PET –
Nutzen und Indikation beim NSCLC

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Kostenerstattung in Europa

Europa im Vergleich: PET in der Onkologie

Wo und für welche Indikationen wird PET von den Gesetzlichen Krankenkassen im ambulanten Bereich bezahlt?

	B	NL	F	GB	I	DK	FIN	CH	E	PL	D
Lungenkarzinom [1)]	✓ D St Re	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kolorektales Karzinom	✓ Re	✓	✓	✓	✓	✓	✓	✓ Re	✓	✓	
Kopf-Hals-Tumor	✓ Re	✓	✓	✓	✓	✓	✓		✓	✓	
Lymphom	✓ St Re	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Melanom	✓ St Re	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Ösophaguskarzinom	✓ St	✓	✓	✓	✓	✓	✓		✓	✓	
Pankreaskarzinom	✓ D St Re	✓	✓	✓	✓	✓	✓			✓	
Ovarialkarzinom	✓ Re	✓	✓	✓	✓					✓	
Mammakarzinom		✓	✓	✓	✓	✓	✓	✓	✓	✓	
Hodenkarzinom		✓	✓	✓	✓			✓		✓	
Schilddrüsenkarzinom		✓	✓	✓	✓	✓	✓			✓	
Hirntumoren	✓ Re	✓	✓	✓	✓	✓	✓	✓		✓	
Unbek. Primärtumor		✓	✓	✓	✓	✓	✓		✓	✓	

✓ PET wird vergütet (Von GKV akzept. Indikation)

✓ PET ist Standarduntersuchung!

✓ Priorität bei Bewertung von Effektivität und Outcome

✓ Akzeptierte Indikation

✓ Akzeptierte, aber selten nachgefragte Indikation

1) Nicht kleinzelliges Bronchialkarzinom

D Diagnose benigne/maligne

St Prätherapeutisches Staging

Re Nachweis eines Rezidives oder Restaging

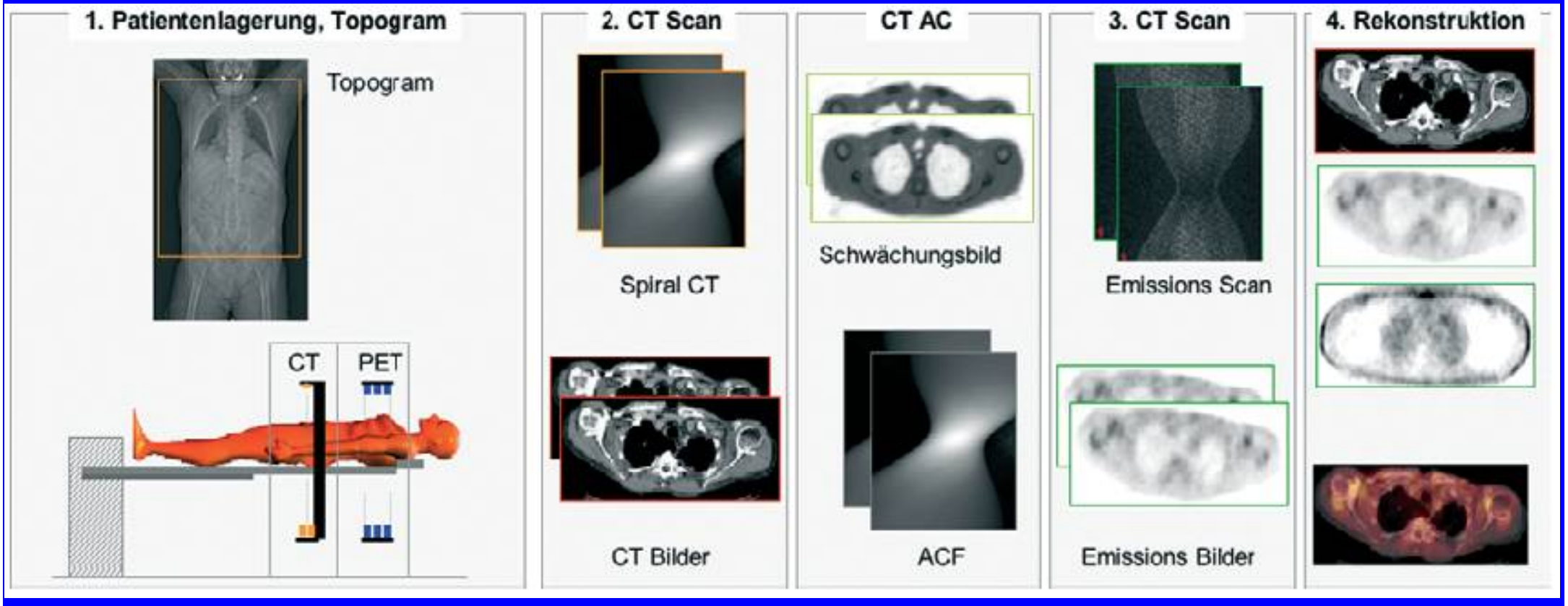
Entwicklungsland
PET nur für Privatpatienten

„Nr. 14 Positronen-Emissions-Tomographie (PET)

§ 1 Zugelassene Indikationen

Die PET darf für die folgenden Indikationen bei Vorliegen der Voraussetzungen nach §§ 2, 3 zulasten der gesetzlichen Krankenversicherung als vertragsärztliche Leistung erbracht werden:

1. Bestimmung des Tumorstadiums von primären nicht kleinzelligen Lungenkarzinomen einschließlich der Detektion von Fernmetastasen
2. Nachweis von Rezidiven (bei begründetem Verdacht) bei primären nicht kleinzelligen Lungenkarzinomen
3. Charakterisierung von Lungenrundherden, insbesondere Beurteilung der Dignität peripherer Lungenrundherde bei Patienten mit erhöhtem Operationsrisiko und wenn eine Diagnosestellung mittels einer invasiven Methodik nicht möglich ist.


1. Patientenlagerung, Topogram
Topogram
CT
PET
2. CT Scan
Spiral CT
CT Bilder
CT AC
Schwächungsbild
ACF
3. CT Scan
Emissions Scan
Emissions Bilder
4. Rekonstruktion

Vorteile PET/CT

- Logistik: one stop shop
- Identische Positionierung
- Reduzierte Bewegungsartefakte
- CT-Daten auch zur Schwächungskorrektur für PET
- CT-Daten auch zur Bestrahlungsplanung (inkl. funktioneller PET-Information) bei entsprechender Lagerung
- Interdisziplinäre Befundung (erhöhte Kompetenz)

PET beim Lungenkarzinom

- Artdiagnose des unklaren Lungenrundherdes
- Staging eines bekannten NSCLC vor Operation oder kurativer Bestrahlung (N, M)
- Therapie-Monitoring bei neo-adjuvanter Chemotherapie (Prognose)
- Verbesserung der Bestrahlungsplanung (Zielvolumen-Definition, Dosis-Eskalation)
- Rezidiv-Diagnostik

JAMA. 2001;285:914-924

Accuracy of Positron Emission Tomography for Diagnosis of Pulmonary Nodules and Mass Lesions

A Meta-analysis

Michael K. Gould, MD, MS
Courtney C. Maclean, BA
Ware G. Kuschner, MD
Chara E. Rydzak, BA
Douglas K. Owens, MD, MS

Context Focal pulmonary lesions are commonly encountered in clinical practice, and positron emission tomography (PET) with the glucose analog 18-fluorodeoxyglucose (FDG) may be an accurate test for identifying malignant lesions.

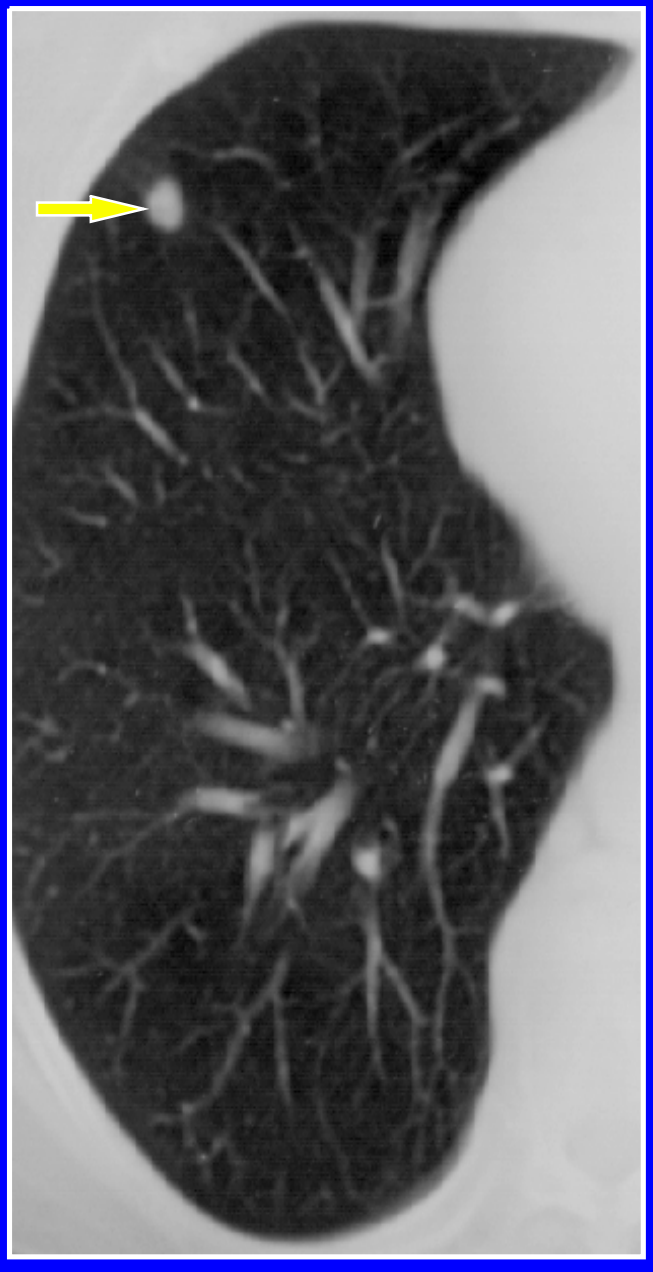
Objective To estimate the diagnostic accuracy of FDG-PET for malignant focal pulmonary lesions.

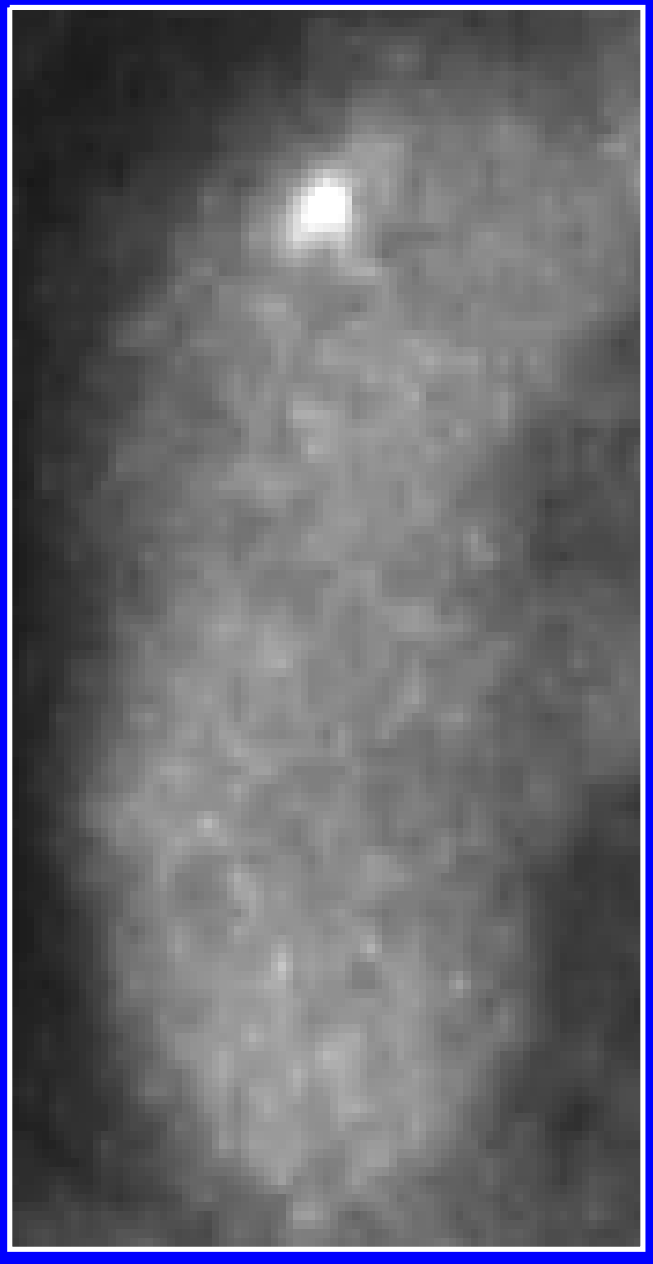
Data Sources Studies published between January 1966 and September 2000 in the MEDLINE and CANCERLIT databases; reference lists of identified studies; abstracts from recent conference proceedings; and direct contact with investigators.

Study Selection Studies that examined FDG-PET or FDG with a modified gamma camera in coincidence mode for diagnosis of focal pulmonary lesions; enrolled at least

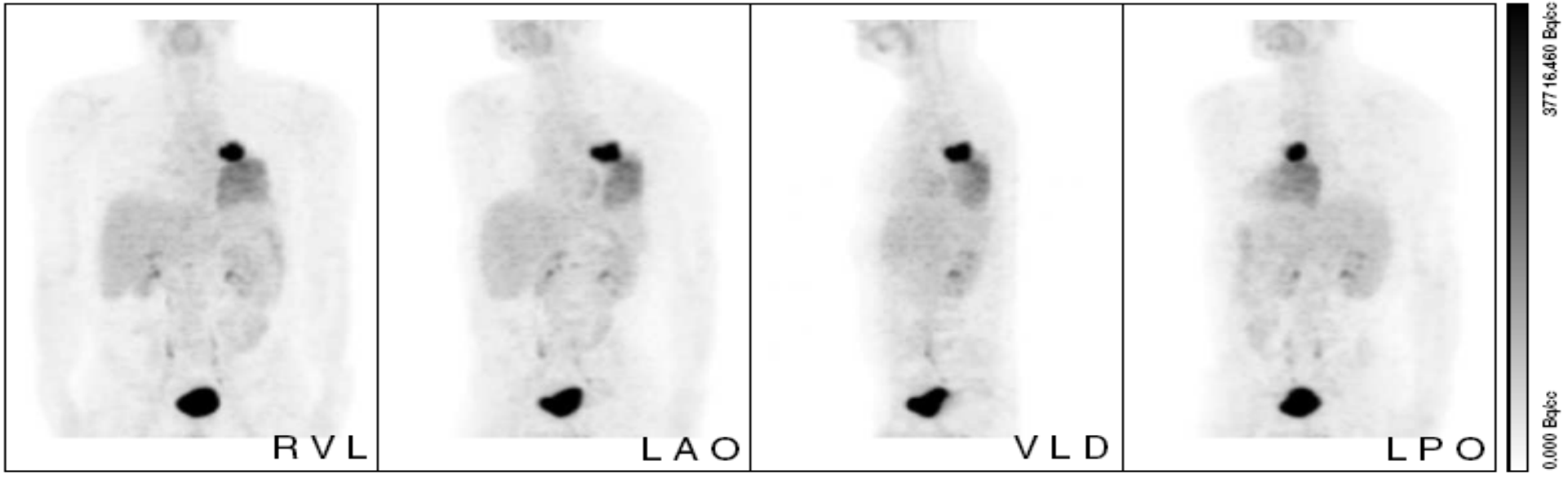
For 1474 focal pulmonary lesions of any size, the maximum joint sensitivity and specificity (the upper left point on the receiver operating characteristic curve at which sensitivity and specificity are equal) of FDG-PET was 91.2% (95% confidence interval, 89.1%-92.9%). In current practice, FDG-PET operates at a point on the summary receiver operating characteristic curve that corresponds approximately to a sensitivity and specificity of 96.8% and 77.8%, respectively. There was no difference in diag-

FOCAL PULMONARY LESIONS ARE commonly encountered in clinical practice. Such lesions may be classified as nodules or masses,



