NKI-AVL

Het Nederlands Kanker Instituut
Antoni van Leeuwenhoek Ziekenhuis

High and low dose regions to normal tissues in IMRT

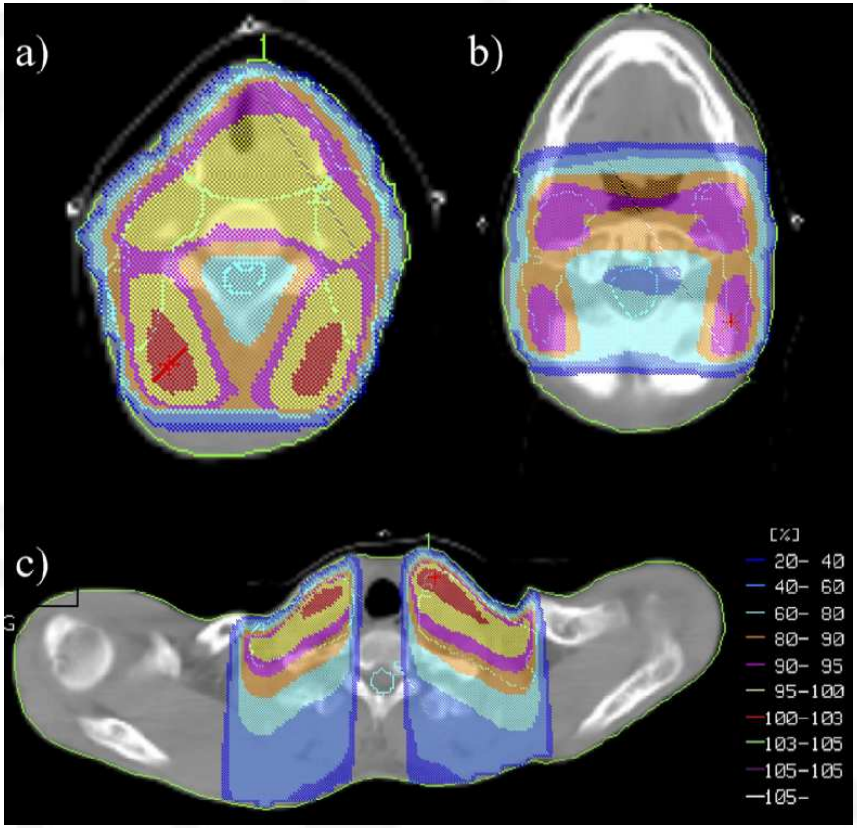
Rick Haas NKI/AvL

IMRT and dose

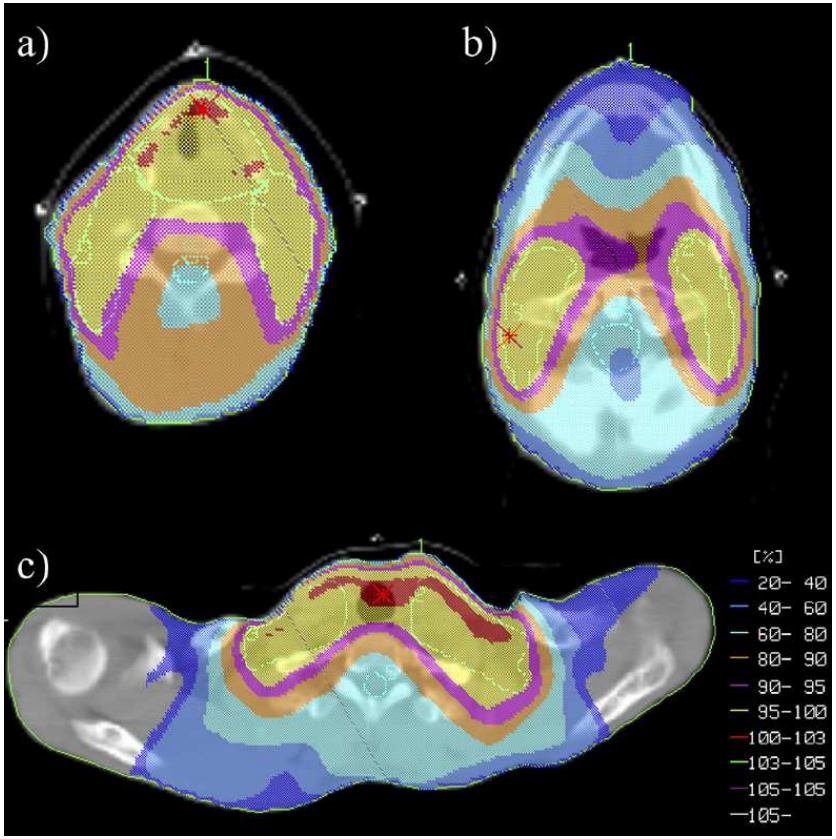
- IMRT is focused to
  - Increase the target dose and/or
  - Decrease the normal tissue dose
- This involves multiple directions of radiation and potentially more low dose volume
- IMRT is, generally, not aiming at reducing secondary cancers

