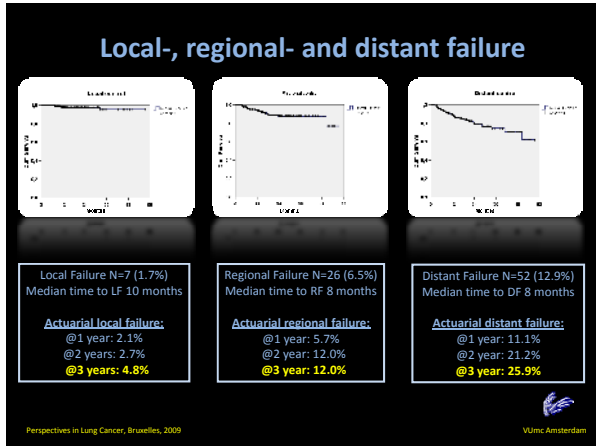
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Patient characteristics

Reason for lung SBRT	
Medically inoperable	338 (84%)
Refusing surgery	64 (16%)
Staging ¹⁸ F-FDG PET scan	
Yes	399 (99%)
No	3 (1%)
Median FEV ₁ (% of predicted)	1.5 liter (62%)
COPD GOLD class	
0-1 none-mild	116 (30%)
2 moderate	131 (35%)
3-4 severe-very severe	131 (35%)
History of lung cancer	
Yes	67 (17%)
No	335 (83%)
Number of fractions	
3	159 (39%)
5	176 (44%)
8	67 (17%)

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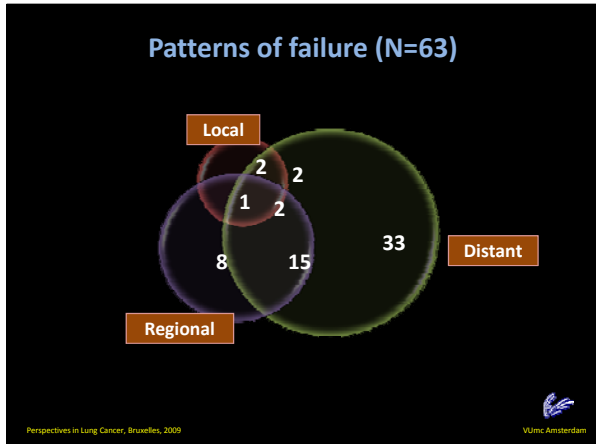
Prognostic factors

Overall survival: Pulmonary function (p<0.001)
WHO performance score (p=0.003)
Charlson co-morbidity score (p=0.044)

Disease-free survival: Stage (p=0.042)

No significant impact: Pathological verification
Medical inoperable or refusing surgery
Number of fractions
Prior malignancy

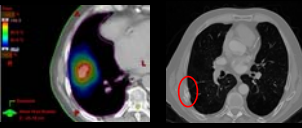
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Toxicity of SRT

(Sub)acute

No toxicity	51%
Fatigue	28%
Chest wall pain	12%
Nausea	9%
Dyspnea	6%
Cough	6%
Erythema	2%
Hemoptysis	1%
Palpitations	1%

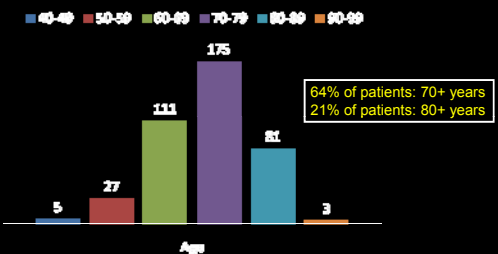


Late

Chest wall pain	11 (3%)
Radiation pneumonitis	7 (2%)
Rib fracture	4 (1%)
Pleural effusion	4 (1%)
Atelectasis	1 (1%)

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Outcome of lung SBRT in frail elderly patients

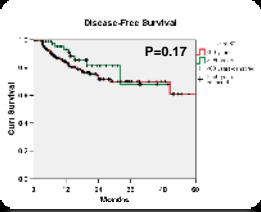


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Outcome of lung SBRT in frail elderly patients

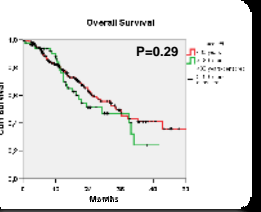
84 patients aged 80+ compared to younger patients
Toxicity profile not different