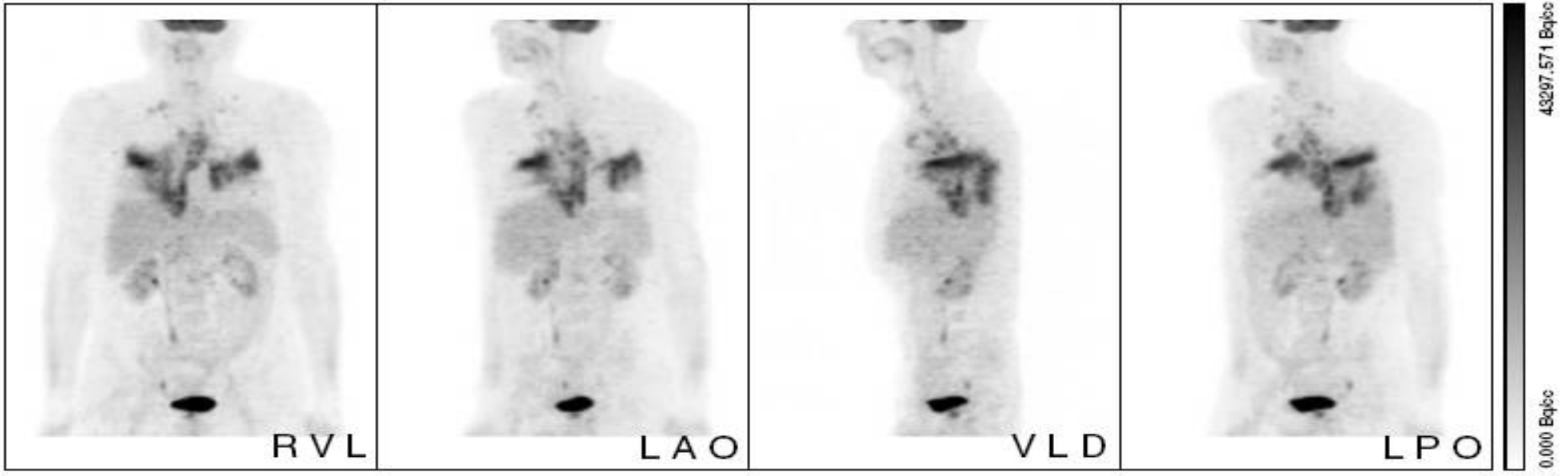


Fall 2



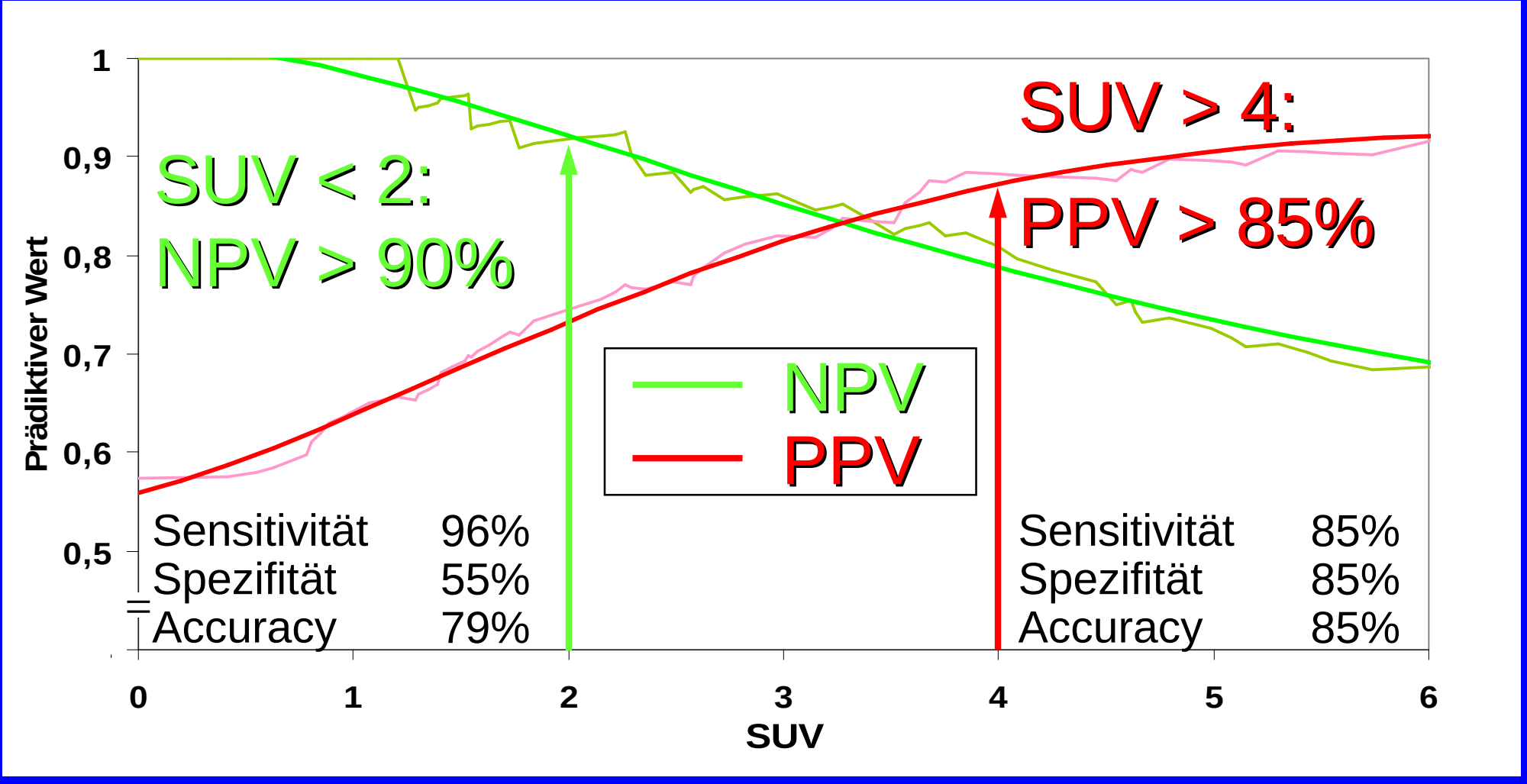
Patient, 56 Jahre, NSCLC

Fall 5

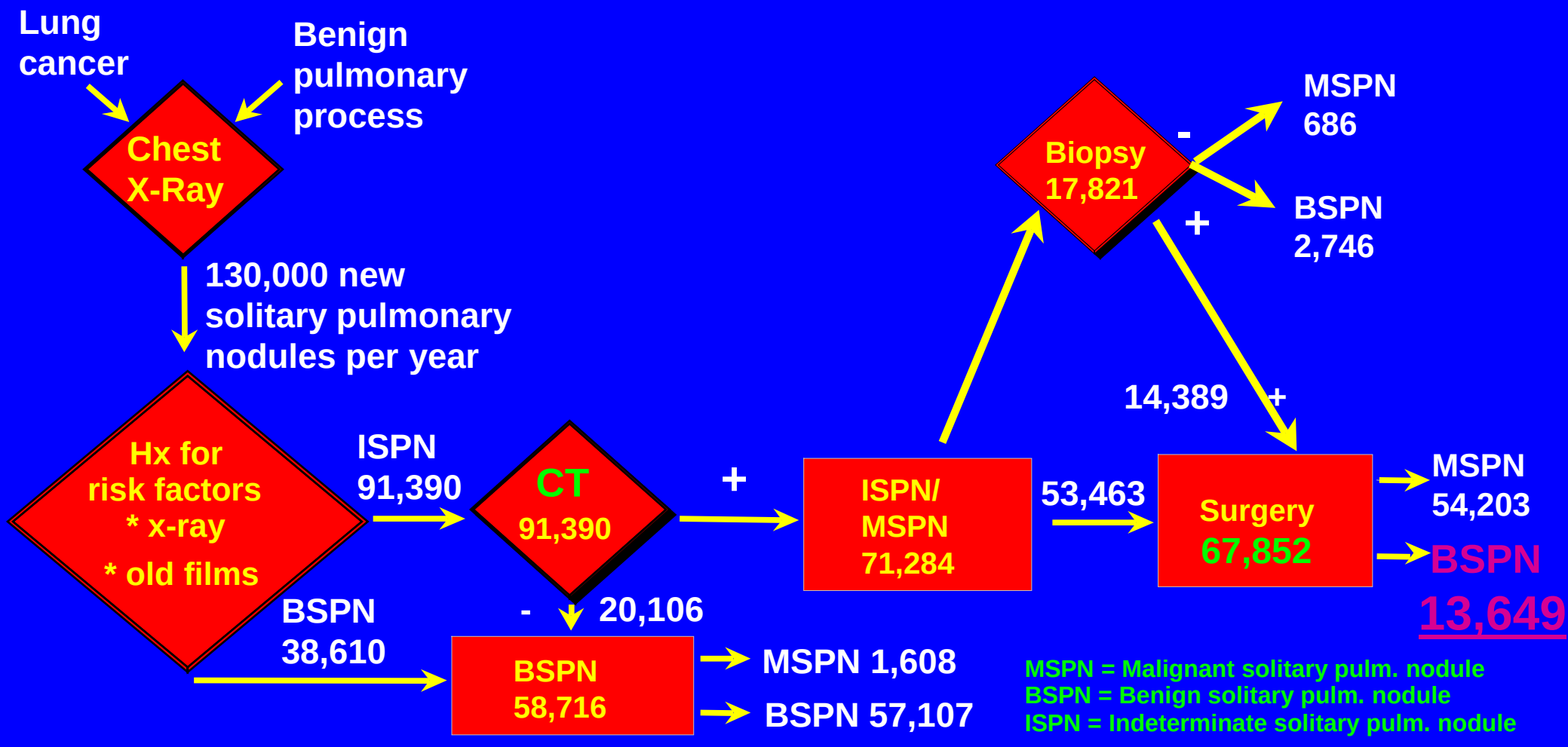


Patient, 64 Jahre, Sarkoidose

SUV im SPN: Prädiktive Werte



Solitary Pulmonary Nodules: Conventional Algorithm



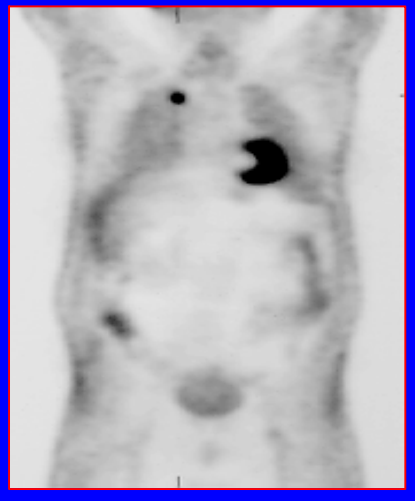
Solitary Pulmonary Nodules: Prospective PET Algorithm

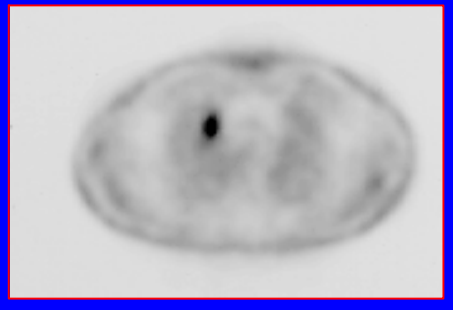
Lung cancer

Benign pulmonary process

Chest X-Ray

130,000 new solitary pulmonary nodules per year





Hx for risk factors
* x-ray
* old films

ISPN 91,390

PET 91,390

\+

ISPN/ MSPN 57,726

Surgery 57,726

MSPN 54,237

BSPN 3,489

\- 33,664

BSPN 38,610

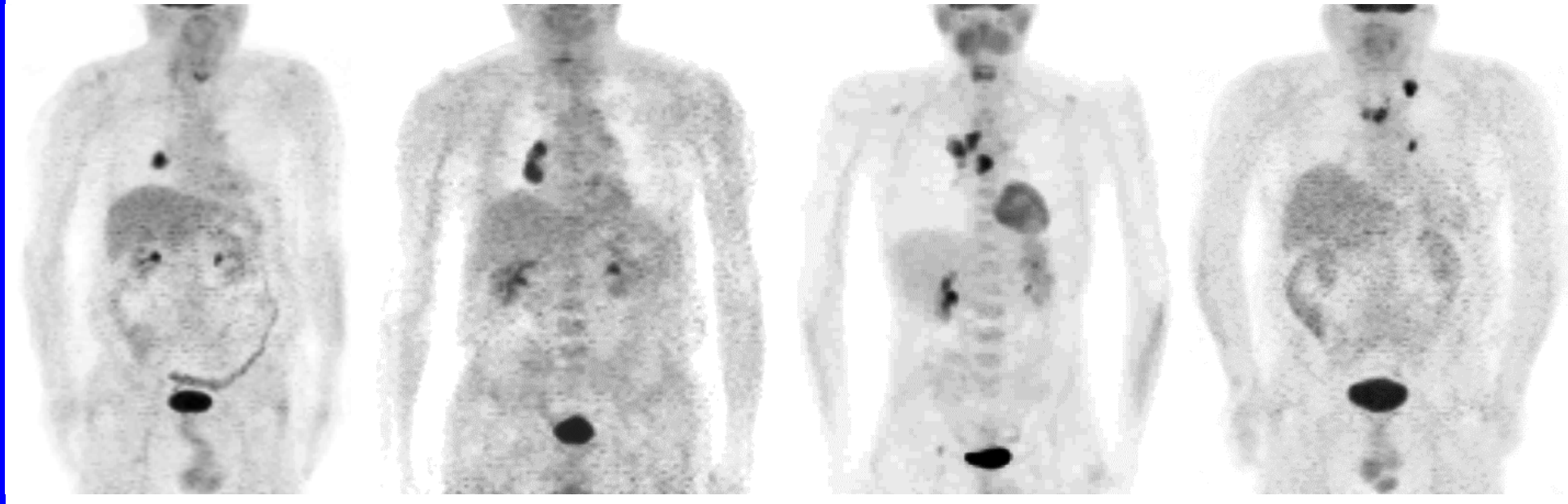
BSPN 72,274

MSPN 2,260

BSPN 70,014

MSPN = Malignant solitary pulm. nodule
BSPN = Benign solitary pulm. nodule
ISPN = Indeterminate solitary pulm. nodule