IMRT and dose

CRT

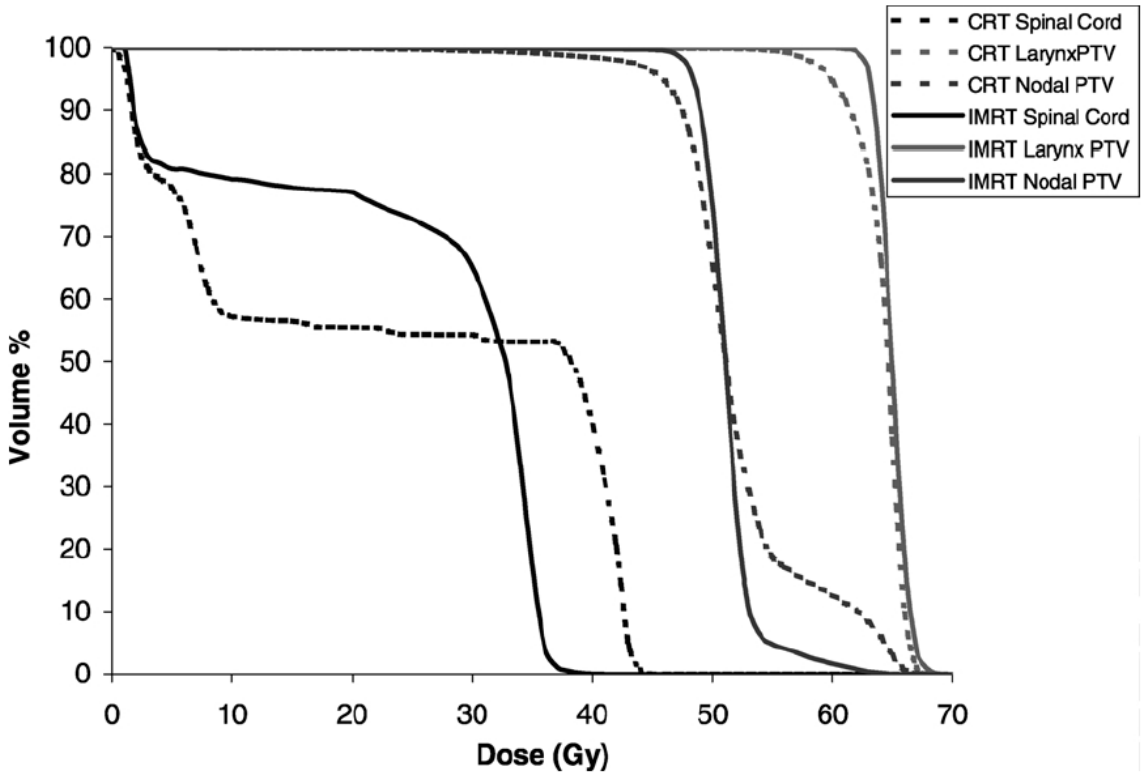


IMRT



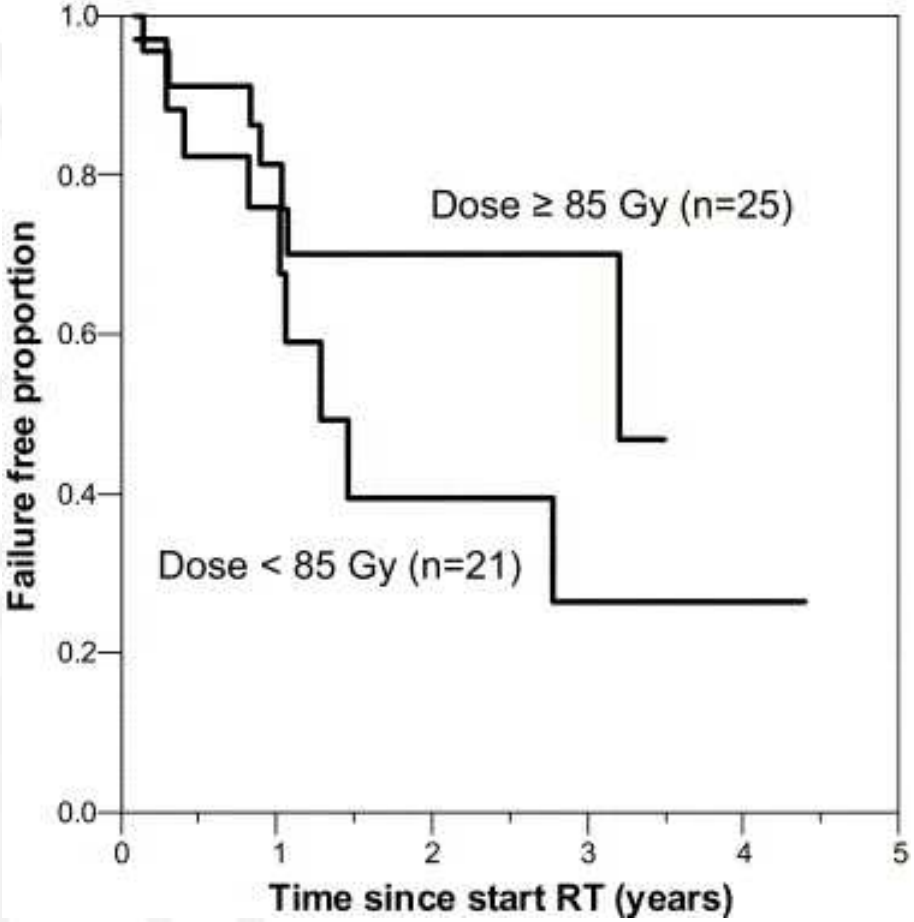
- Clark et al R&O 2004

IMRT and dose
More low dose volume



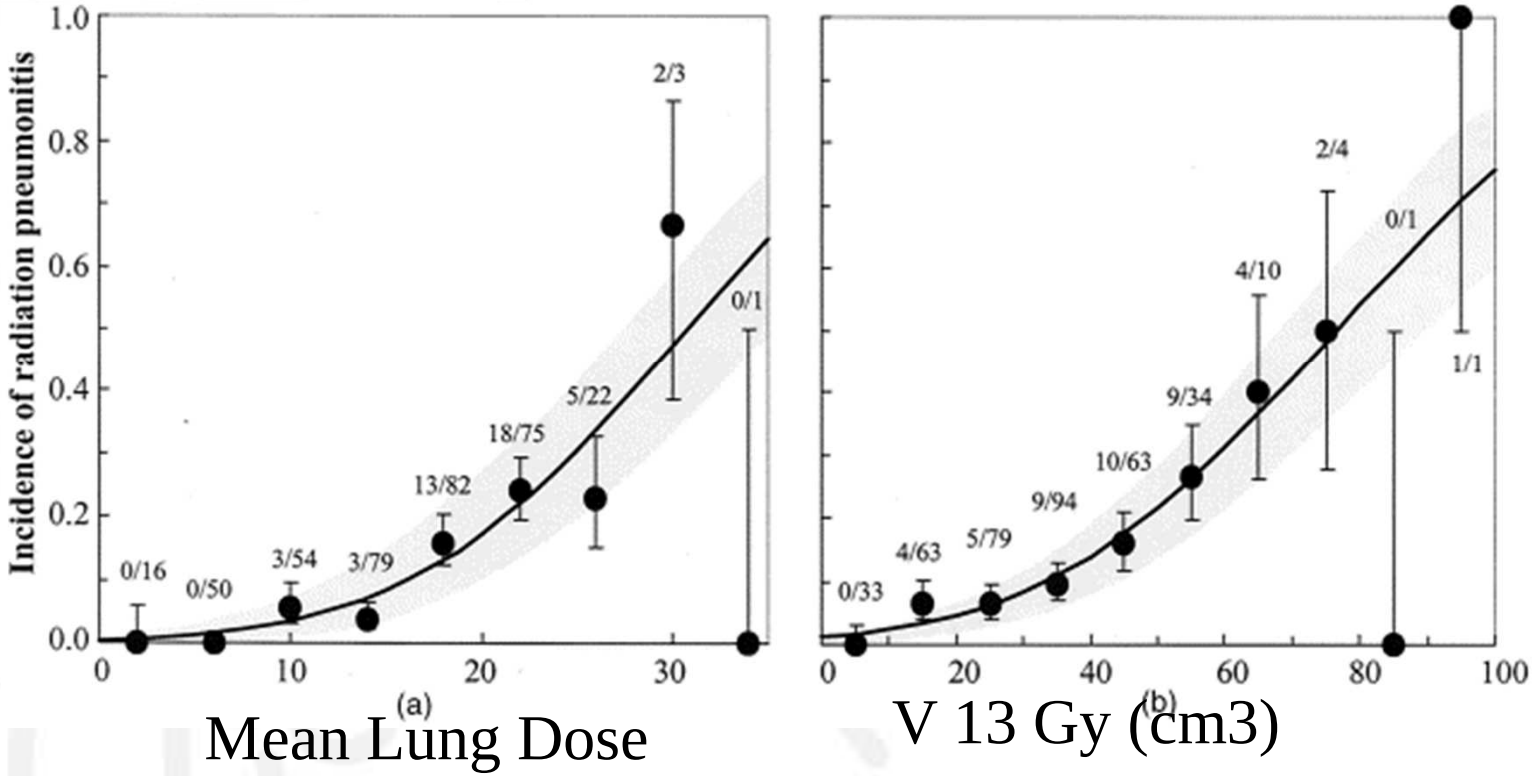
- Clark et al R&O 2004

IMRT and dose
Lung cancer dose escalation



Belderbos et al 2006

IMRT and dose
lung dose and pneumonitis