Disease-Free Survival



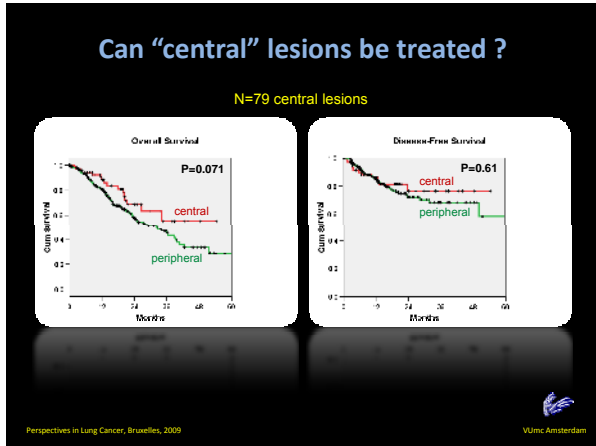
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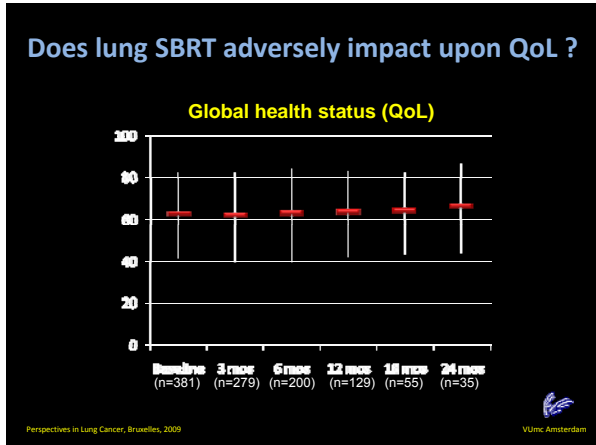
Overall Survival

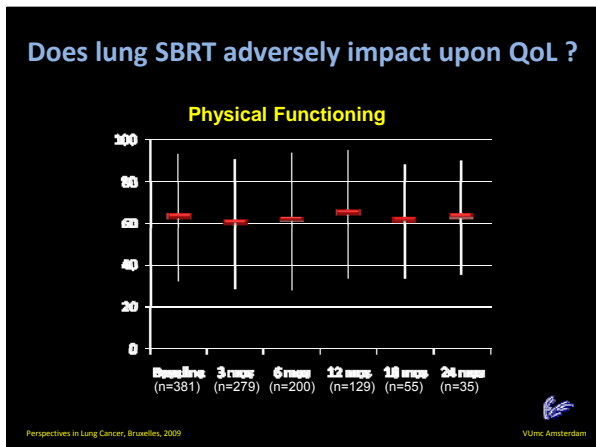


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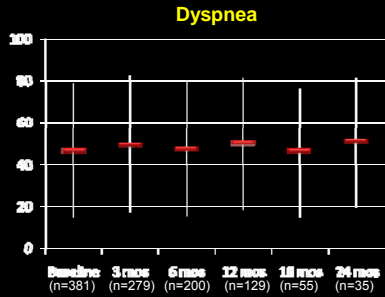
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Does lung SBRT adversely impact upon QoL ?



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SBRT for NSCLC: Conclusions

- Highly effective: local control rates $\geq 95\%$
- Low (sub)acute and late toxicity; no adverse impact on QoL
- Patient-friendly non-invasive technique
- Central lesions can be effectively treated with 5-8 fractions

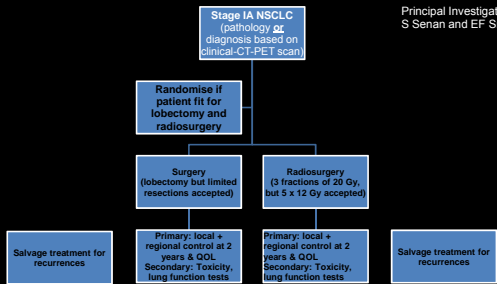
SBRT should be regarded the standard of care for medically inoperable patients with Stage I NSCLC

SBRT is currently being investigated in prospective randomized trials for medically operable patients (Stage IA)

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Randomized phase III trial of surgery versus radiosurgery in stage IA NSCLC



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