N-Staging mit FDG-PET



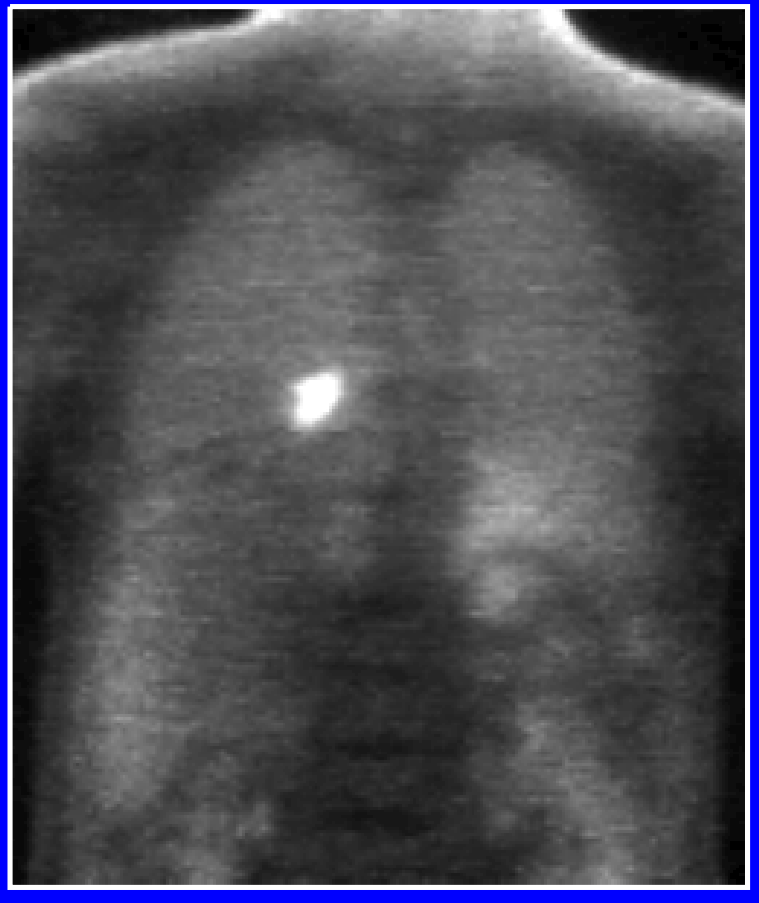
N0 N1 N2 N3

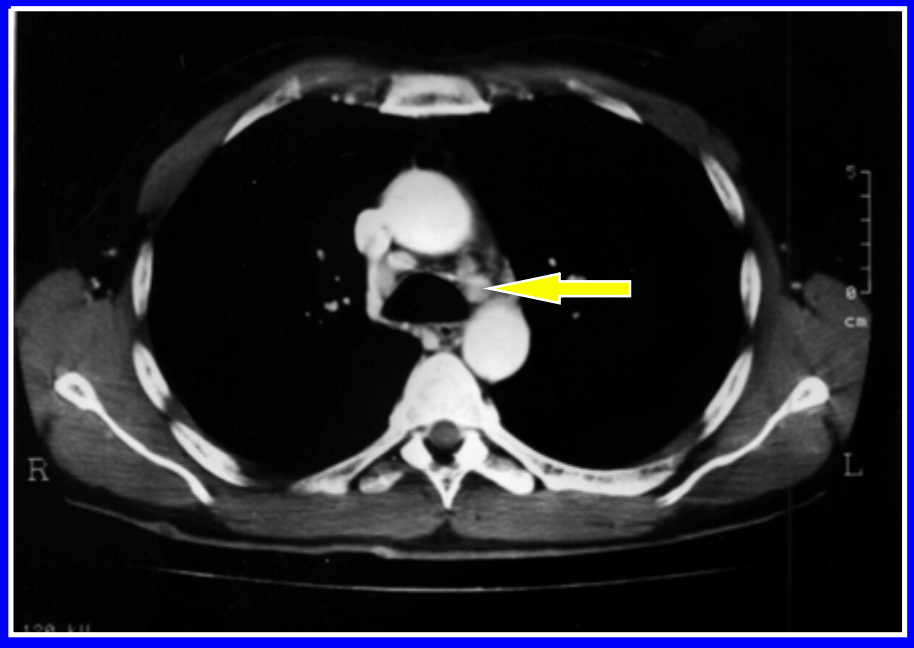
BC re. Unterlappen

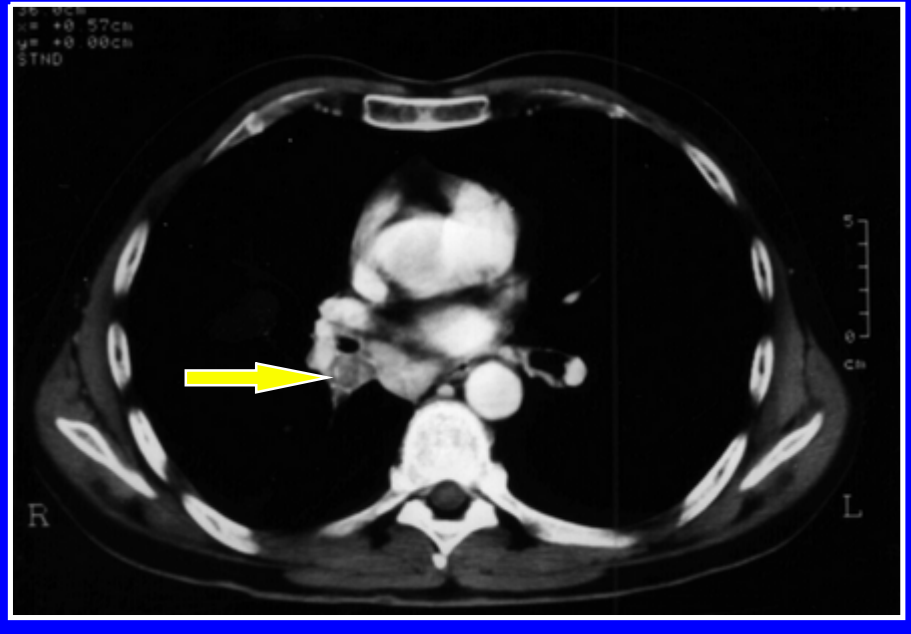
CT: N2 (N3)

FDG-PET: N0

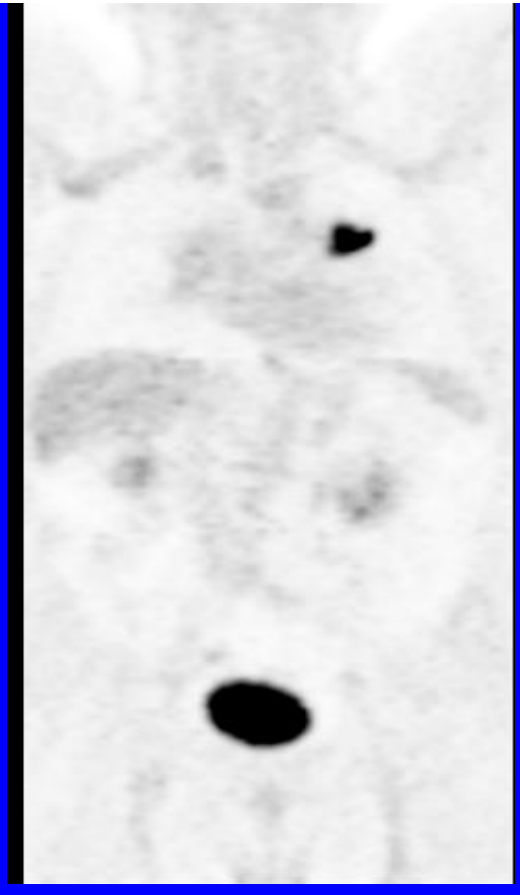
Histologie: N0

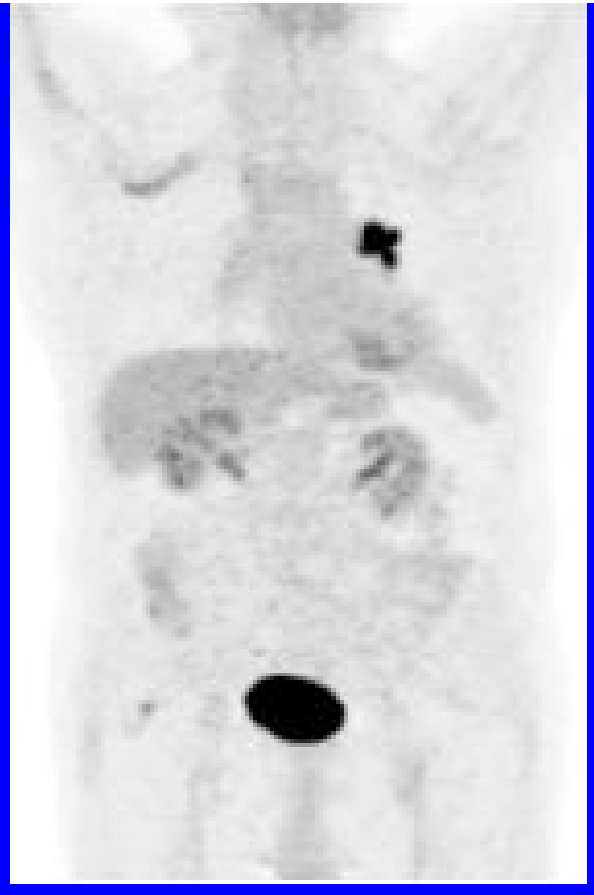


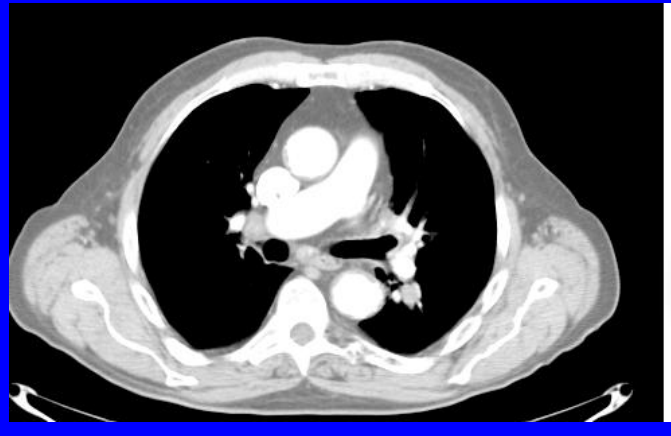


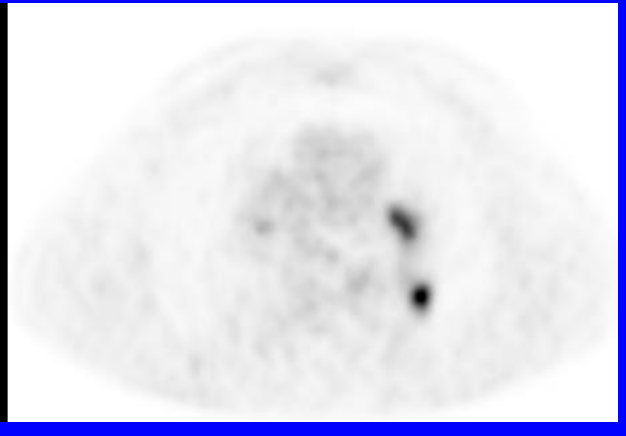


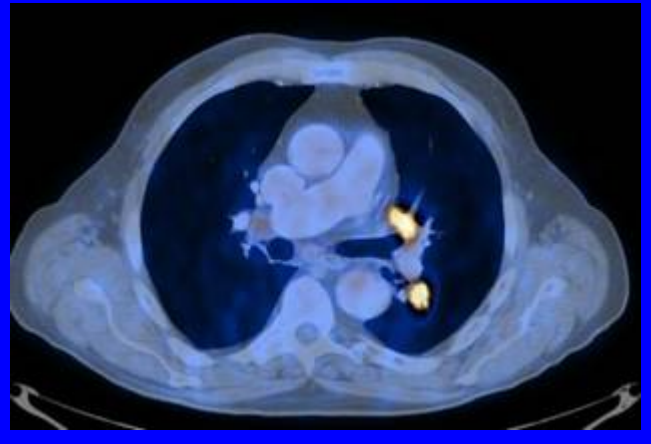
NSCLC 7/02
Preoperatives
Staging
pT2N1M0





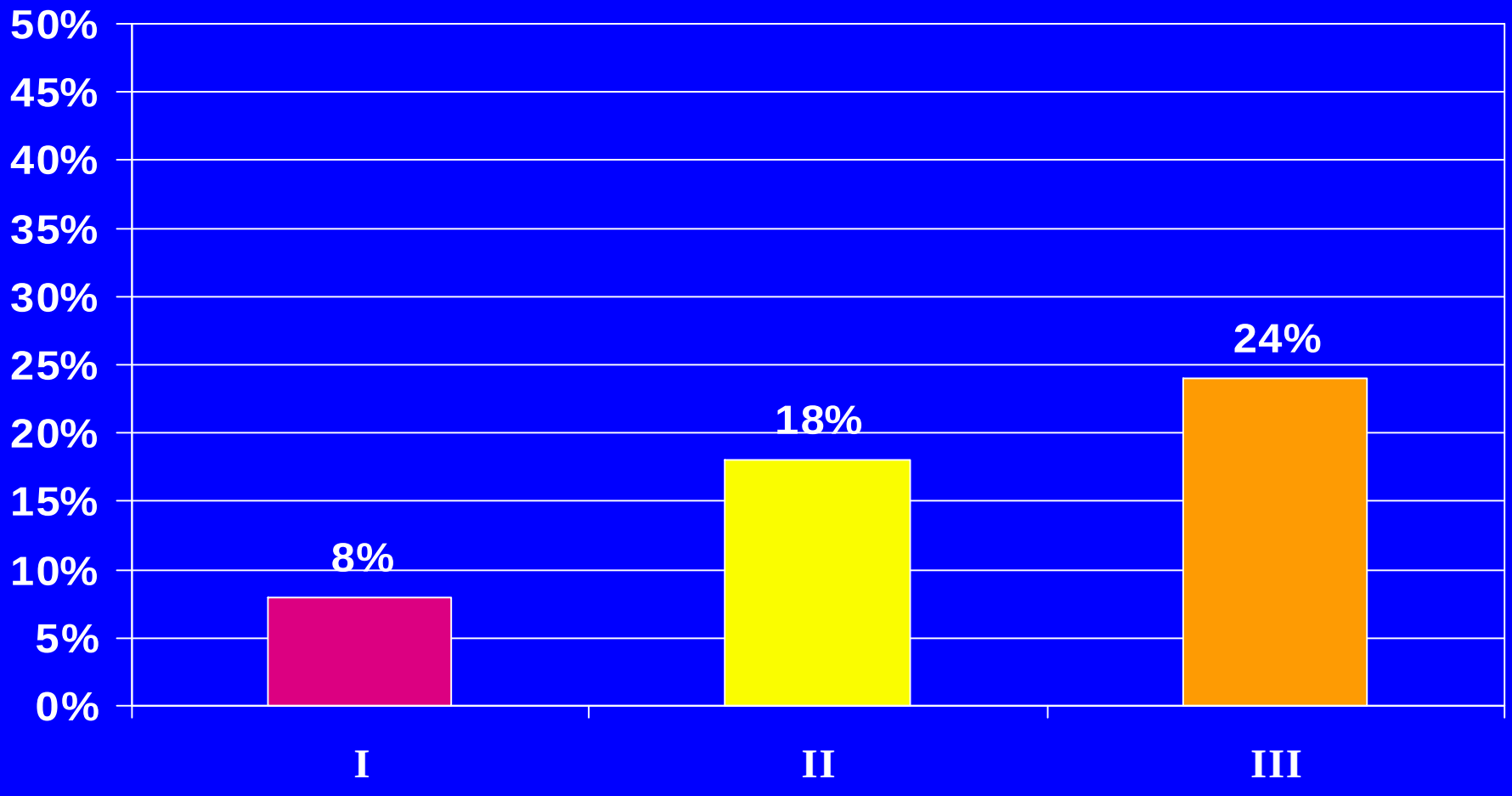






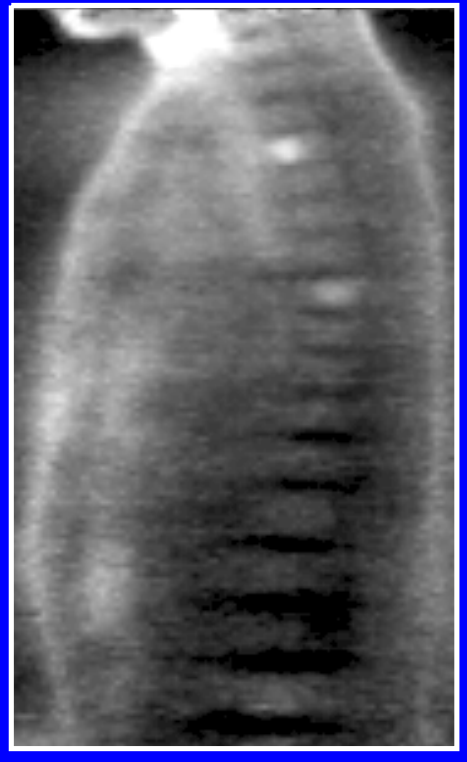
Pat. HS,
männlich
67 Jahre
BCA T2N0M0
konsekutive
Atelektase