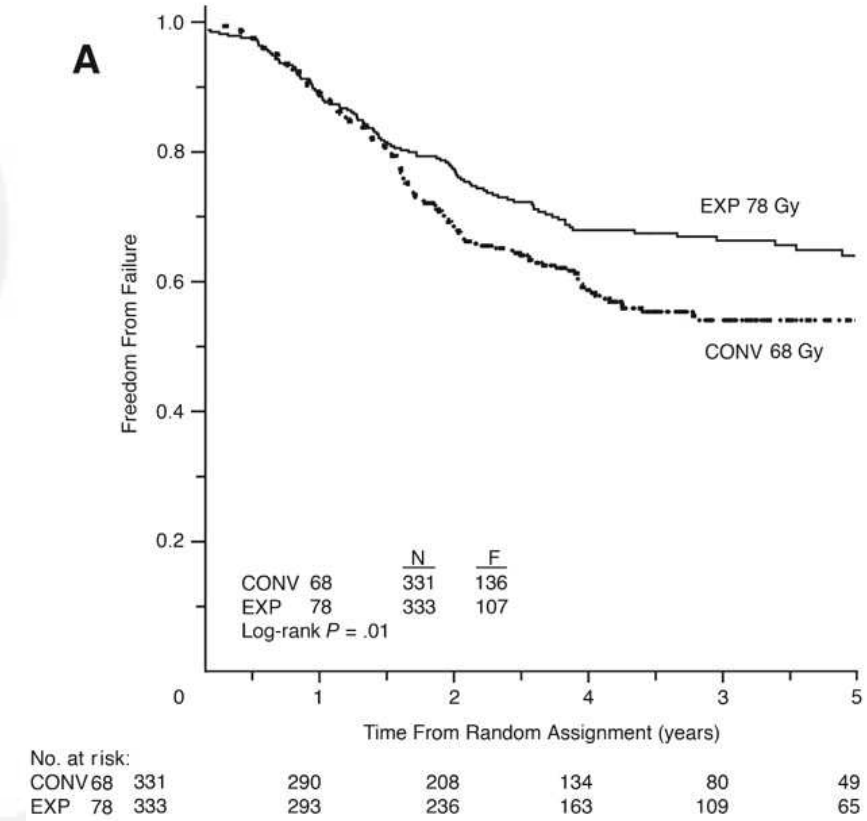
Mean Lung Dose

V 13 Gy (cm3)

Grade II pneumonitis

Seppenwoolde 2003

IMRT and dose
FFS Prostate 68 vs 78 Gy

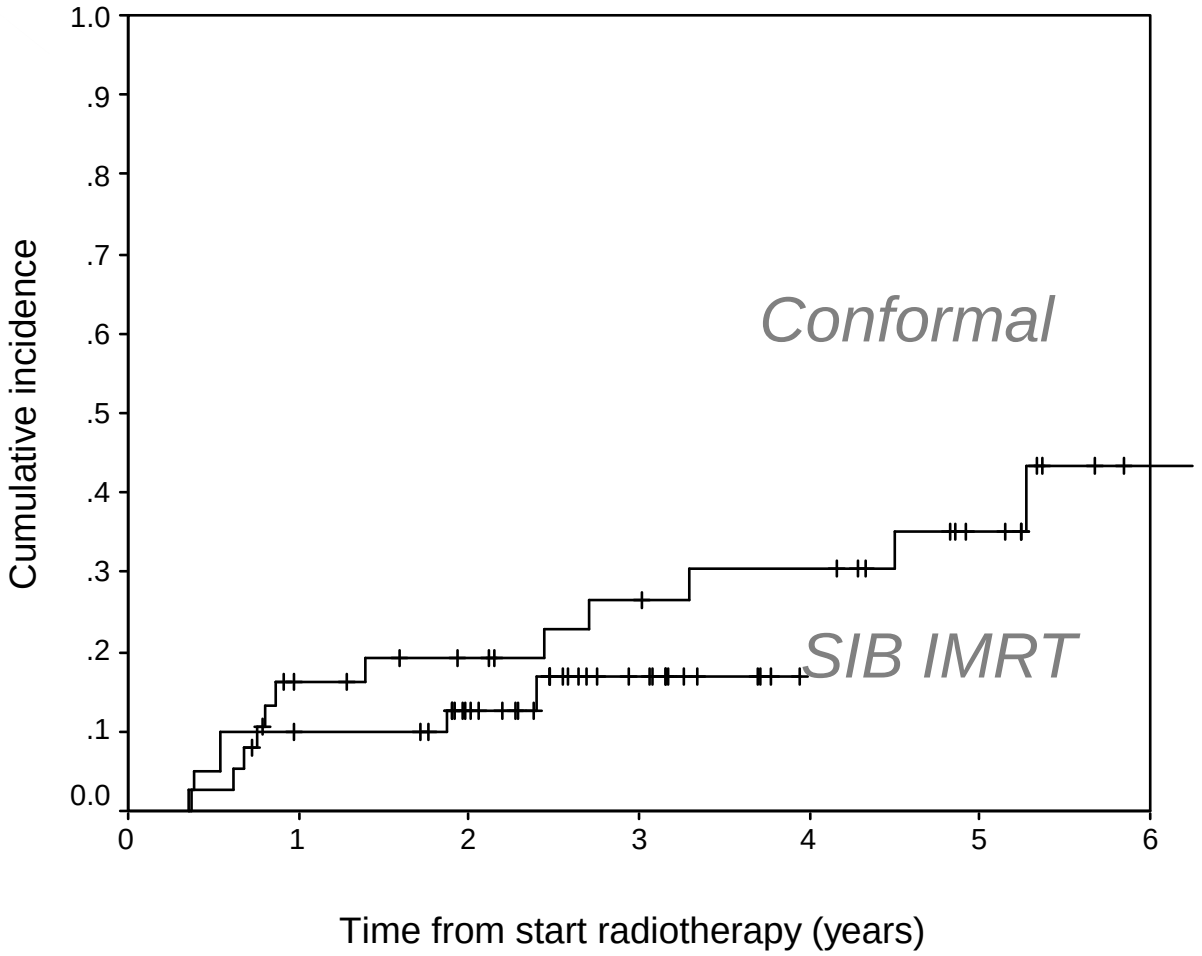


Peeters et al 2006

Prostate
Acute GI toxicity

	Conformal	SIB IMRT	P-value
Grade ≥ 2	61 %	20 %	0.001
Grade ≥ 3	13 %	0 %	

Prostate
Late GI toxicity (grade ≥ 2)



IMRT and dose

- ✓ Using IMRT for both lung and prostate cancer allows for dose escalation
- ✓ IMRT for head and neck cancer decreases side effects and increases coverage

Impact of IMRT

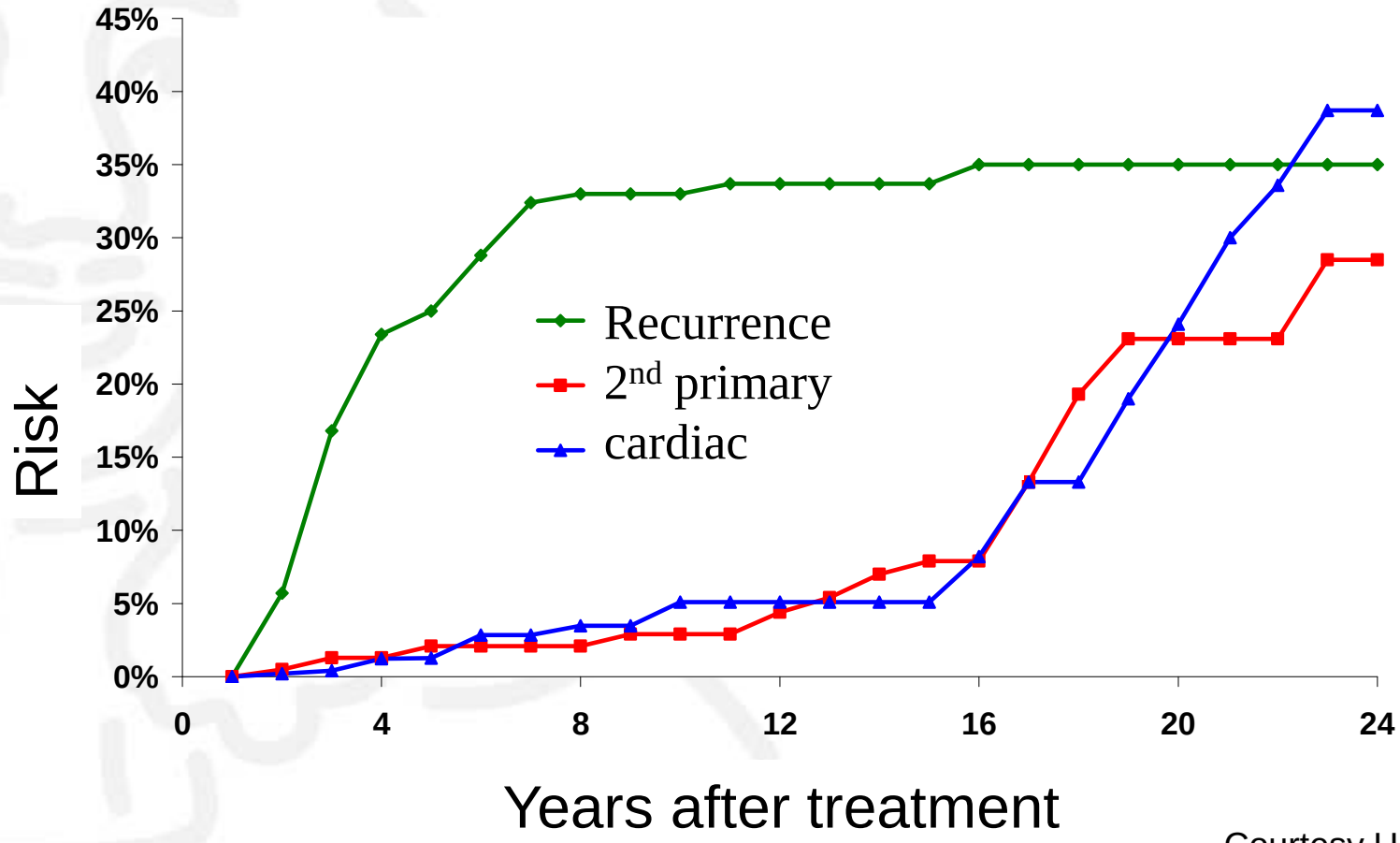
IMRT vs CRT: differences in dose distribution

- Increase in monitor units:
  - Larger total-body radiation dose (photon and neutron component for higher energy)
    - but no wedges, or physical compensators etc.
  - Related to delivery units (IMRT, TOMO, etc)

- Larger volume of normal tissue exposed to lower radiation: the effects related to dose-response curve for radiation induced carcinogenesis or nonmalignant toxicities