FDG-PET: M1
nach konventionellem M0-Staging

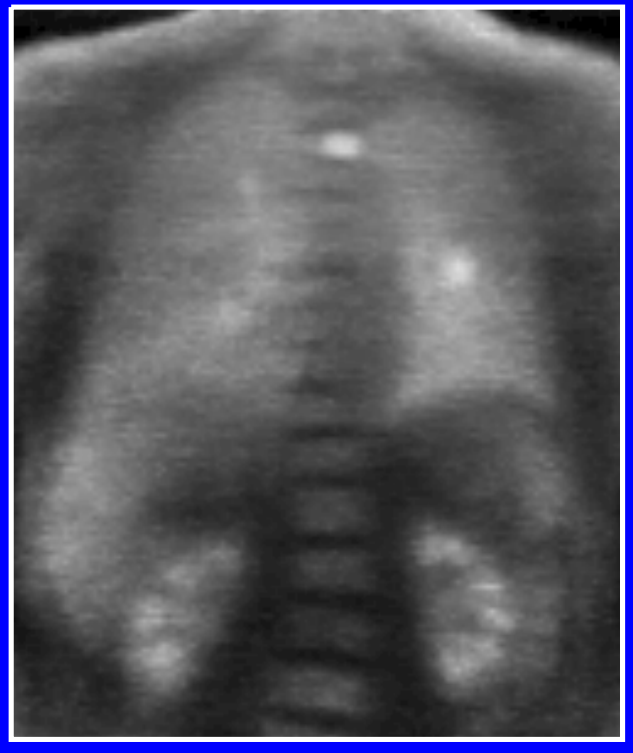


MacManus Int J Radiat Oncol Biol Phys 2001

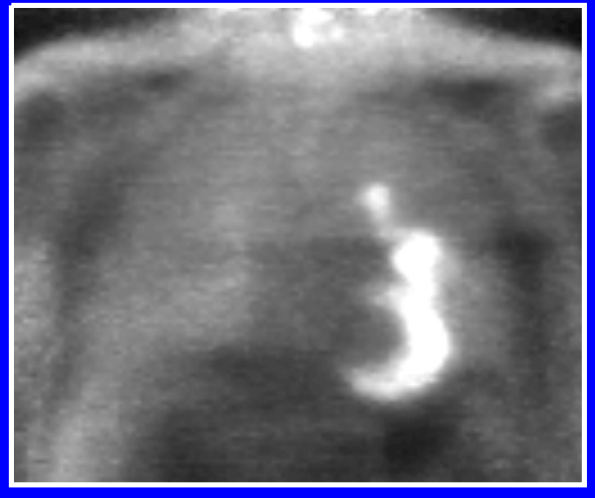
BC li. OL mit vorher nicht bekannten ossären Metastasen (N1 M1)



sagittal

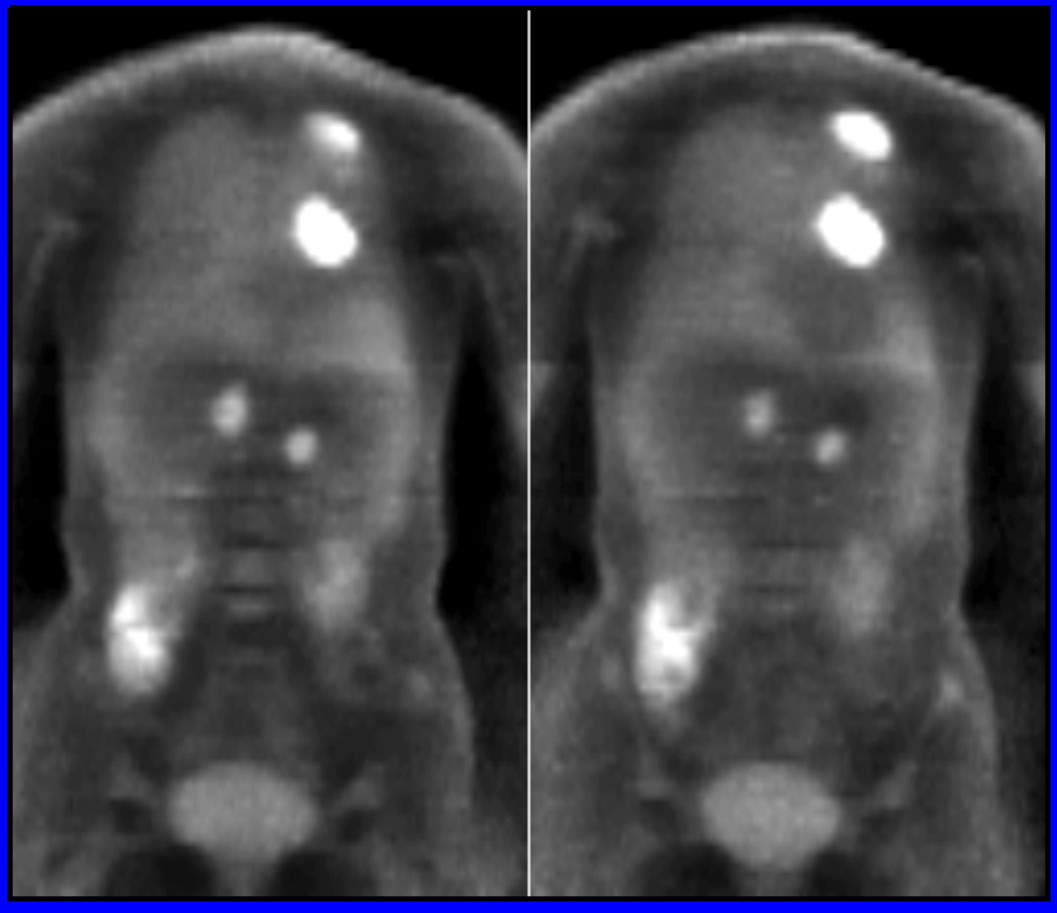


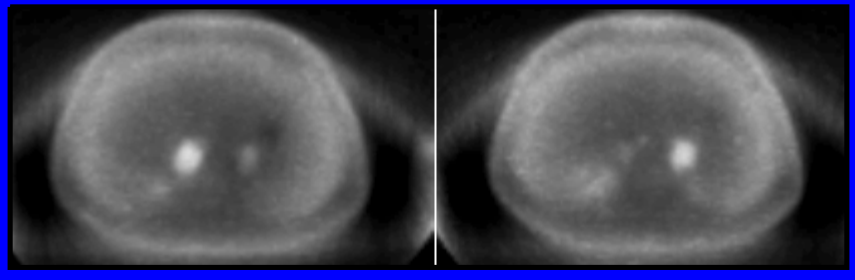
coronal (dorsal)

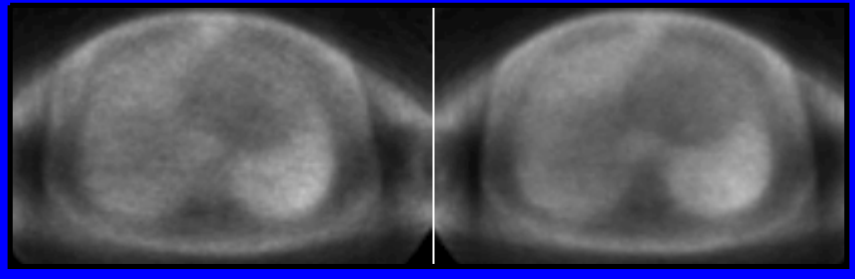


coronal (ventral)

Bronchial-Karzinom mit Nebennierenmetastasen bds.





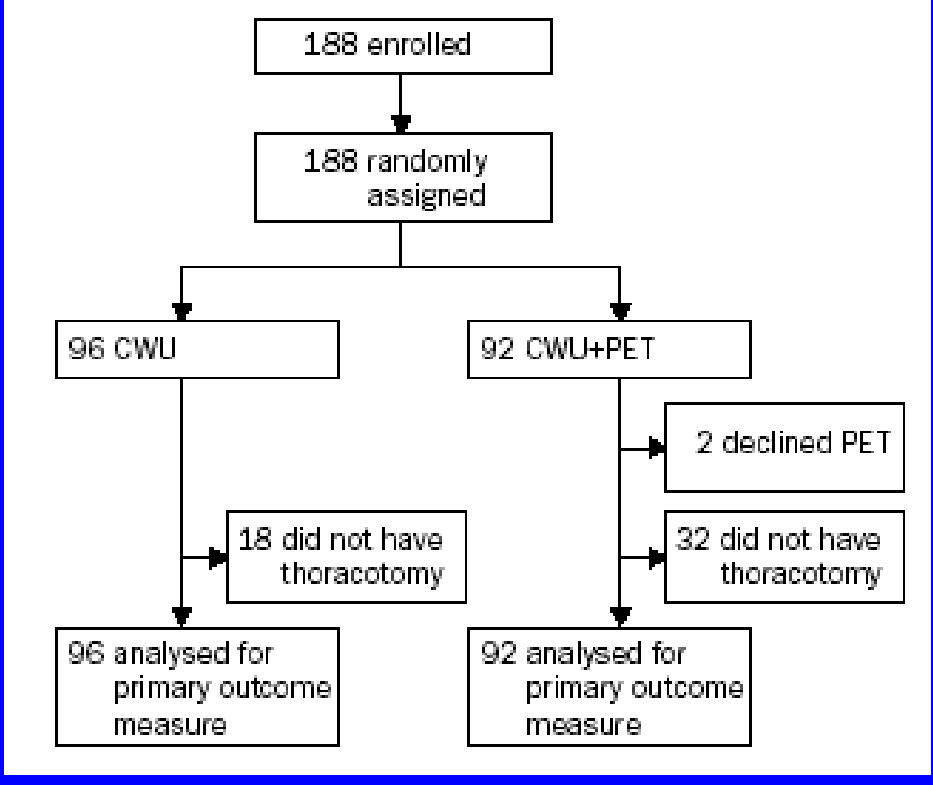


Änderungen in der Therapie durch FDG-PET im Primärstaging des NSCLC

Autor	Jahr	n	Prozentuale Änderungen NM-Staging mit FDG-PET
Knopp	1992	49	33% (16/49)
Lewis	1994	34	41% (14/34)
Baum	1995	19	32% (6/19)
Valk	1995	57	51% (29/57)
Bury	1996	61	31% (19/61)
Guhlmann	1997	32	28% (9/32)
Summe		*252*	*37% (93/252)*

Effectiveness of positron emission tomography in the preoperative assessment of patients with suspected non-small-cell lung cancer: the PLUS multicentre randomised trial

*Harm van Tinteren, Otto S Hoekstra, Egbert F Smit, Jan H A M van den Bergh, Ad J M Schreurs, Roland A L M Stallaert, Piet C M van Velthoven, Emile F I Comans, Fred W Diepenhorst, Paul Verboom, Johan C van Mourik, Pieter E Postmus, Maarten Boers, Gerrit J J Teule, and the PLUS study group**



	CWU (n=96)	CWU+PET (n=92)
Characteristic		
Age (years, mean [SD])	65 (10)	66 (10)
Sex		
Men	75 (78%)	69 (75%)
Women	21 (22%)	23 (25%)
Karnofsky index		
70–80	6 (6%)	10 (11%)
90–100	90 (94%)	82 (89%)
Weight loss >5%	15 (16%)	14 (15%)
Clinical stage		
I	63 (66%)	58 (63%)
II	5 (5%)	6 (7%)
IIIA	22 (23%)	23 (25%)
IIIB	6 (6%)	4 (4%)
IV*		1 (1%)
Comorbidity		
Vascular, diabetes mellitus	31 (32%)	30 (33%)
Chronic obstructive pulmonary disease	30 (31%)	23 (25%)
Previous malignancies	13 (14%)	17 (19%)
Definite diagnosis of non-small-cell lung cancer	46 (48%)	48 (52%)
Pre-randomisation imaging tests (CT of the thorax excluded)	56 (58%)	54 (59%)
Bone scan	26 (27%)	25 (27%)
CT/US of the abdomen	46 (48%)	42 (46%)
CT/MRI of the brain	3 (3%)	5 (5%)
CT/MRI of other area	1 (1%)	5 (5%)
Radiograph of other area	7 (7%)	10 (11%)

Data are number of patients (%) unless otherwise stated. CT=computed tomography; US=ultrasound; MRI=magnetic resonance imaging. *Solitary brain metastasis on CT.

	CWU (n=96)	CWU+PET (n=92)
No thoracotomy	18 (19%)	32 (35%)
Confirmed N2/3	10	18
Confirmed distant metastases	1	7
Benign primary lesions	2	3
Other tumour	2	1
Intercurrent morbidity, refusal	3	3
Thoracotomy	78 (81%)	60 (65%)
Non-futile thoracotomy	39 (41%)	41 (44%)
Futile thoracotomy	39 (41%)	19 (21%)
Benign	7	2
Explorative thoracotomy	1	1
IIIA–N2	6	4
IIIB	6	2
Recurrence or death within 1 year	19	10

Table 2: **Specification of primary outcome**

Cost-effectiveness of FDG-PET in staging non-small cell lung cancer: the PLUS study.

Verboom P, van Tinteren H, Hoekstra OS, et al.
Eur J Nucl Med Mol Imaging (2003) 30:1444-9

CWU: 9573 € per patient
CWU + PET: 8284 € per patient
The major cost driver was the number of hospital days related to recovery from surgery.

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

The value of positron emission tomography in patients with non-small cell lung cancer

Frank Kee [a,*], Sara Erridge [b], Ian Bradbury [c], Karen Cairns [d]

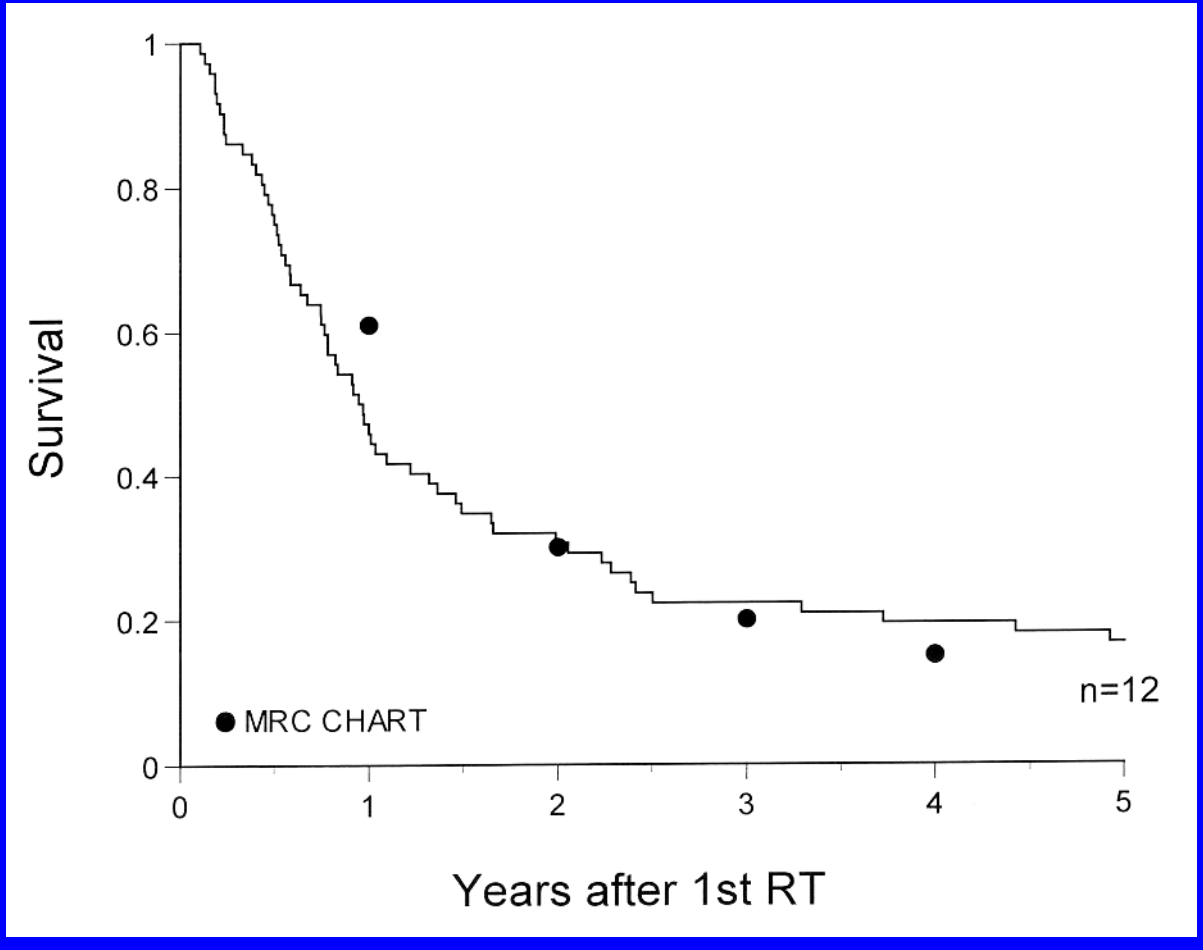
Results: The model confirmed the apparent cost-effectiveness of FDG-PET and indicated that the EVPI associated with the utility of futile thoracotomy considerably exceeds that associated with measures of accuracy.

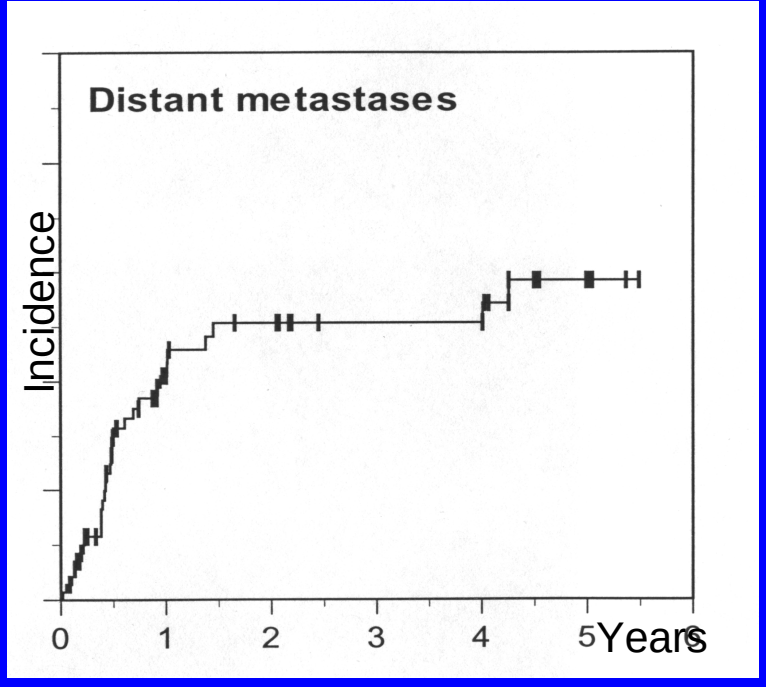
Conclusion: The study highlights the importance of patient related utilities in assessing the cost-effectiveness of diagnostic technologies. In the specific case of PET for pre-operative staging of NSCLC, future research effort should focus on such elicitation, rather than further refinement of accuracy estimates.

EVPI: expected value of perfect information

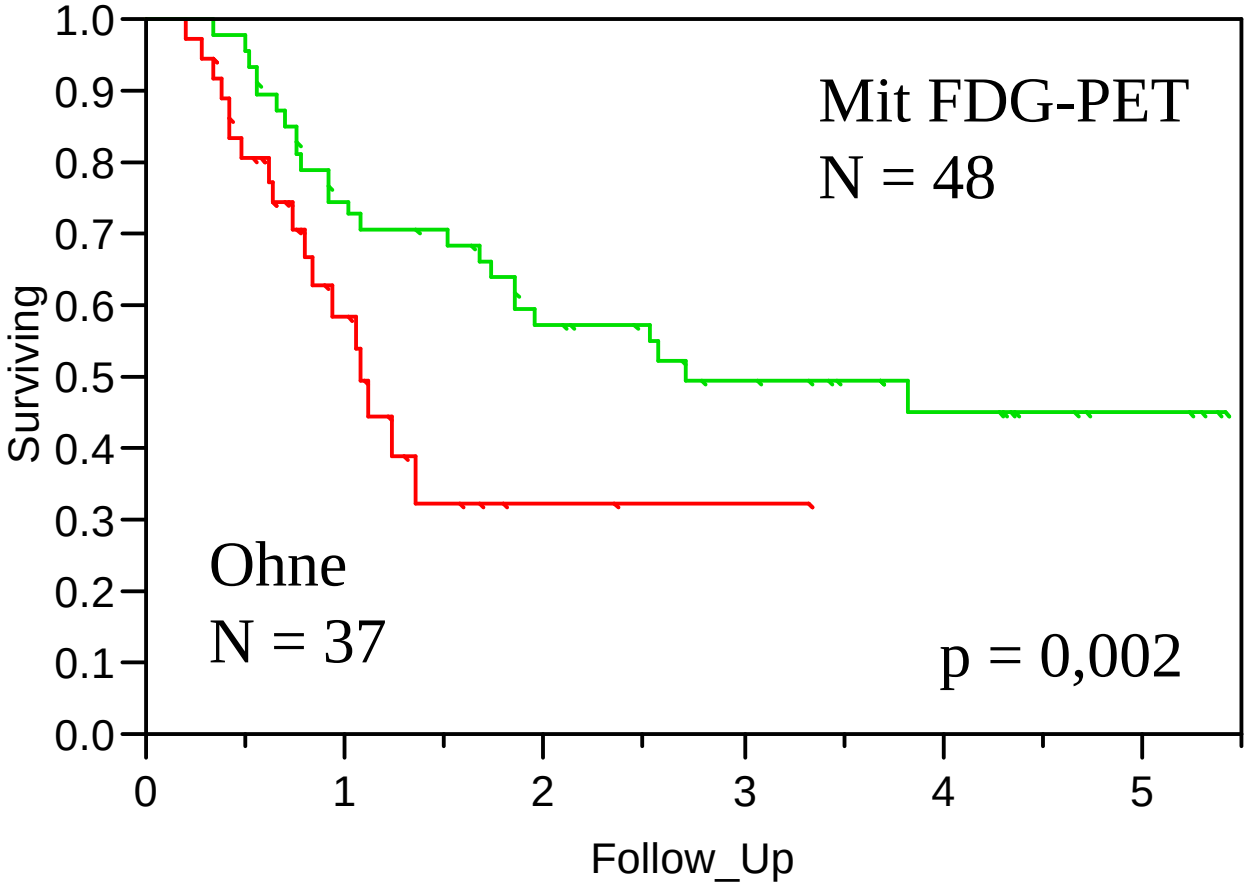
Fazit: der jüngere Pat. profitiert mehr vom PET als der ältere.

CHARTWEL-Bronchus Phase I/II





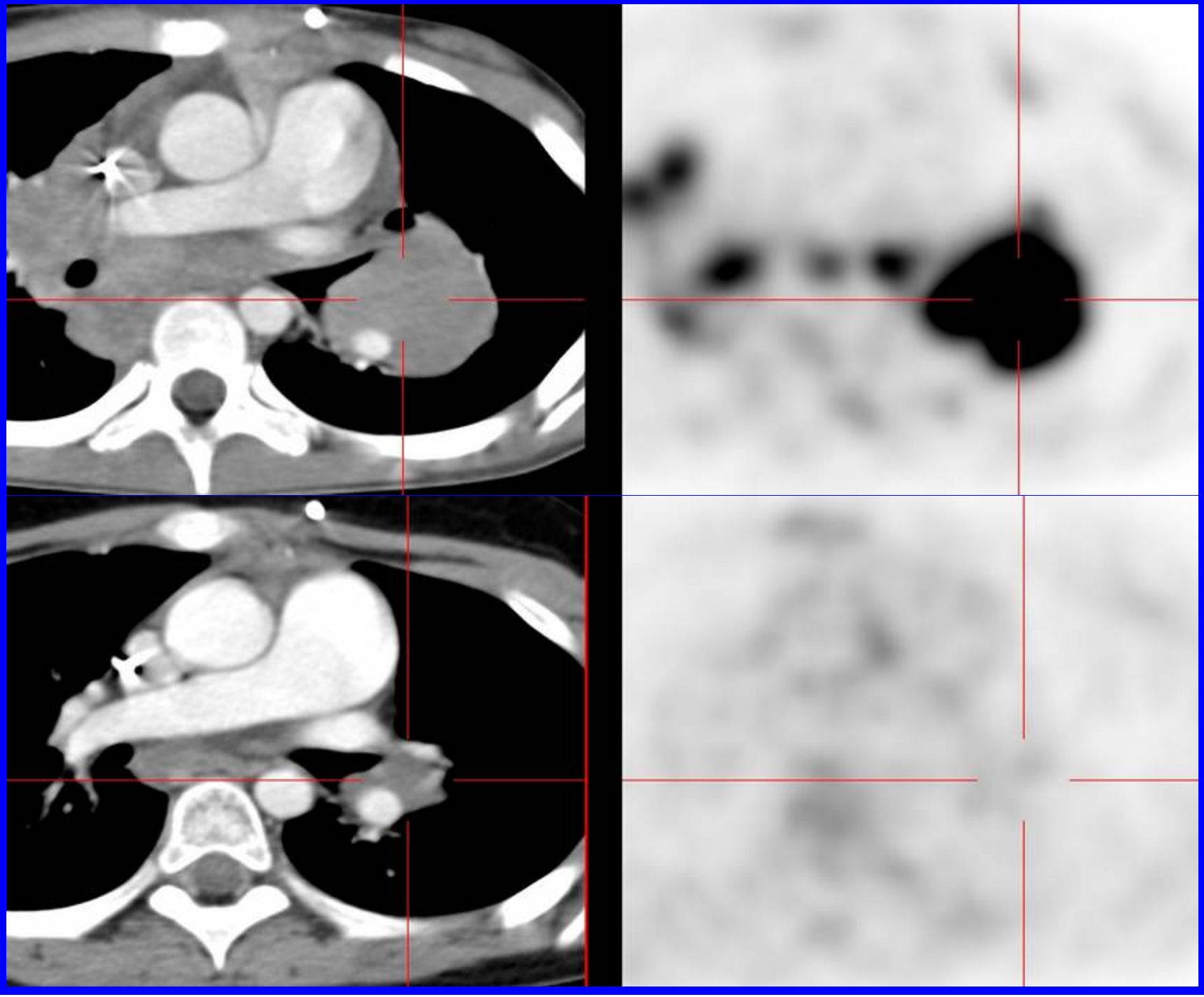
Adjuvante Radiochemotherapie und kurative Operation beim NSCLC Stadium III



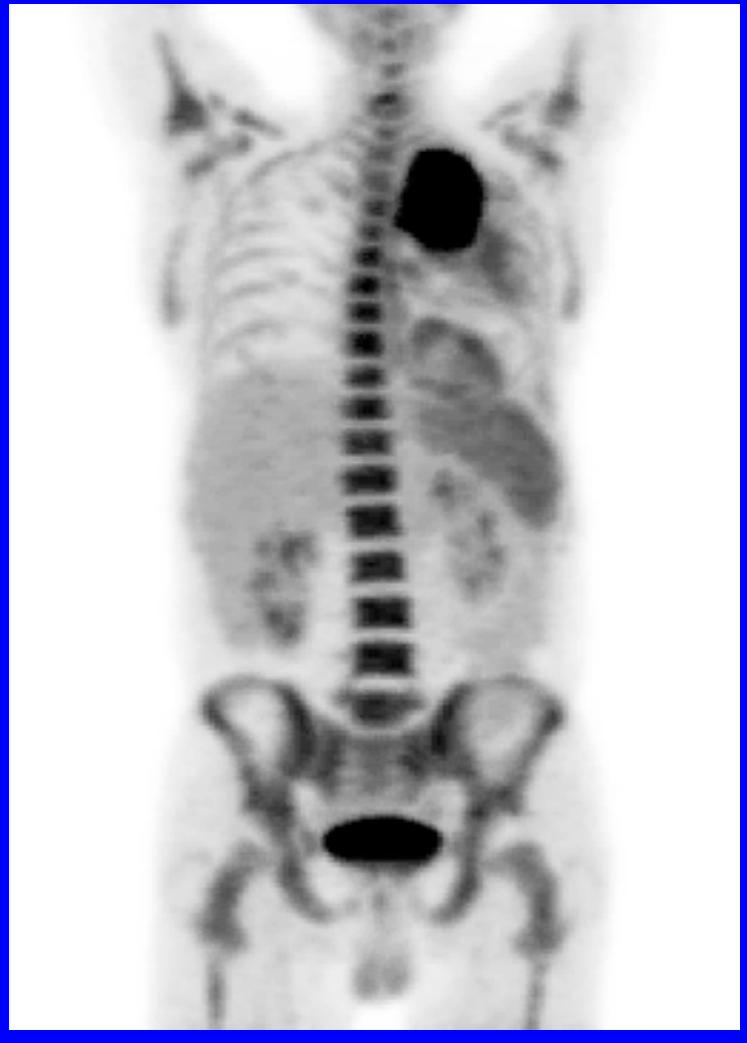
Therapie-Monitoring

Abnahme der FDG-Speicherung ist Ausdruck abnehmender Tumor-Vitalität / -Zellzahl

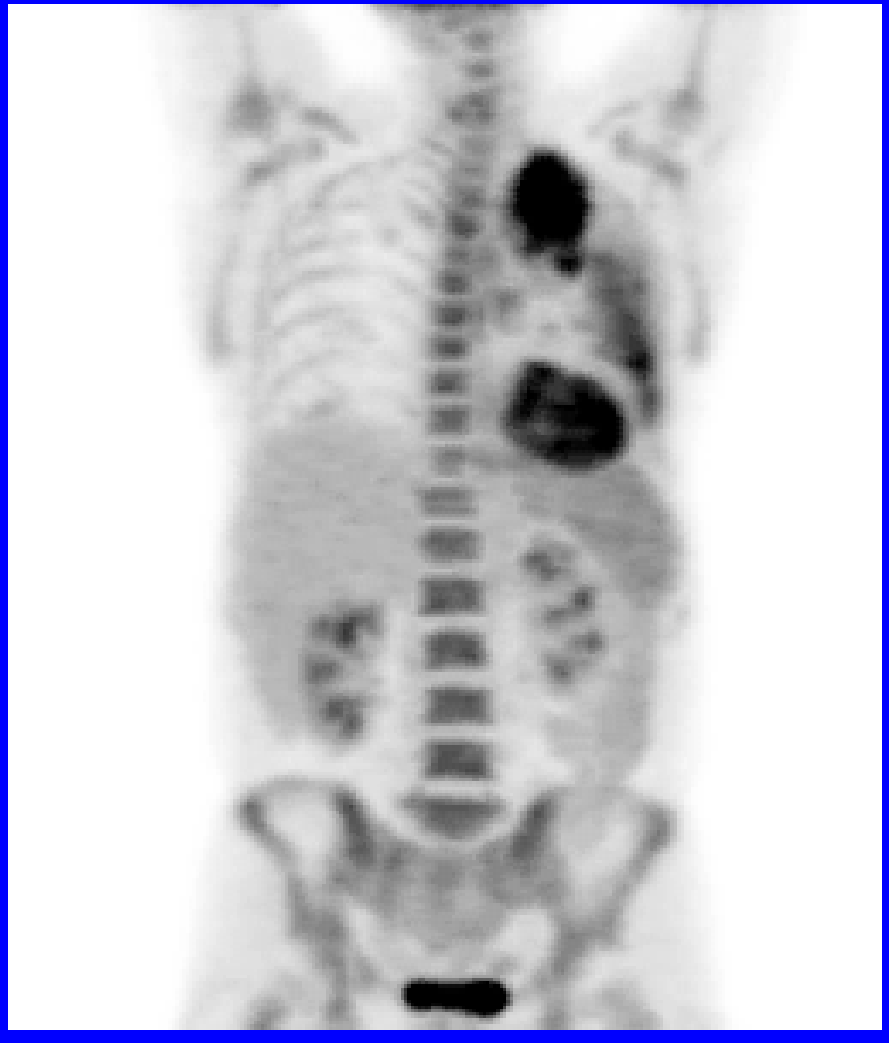
- Lymphom
- Bronchial-Karzinom
- Mamma-Karzinom
- Oesophagus-Karzinom
- GIST
- Kolorektale Lebermetastasen