- Clinically relevant in pediatric oncology

Long Latency
late side effects and secondary cancers

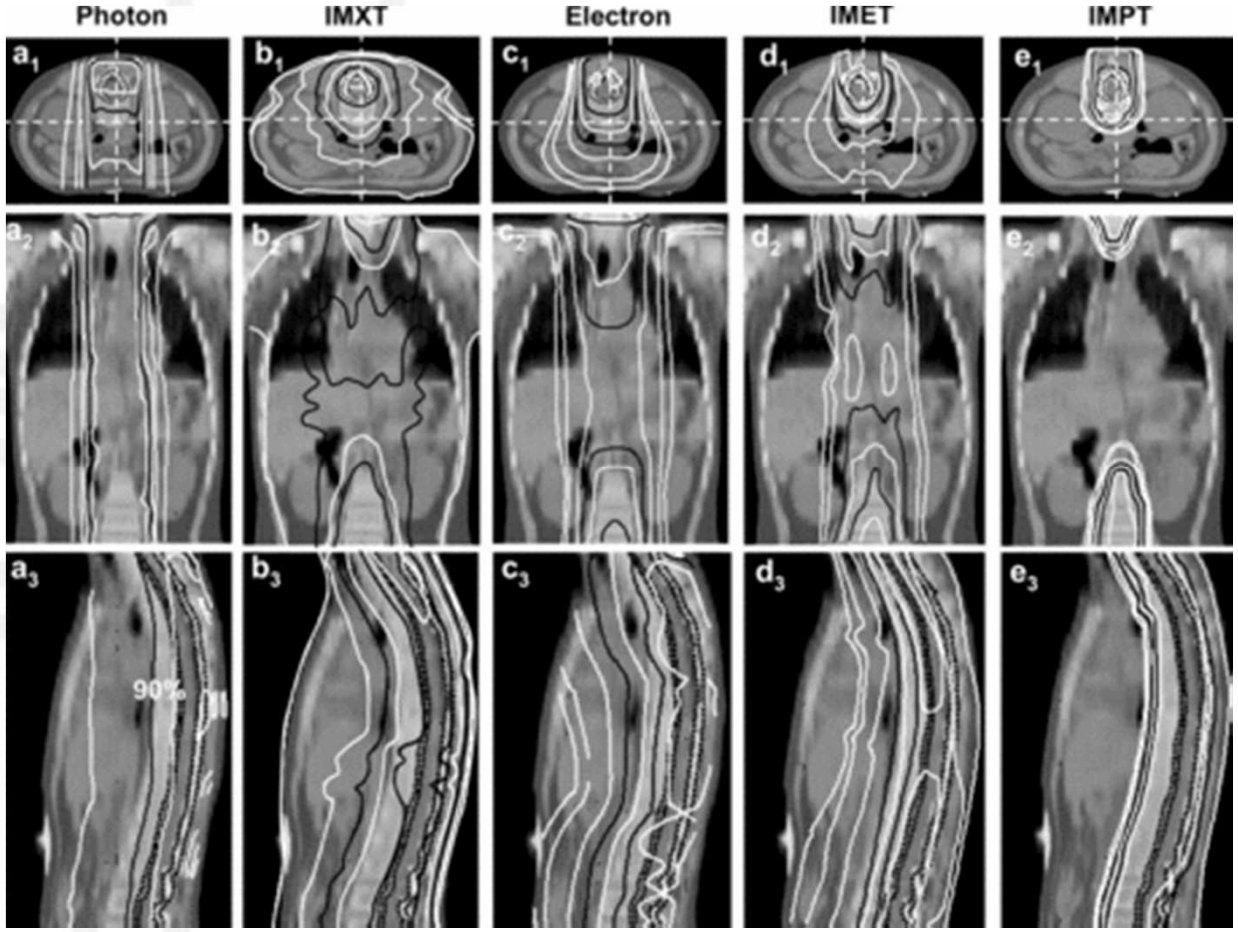


Courtesy Hans Langendijk

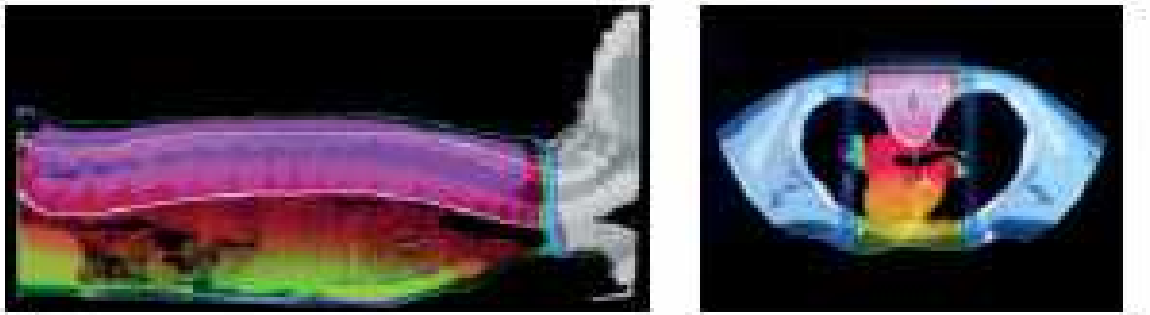
IMRT and dose

- Mu et al 2005
- Pediatric case spinal cord irradiation
- RT comparison with photon, electron and proton techniques

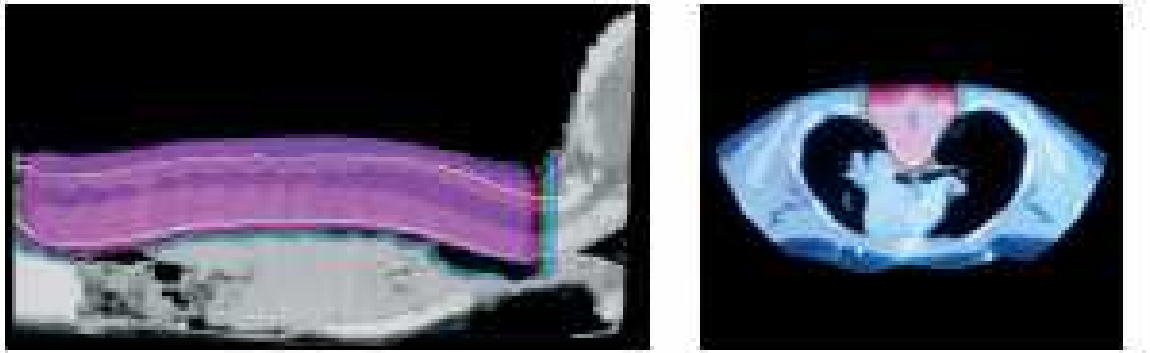
IMRT and dose



Mu et al 2005



Photons



Protons: Vital healthy organs are spared with Particle Therapy

Fotonen versus protonen: Vergelijkende planning

Courtesy Hans Langendijk

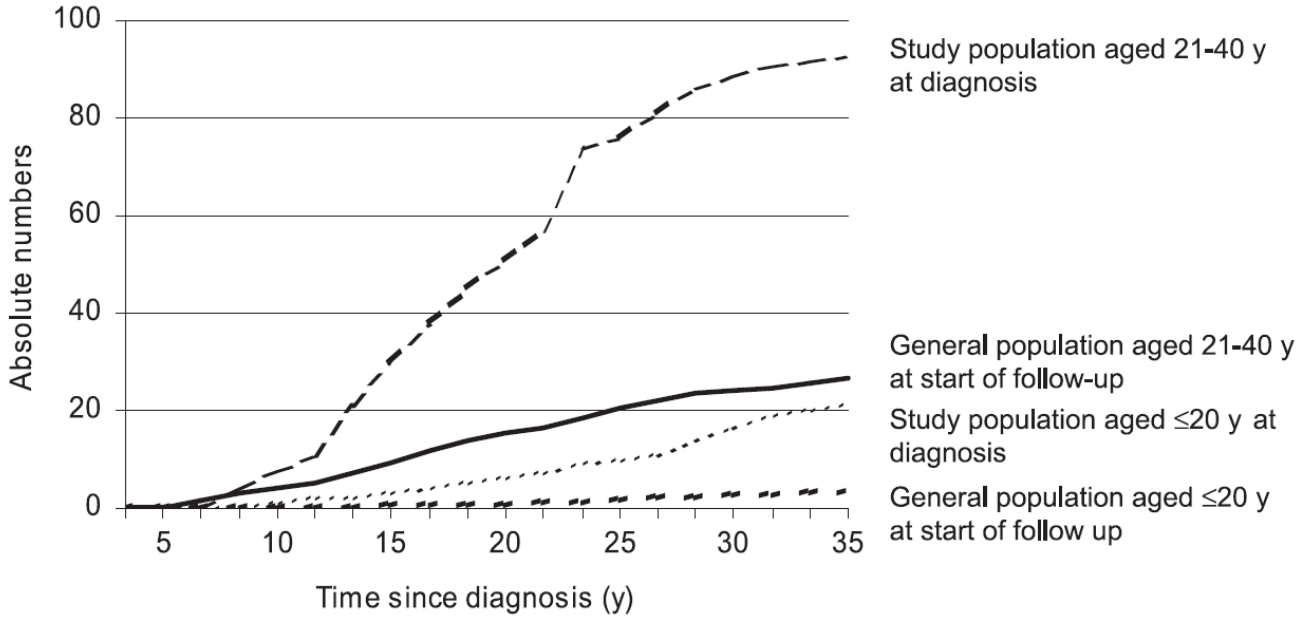
Estimation of secondary lethal cancers pediatric case