Metabolischer Non-Responder



vor Therapie

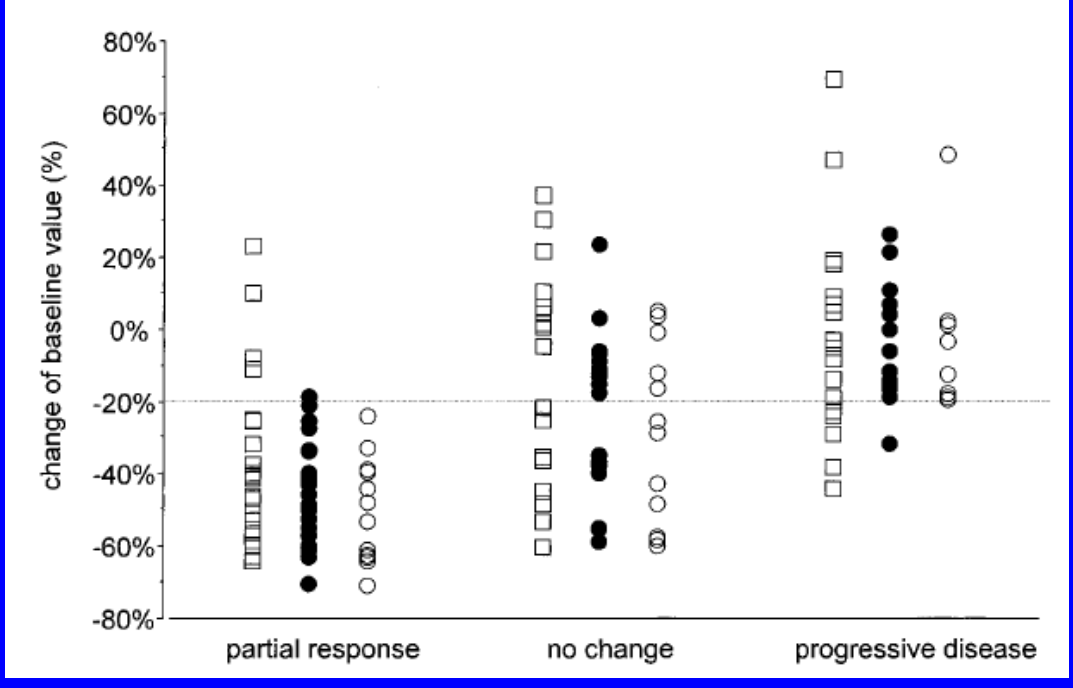


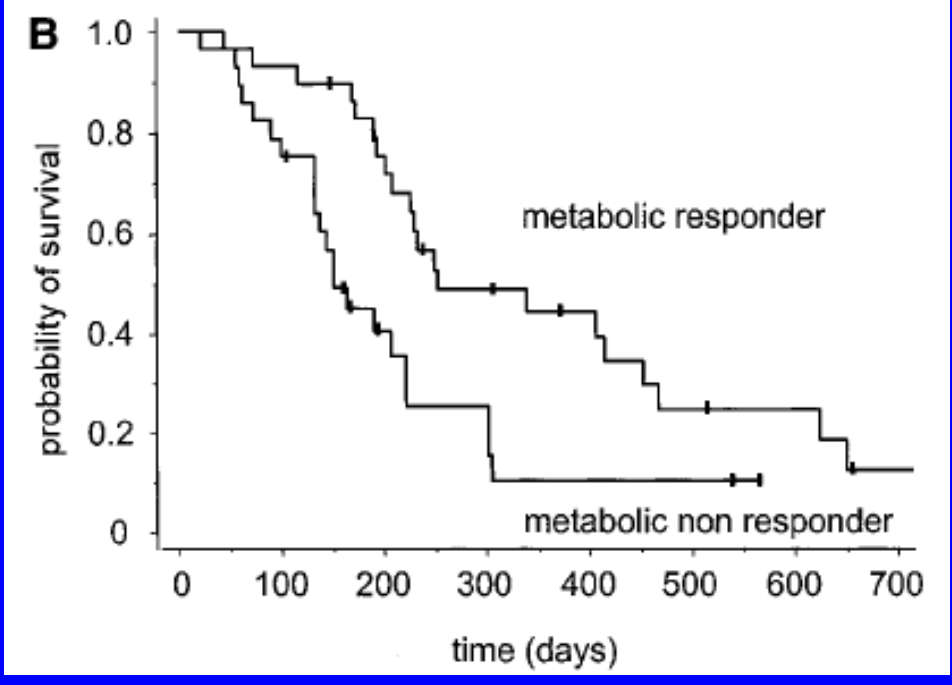
nach Therapie

Positron Emission Tomography in Non–Small-Cell Lung Cancer: Prediction of Response to Chemotherapy by Quantitative Assessment of Glucose Use

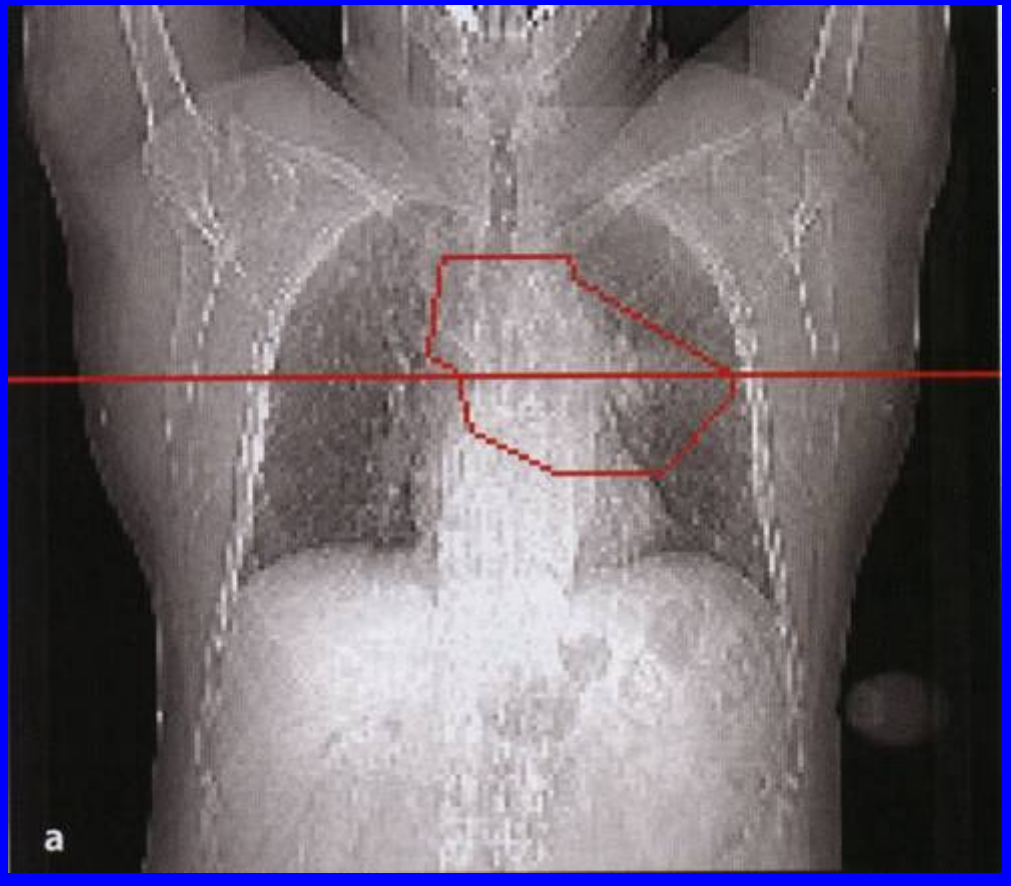
By Wolfgang A. Weber, Volker Petersen, Burkhard Schmidt, Leishia Tyndale-Hines, Thomas Link, Christian Peschel, and Markus Schwaiger

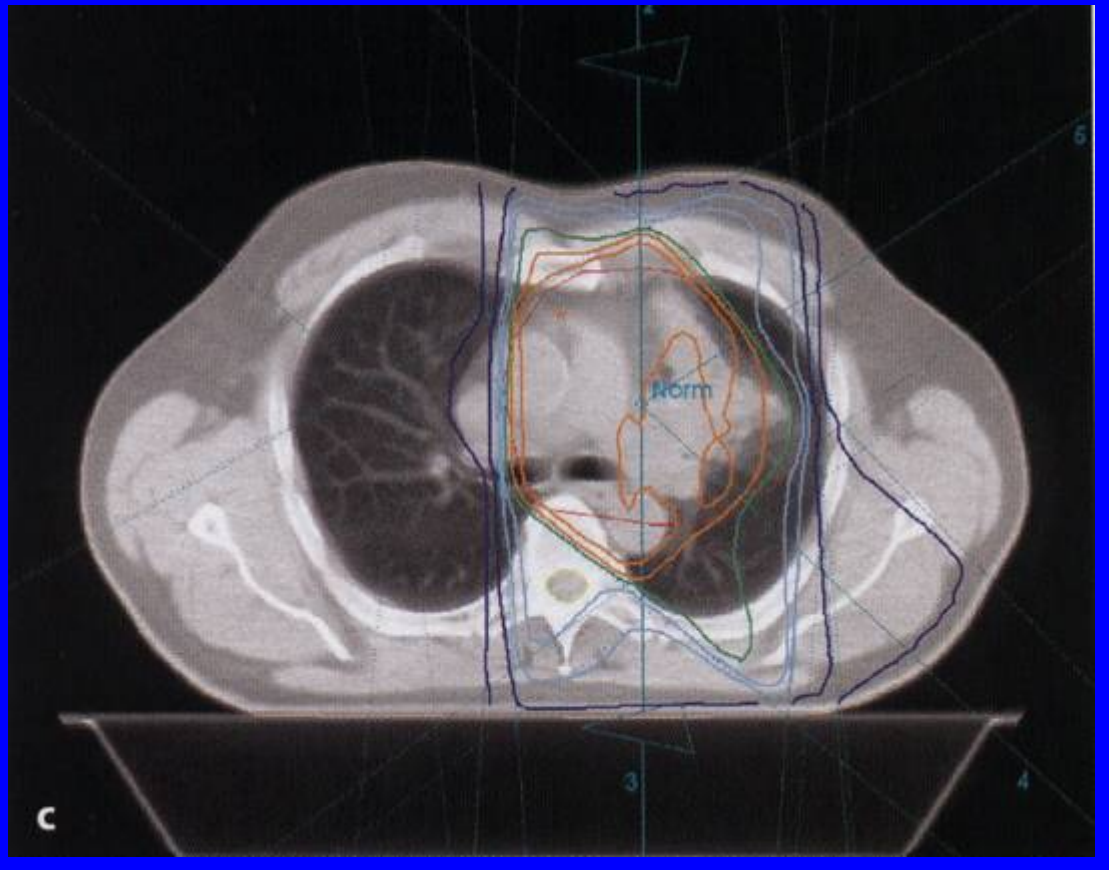
N 57 Pat., FDG vor und nach dem ersten Zyklus (Tag 21)





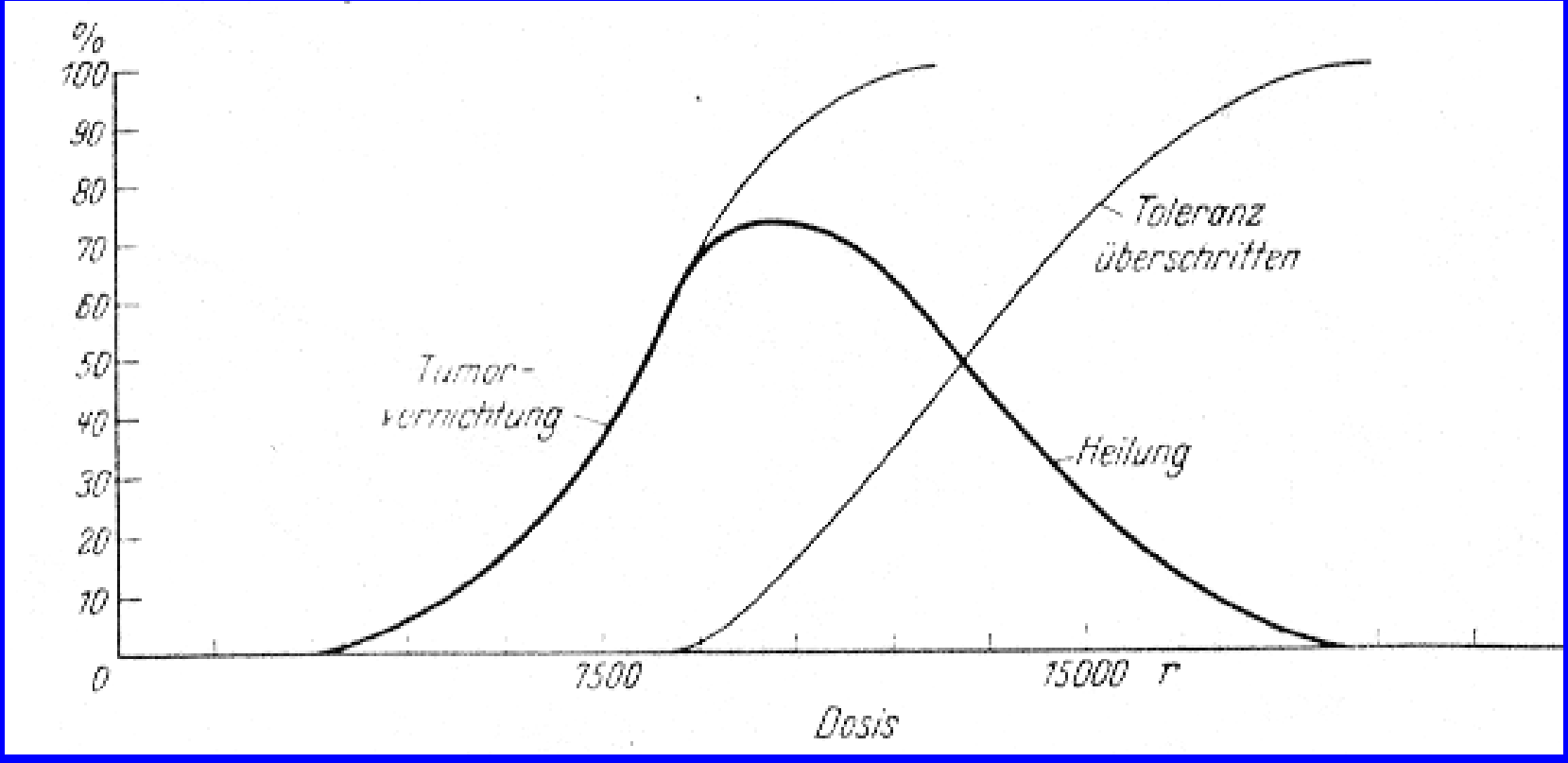
Derzeitiger Standard: 3D-CRT





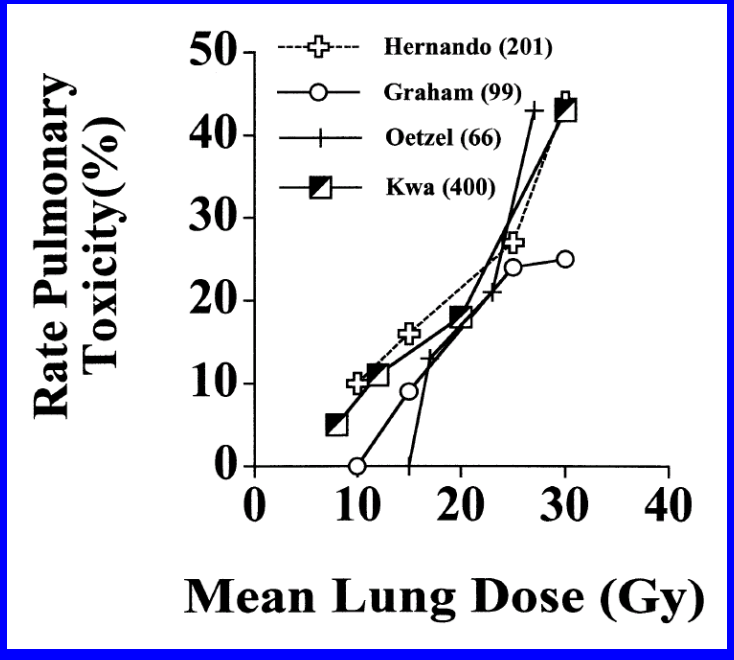
Baumann, Flentje, Drings, *Der Onkologe* 8: 448-461, 2002

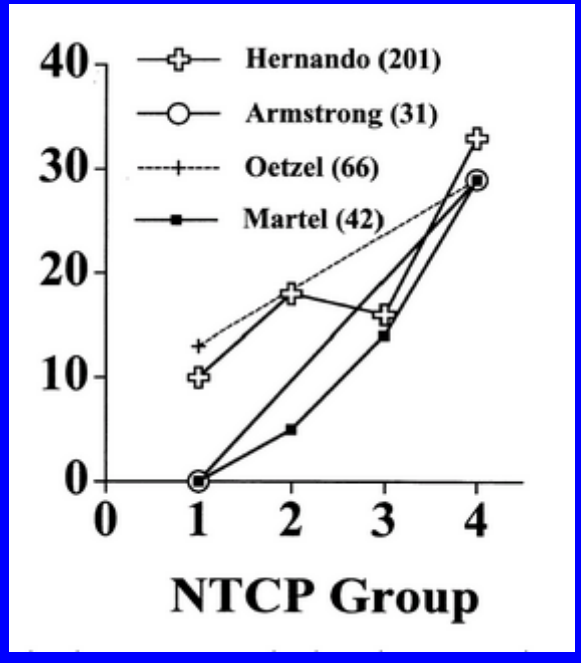
Verbesserung des therapeutischen Verhältnisses

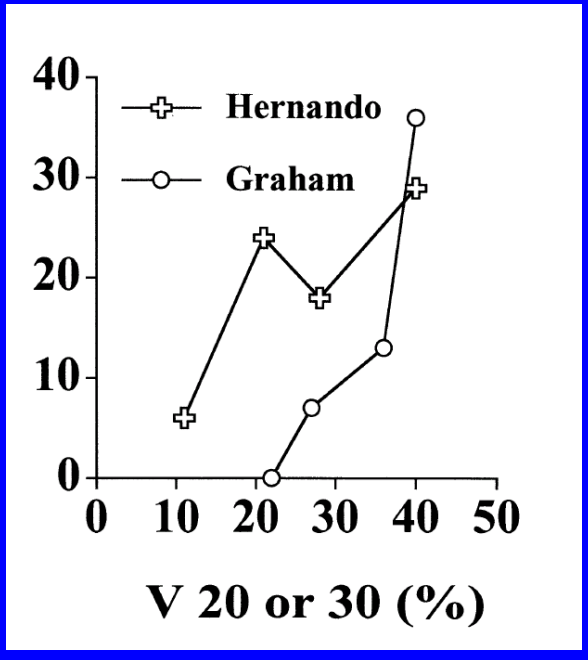


H. Holthusen, *Strahlentherapie* 57: 254-268,1936

Radiogene Pneumonitis & Fibrose: Abhängigkeit vom Volumen

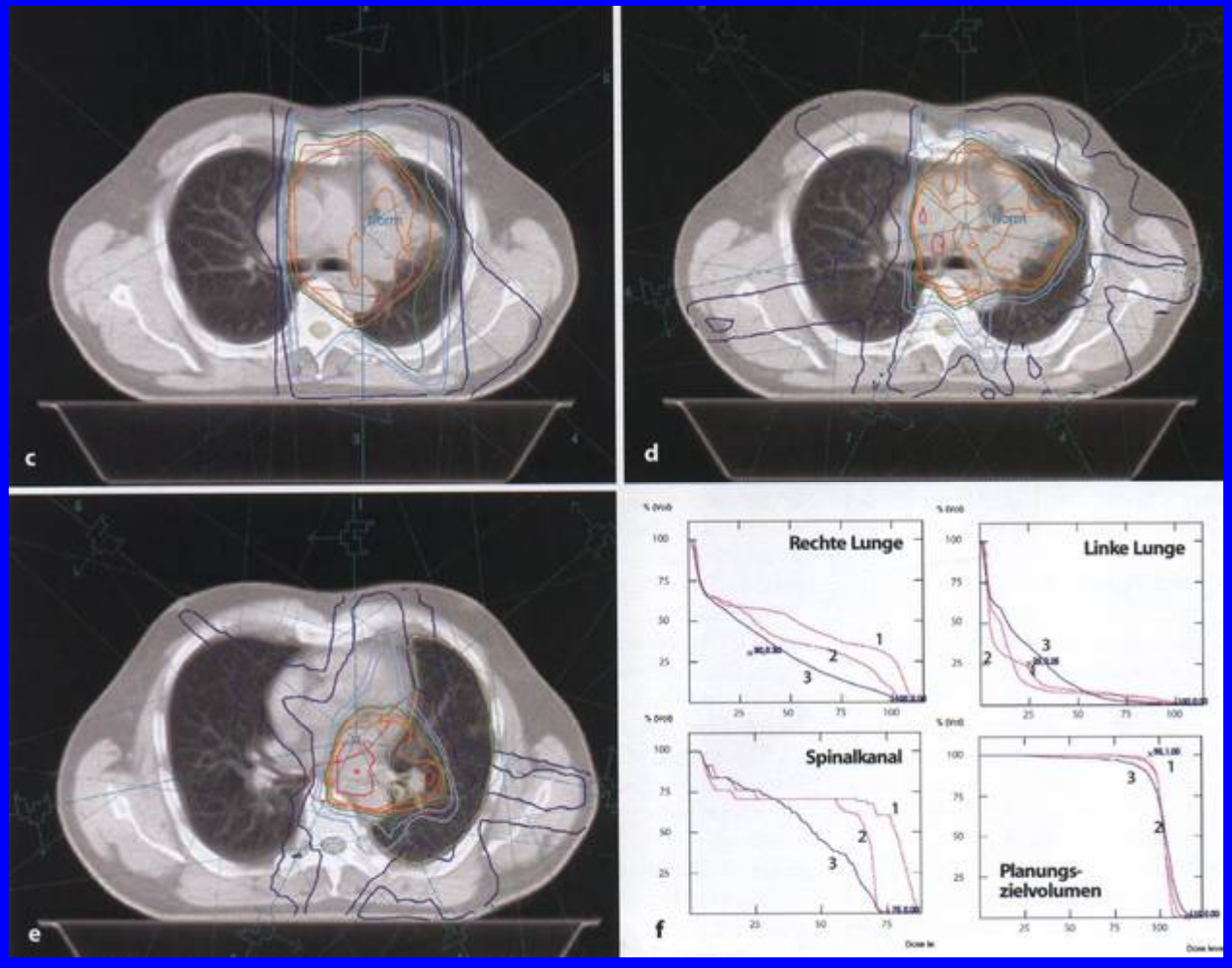




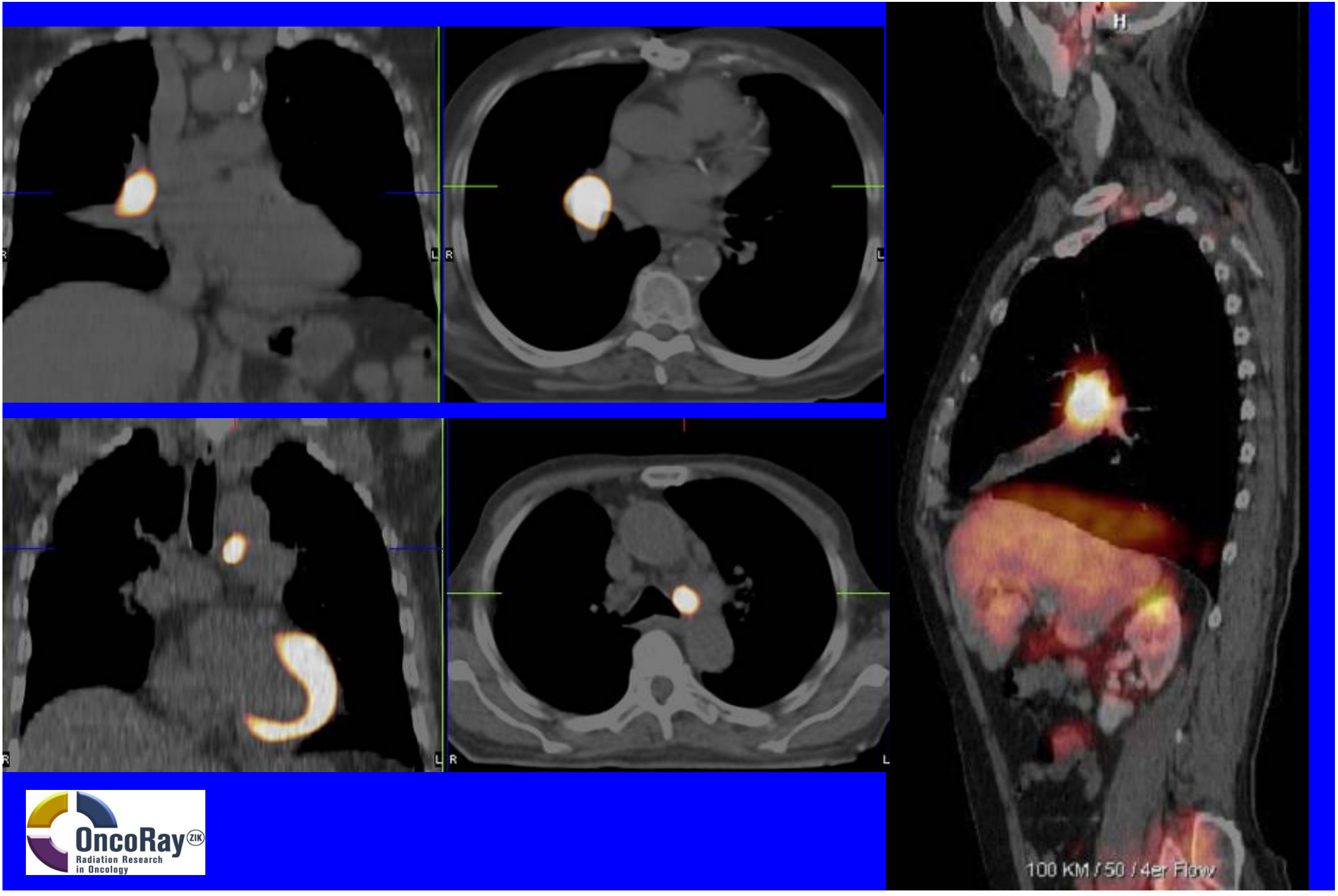


Hernando et al., *IJROBP 51: 650-659*, 2001

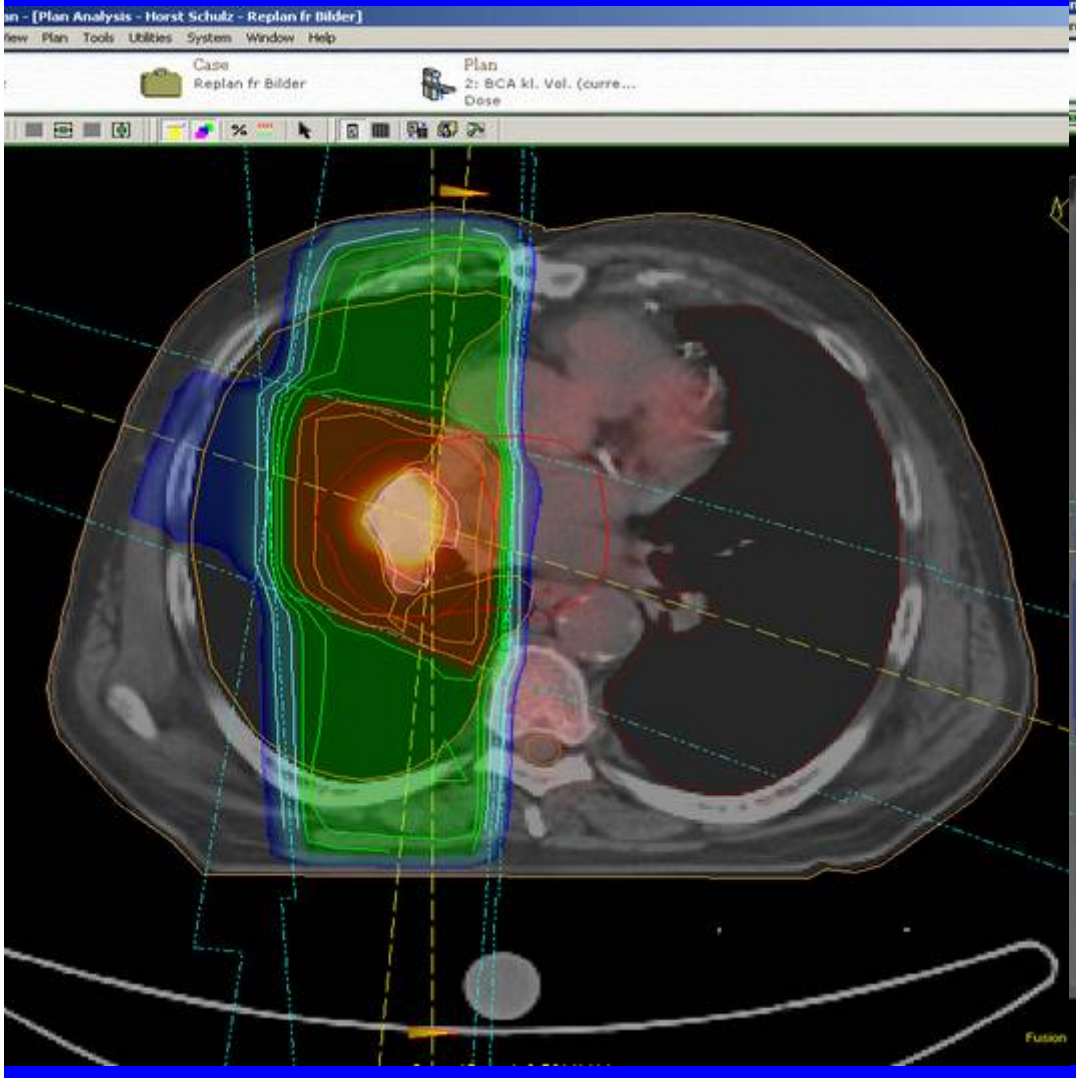
Intensitätsmodulierte Strahlentherapie

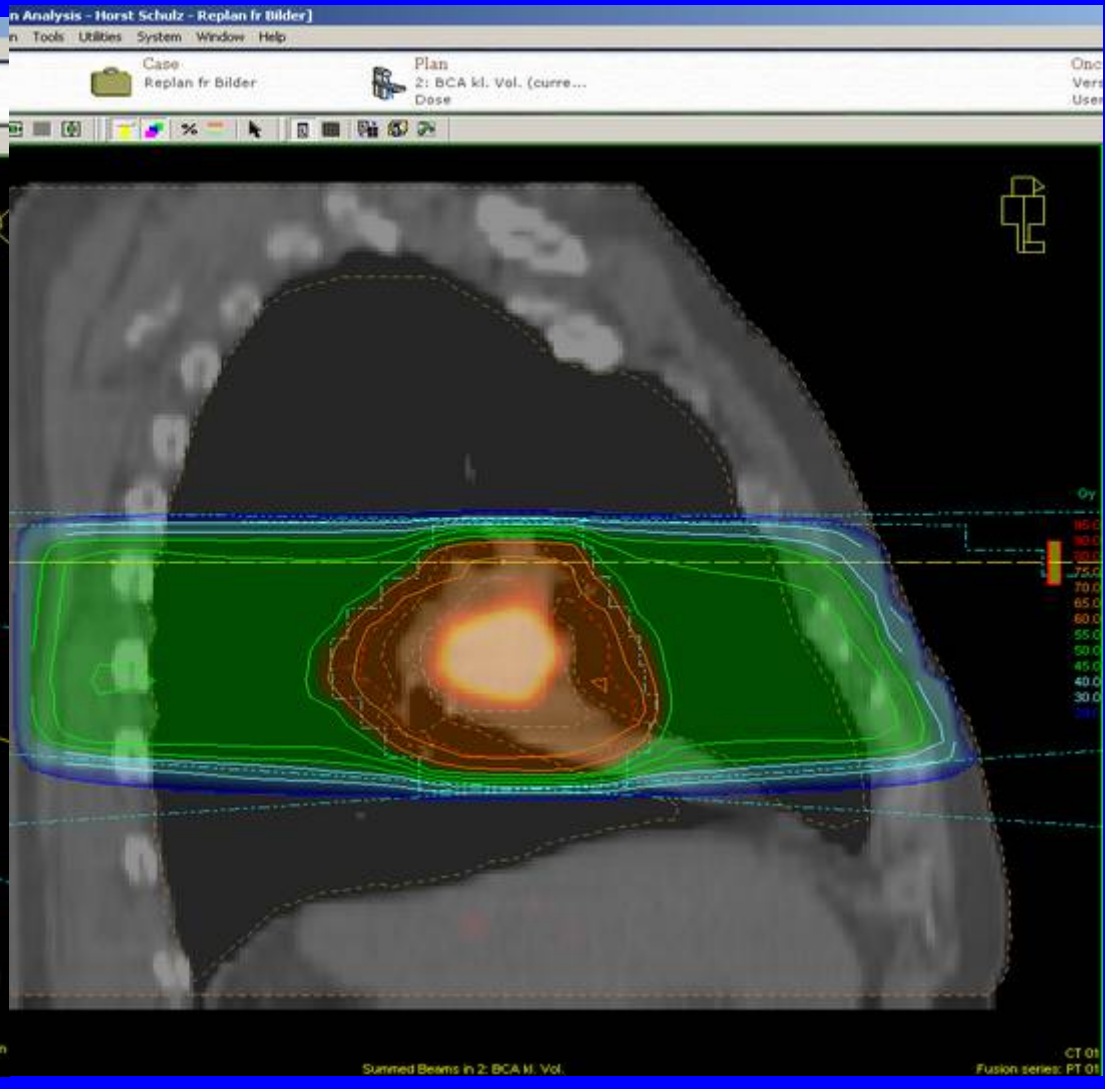


Baumann, Flentje, Drings, *Der Onkologe* 8: 448-461, 2002



OncoRay ZIK
Radiation Research in Oncology


- [Plan Analysis - Horst Schulz - Replan fr Bilder]
Tools Utilities System Window Help
Case
Replan fr Bilder
Plan
2: BCA kl. Vol. (curre...
Dose
Fusion