	Photon	IMRT	Electr	IMET	IMPT
Oesophagus	0.20	0.20	0.20	0.20	0.13
Thyroid	0.15	0.15	0.18	0.16	0.00
Lung	0.17	0.37	0.21	0.12	0.02
Mammary glands	0.05	0.12	0.03	0.00	0.00
Liver	0.11	0.15	0.09	0.05	0.00
Stomach	0.24	0.44	0.27	0.15	0.01
Abdominal cavity	0.23	0.34	0.24	0.19	0.02
Patient outline	0.02	0.03	0.02	0.01	0.01
Effective dose	1.761	2.696	1.863	1.326	0.306
Total risk of SLC	0.198	0.303	0.210	0.149	0.034

(IM)RT and dose

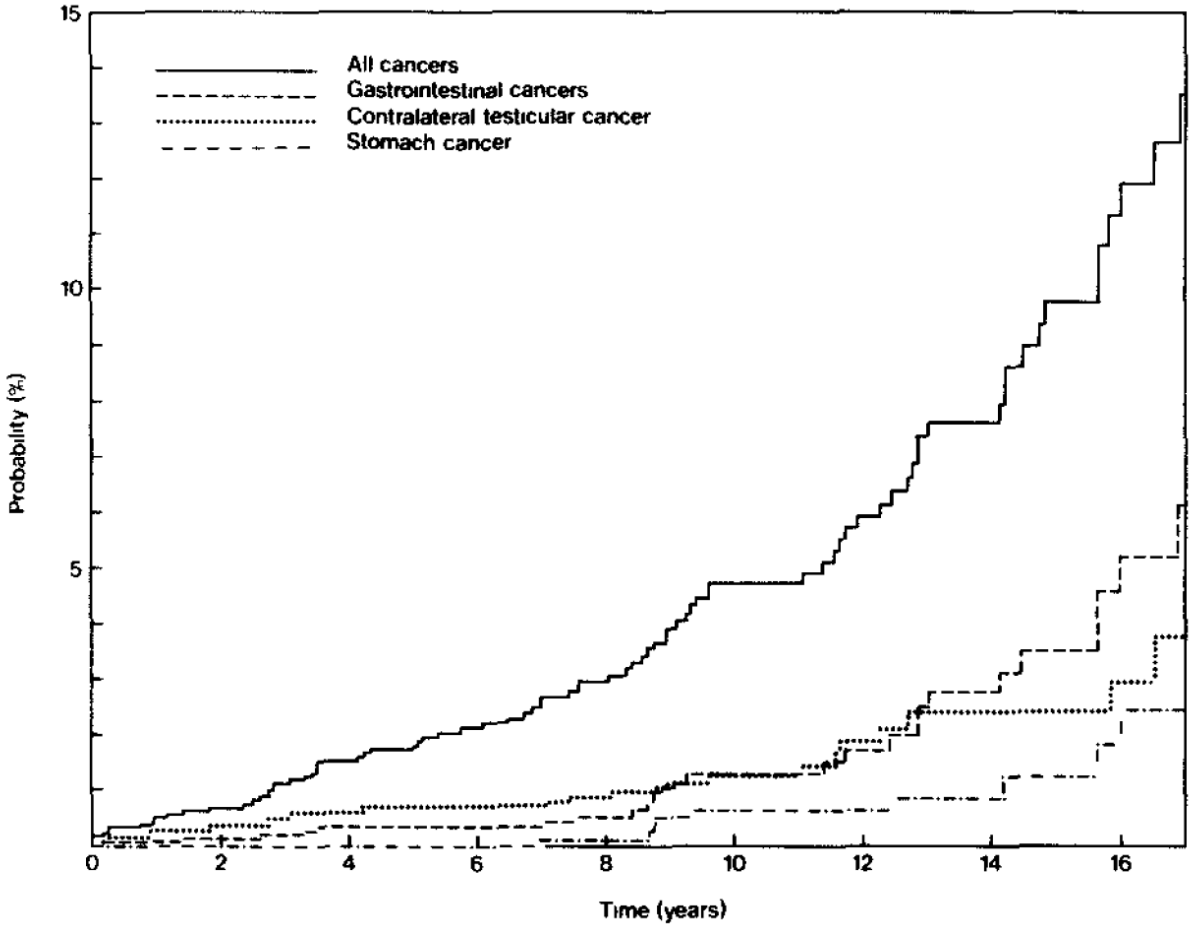
=> Late toxicity

Myocard infarction after mediastinal RT



Aleman 2007

Late toxicity



3-7 fold increased risk for sec. cancer after 30 Gy for testicular cancer predominantly inside the field

Leeuwen et al 1993

(IM)RT and late toxicity

- Increased breast cancer after Hodgkin disease
  - <5 Gy no increased risk
  - >5 Gy Relative Risk 2.7 fold
  - Protective effect of chemotherapy due to early menopause