n Analysis - Horst Schulz - Replan fr Bilder]
Tools Utilities System Window Help
Case
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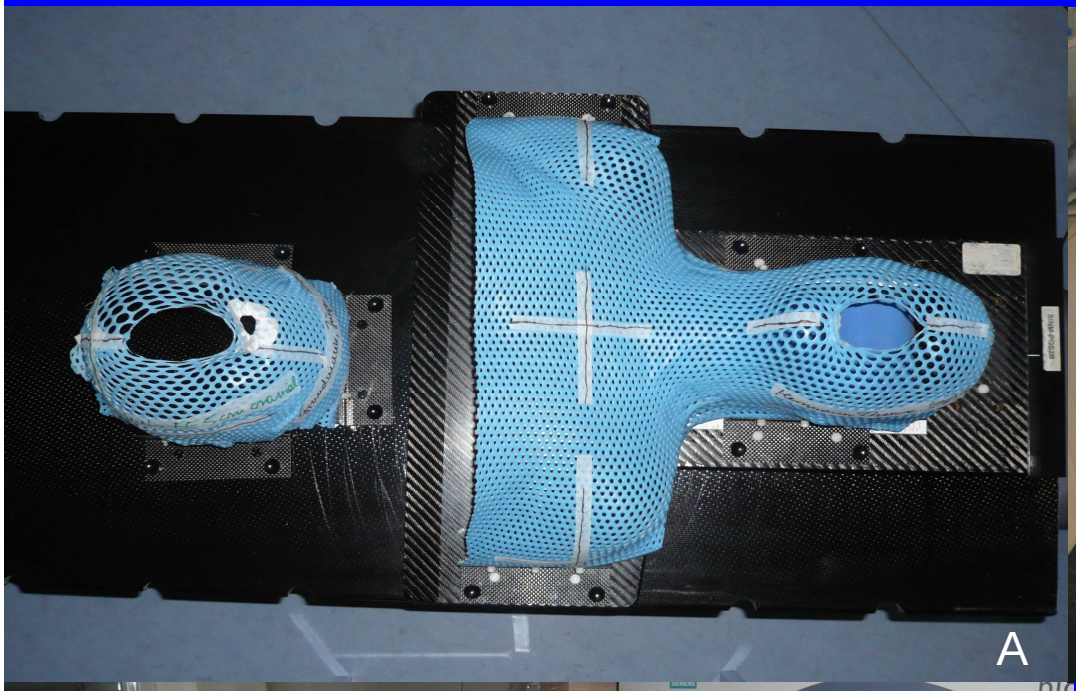
Plan
2: BCA kl. Vol. (curre...
Dose
Gy
Summed Beams in 2: BCA kl. Vol.
CT 01
Fusion series: PT 01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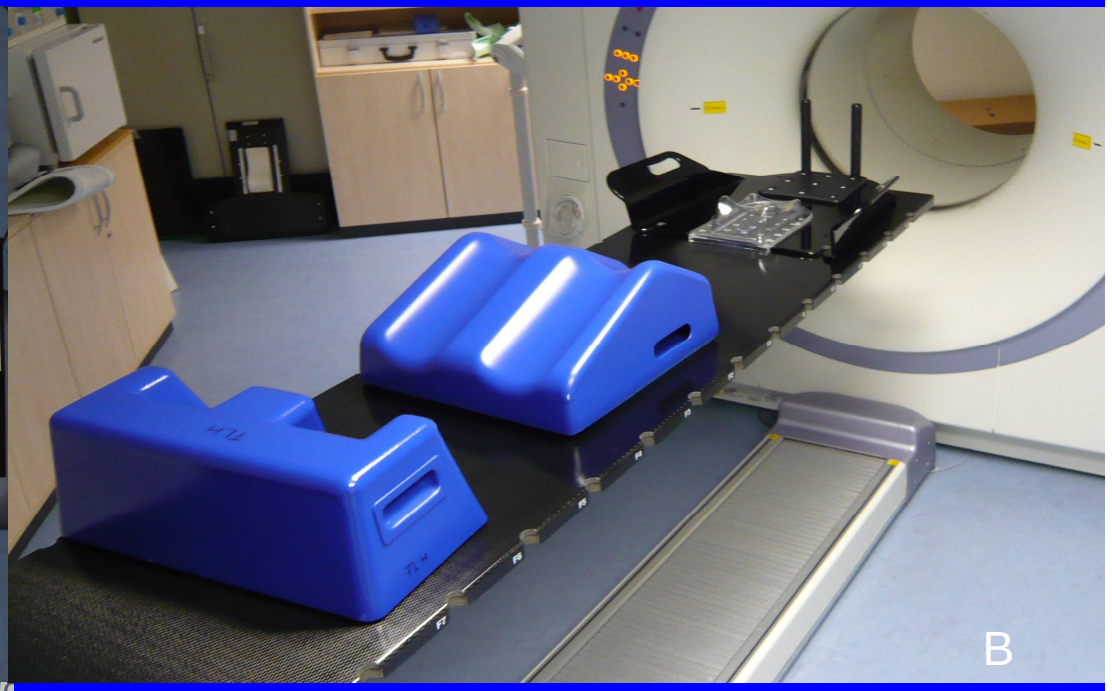
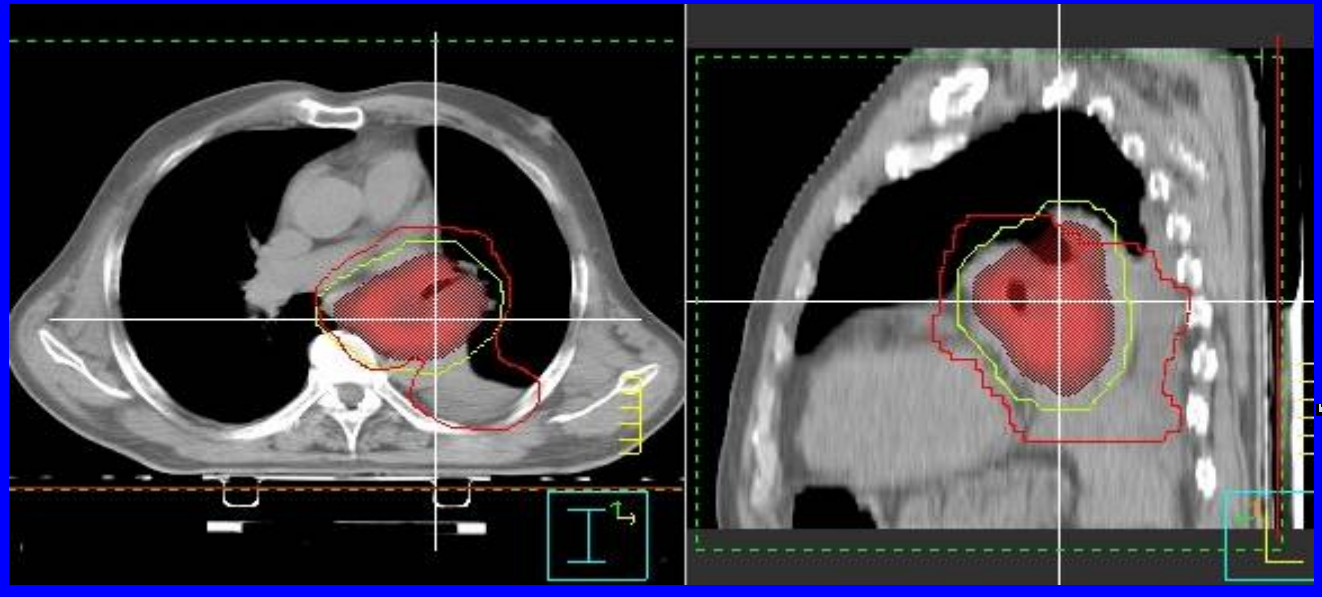
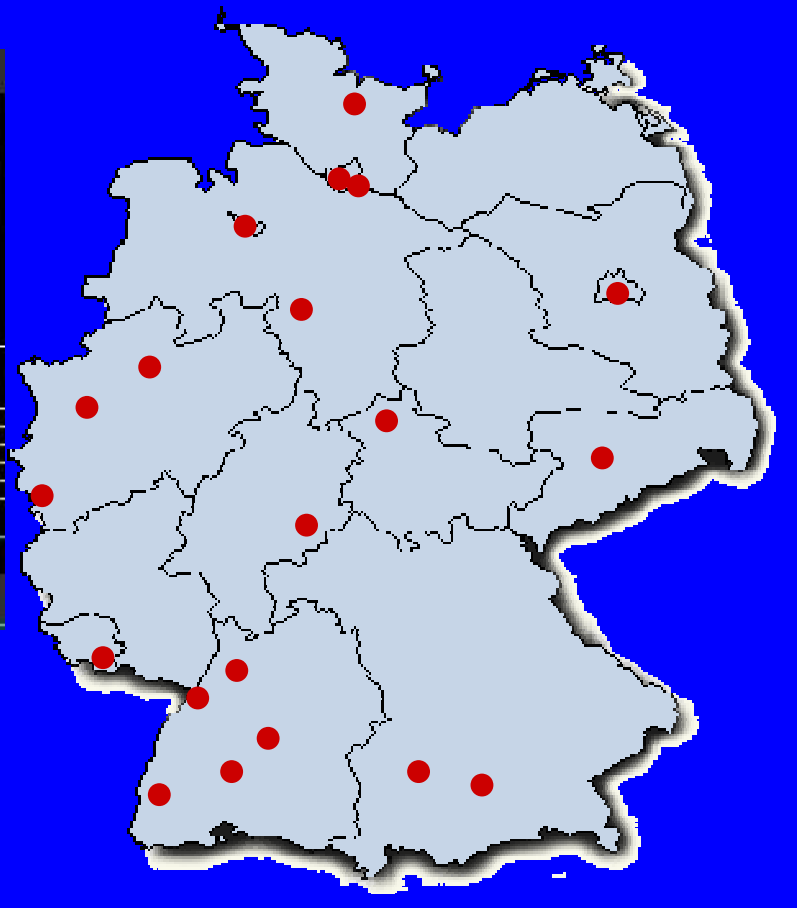

B


C

H1
H2
H3
H4

FDG-PET in der Strahlentherapie-planung bei NSCLC: PET-PLAN





PTV (definiert nach FDG-PET)

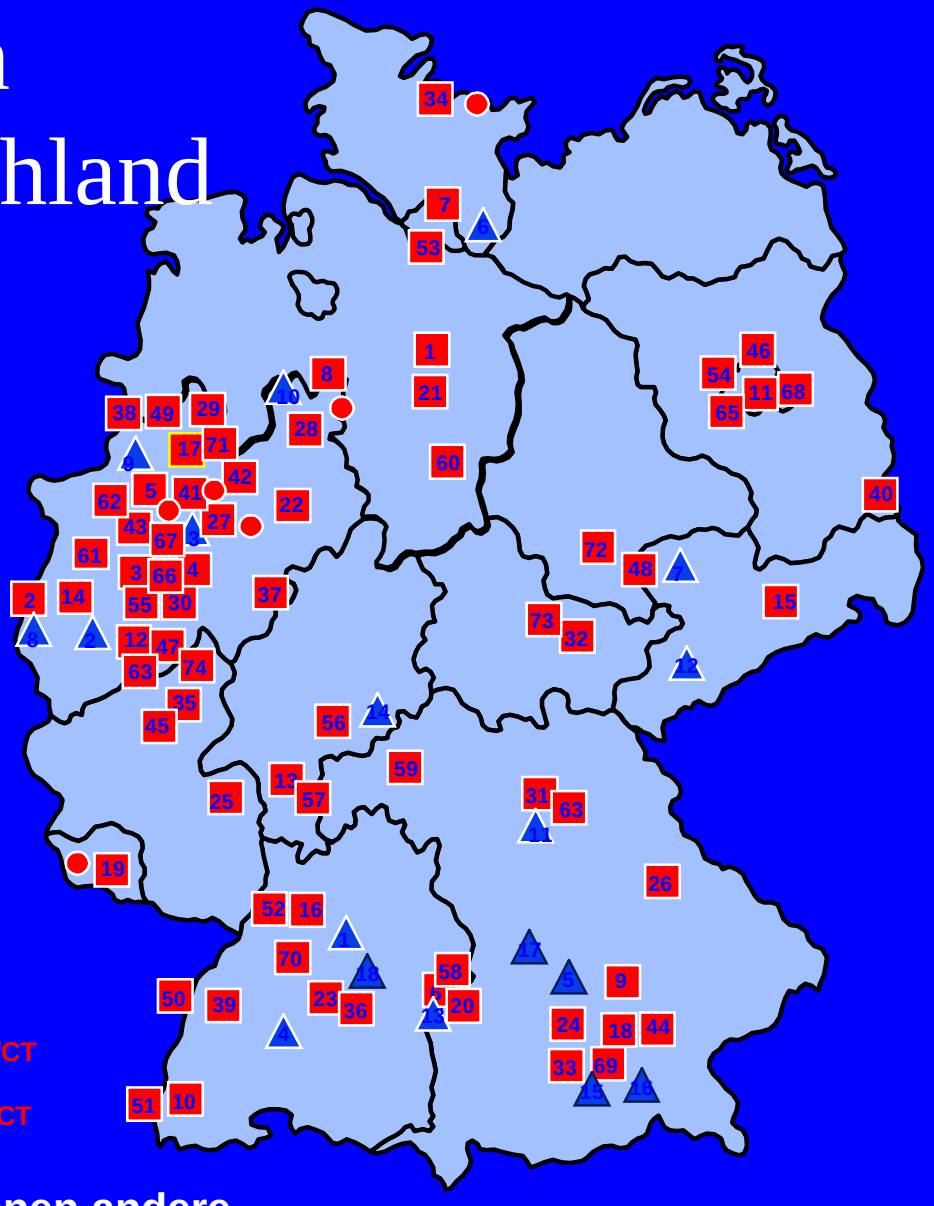
PTV (definiert nach CT)

181039WB

PET-Standorte in Deutschland

Mai 2004

■ Installationen Siemens



1	Heidelberg
2	Jülich
3	Düsseldorf
4	Tübingen
5	München
6	Hamburg
7	Leipzig
8	Aachen
9	Oberhausen
10	Bielefeld
11	Nürnberg
12	Zwickau
13	Ulm PET/CT
14	Fulda
15	München
16	München PET/CT
17	Augsburg
18	Stuttgart PET/CT

△ Installationen andere

1	Hannover
2	Aachen
3	Köln
4	Köln
5	Essen
6	Ulm
7	Hamburg
8	Bad Oeynhausen
9	München
10	Freiburg
11	Berlin-Charité
12	Bonn
13	Frankfurt
14	Jülich
15	Rossendorf
16	Heidelberg
17	Münster
18	München
19	Homburg/Saar
20	Ulm
21	Hannover biograph
22	Wuppertal
23	Stuttgart
24	München
25	Mainz
26	Regensburg
27	Düsseldorf
28	Lemgo
29	Münster
30	Köln
31	Erlangen
32	Jena
33	München
34	Kiel
35	Koblenz
36	Plochingen
37	Siegen
38	Rheine
39	Karlsruhe
40	Frankfurt/Oder
41	Dortmund
42	Hamm
43	Essen
44	München
45	Koblenz
46	Berlin-Buch
47	Bonn
48	Leipzig
49	Coesfeld
50	Ludwigshafen
51	Freiburg
52	Heidelberg
53	Hamburg
54	Berlin-Europet
55	Köln
56	Neuromed Mobile PET
	Castrop-Rauxel
	Kiel
	Braunschweig
	Lüdenscheid
	Osnabrück
●	Leverkusen
	Bergisch-Gladbach
57	Frankfurt
58	Ulm
59	Würzburg
60	Göttingen
61	Mönchengladbach
62	Essen / biograph
63	Erlangen
64	Bonn / biograph
65	Berlin
66	Köln
67	Hemer
68	Berlin / biograph
69	München / biograph
70	Tübingen / biograph
71	Münster / biograph
72	Halle
73	Bad Berka Biograph
74	Bonn biograph

PET(/CT) Indikationen NSCLC

- Artdiagnose (z.B. unklarer Lungenrundherd)
- Staging vor Operation, kurativer Bestrahlung oder Chemotherapie
- Therapie-Monitoring bei neo-adjuvanter Chemotherapie
- Verbesserung der Bestrahlungsplanung (Zielvolumen-Definition, Dosis-Eskalation)
- Rezidiv-Diagnostik bei Therapie-Optionen