Hill et al 2005

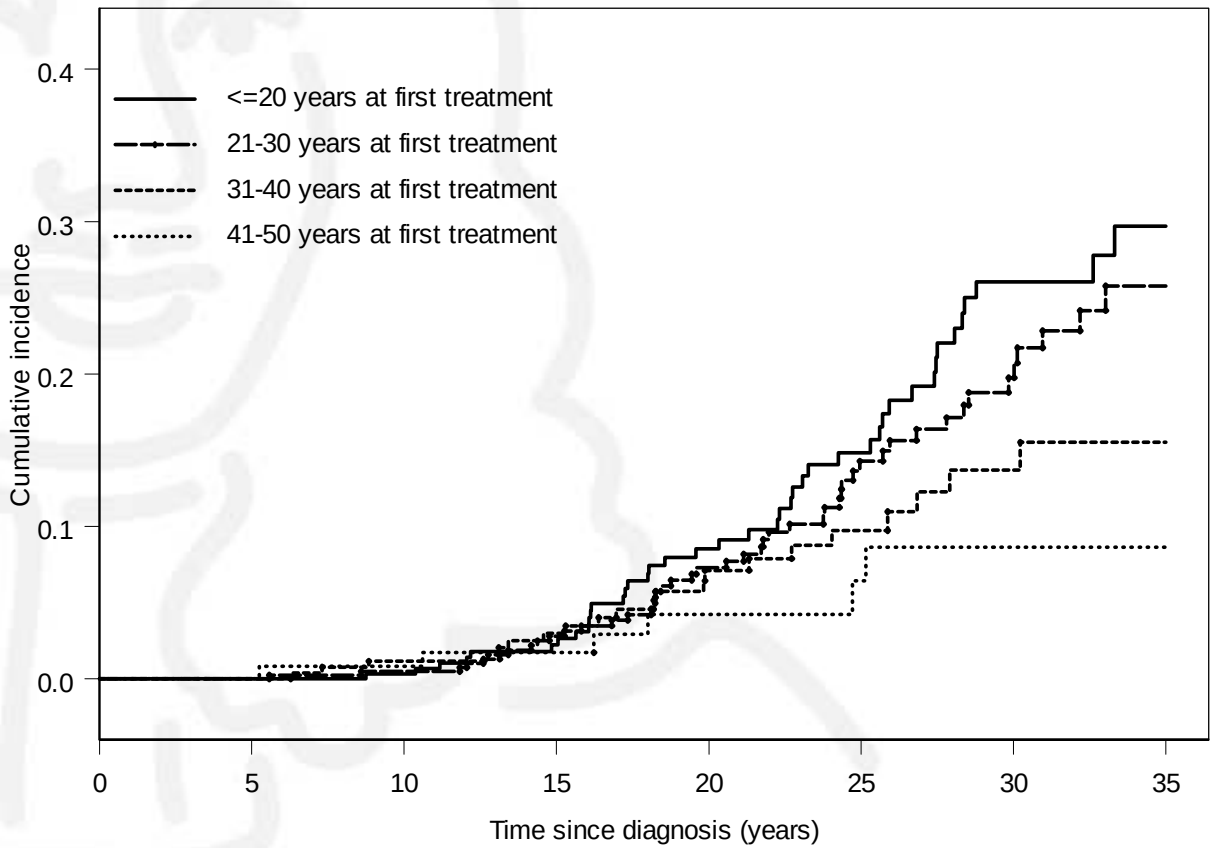
(IM)RT, dose and volume

- Does reduction of fields reduce secondary cancer risk?

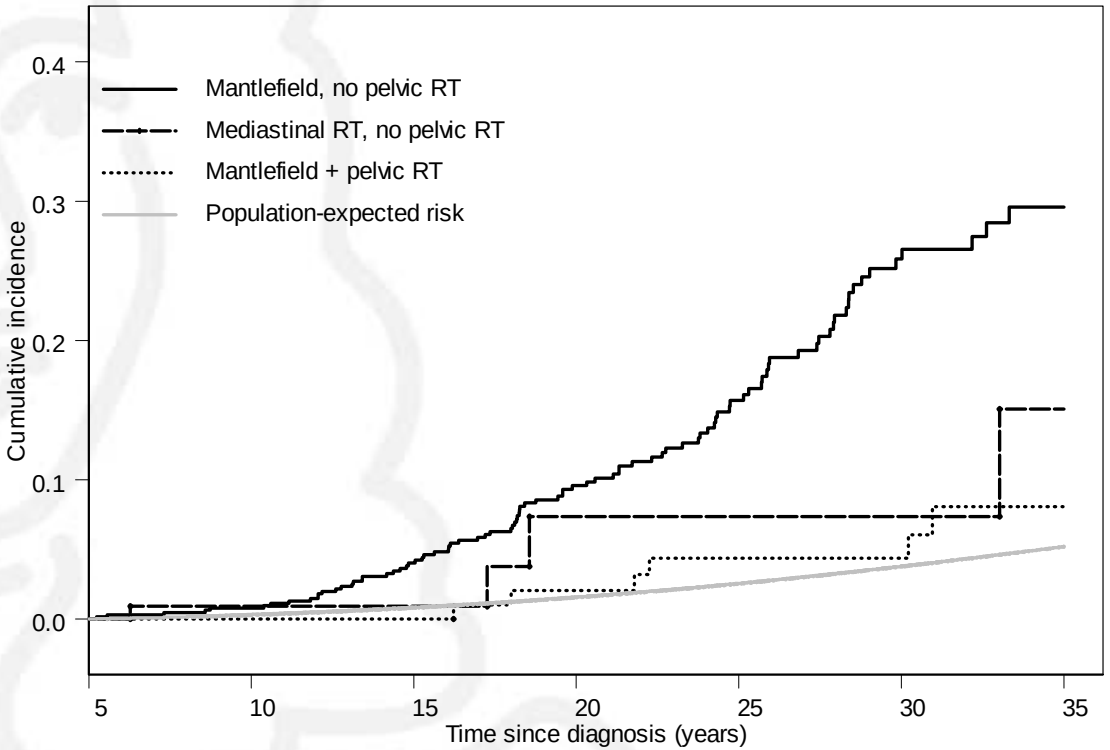
(IM)RT, dose, volume and age applied

- 1122 female patients treated with RT for Hodgkin disease
- <51 years
- Incidence of breast cancer

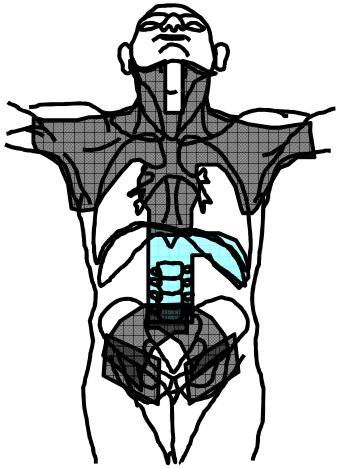
Breast cancer after RT for HD

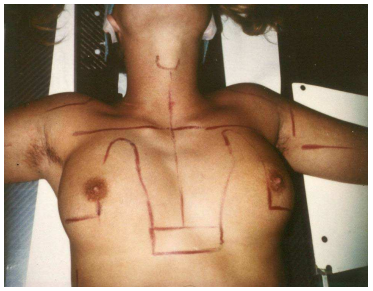


Breast cancer after RT for HD



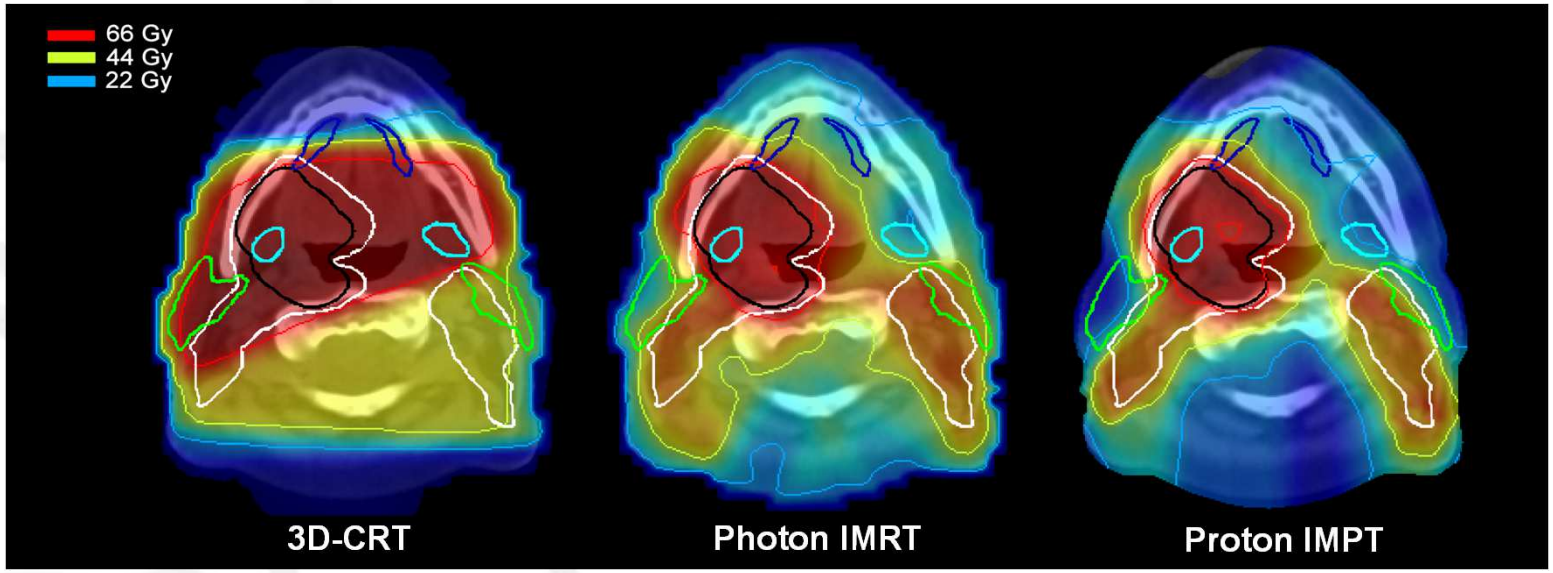
Nr at risk							
Mantlefield	637	582	448	293	151	64	11
Mediastinum	109	99	42	20	11	10	5
Mantle&pelvic RT	107	87	69	51	33	19	1

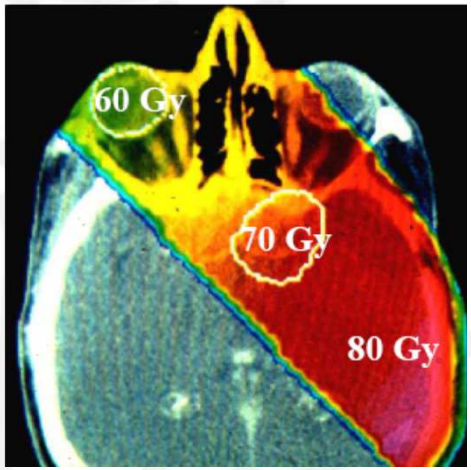


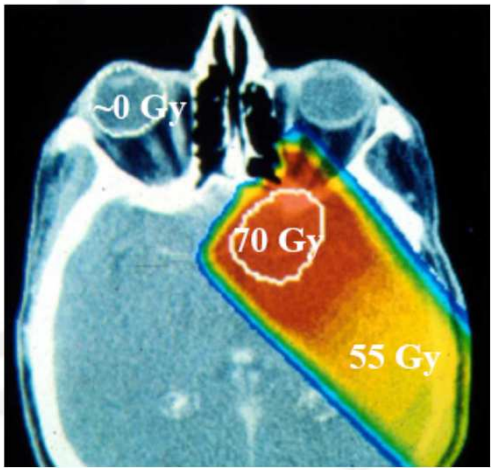


De Bruin et al submitted

Particle therapy?







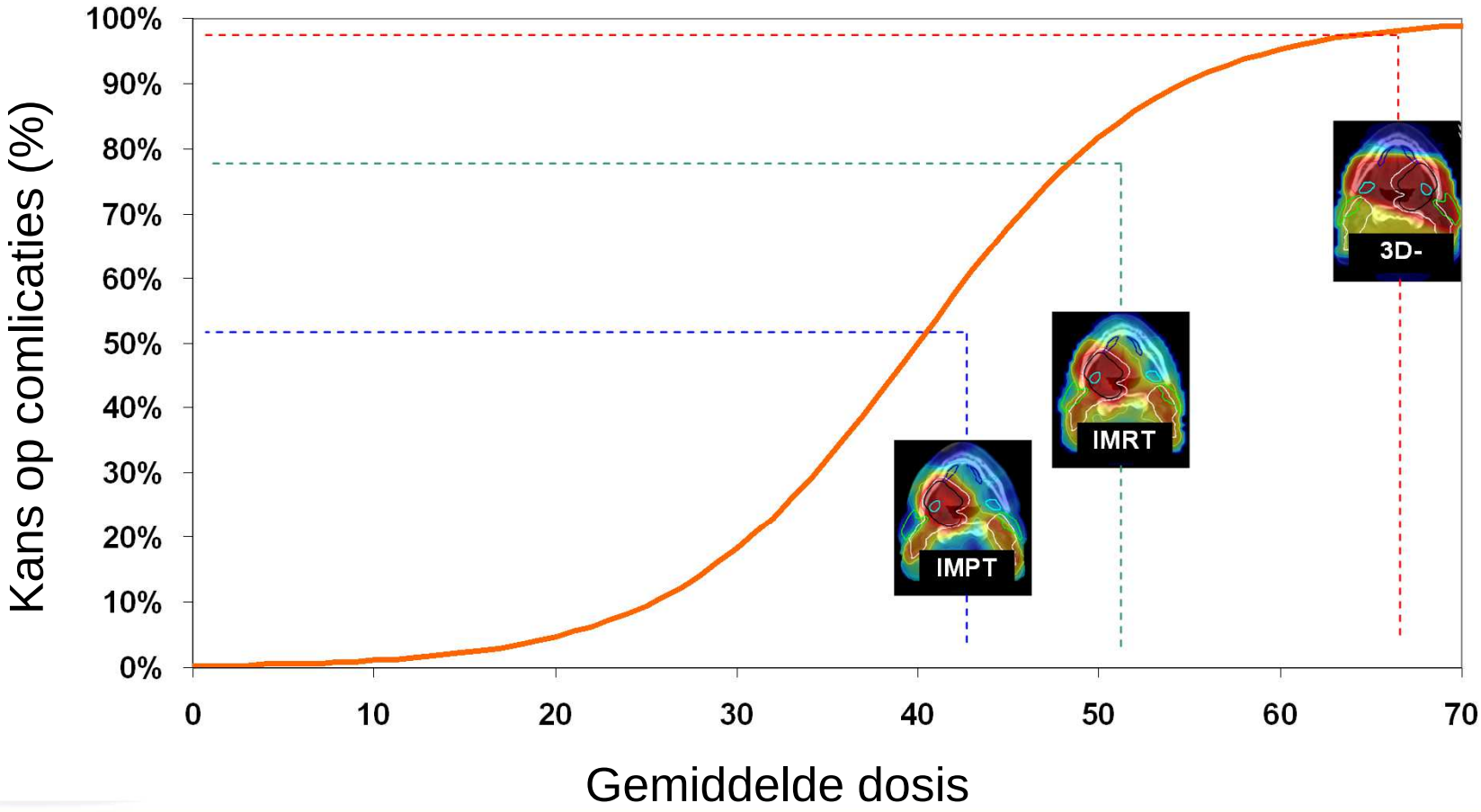
Fotonen versus protonen: Vergelijkende planning of in silico studie

Courtesy Hans Langendijk

In silico studies

Vertaling naar klinisch voordeel m.b.v. NTCP-model

Courtesy Hans Langendijk



Conclusions

- Toxicity is more than your gantry can cause
- Integral dose is largely dependent on machine and technique not on IMRT or not
- Patient data on IMRT sec. cancers are not mature yet
- Risk for sec. cancers is higher for younger patients
- A difference in radiation field can translate in less cancer (BC in HD disease)

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