

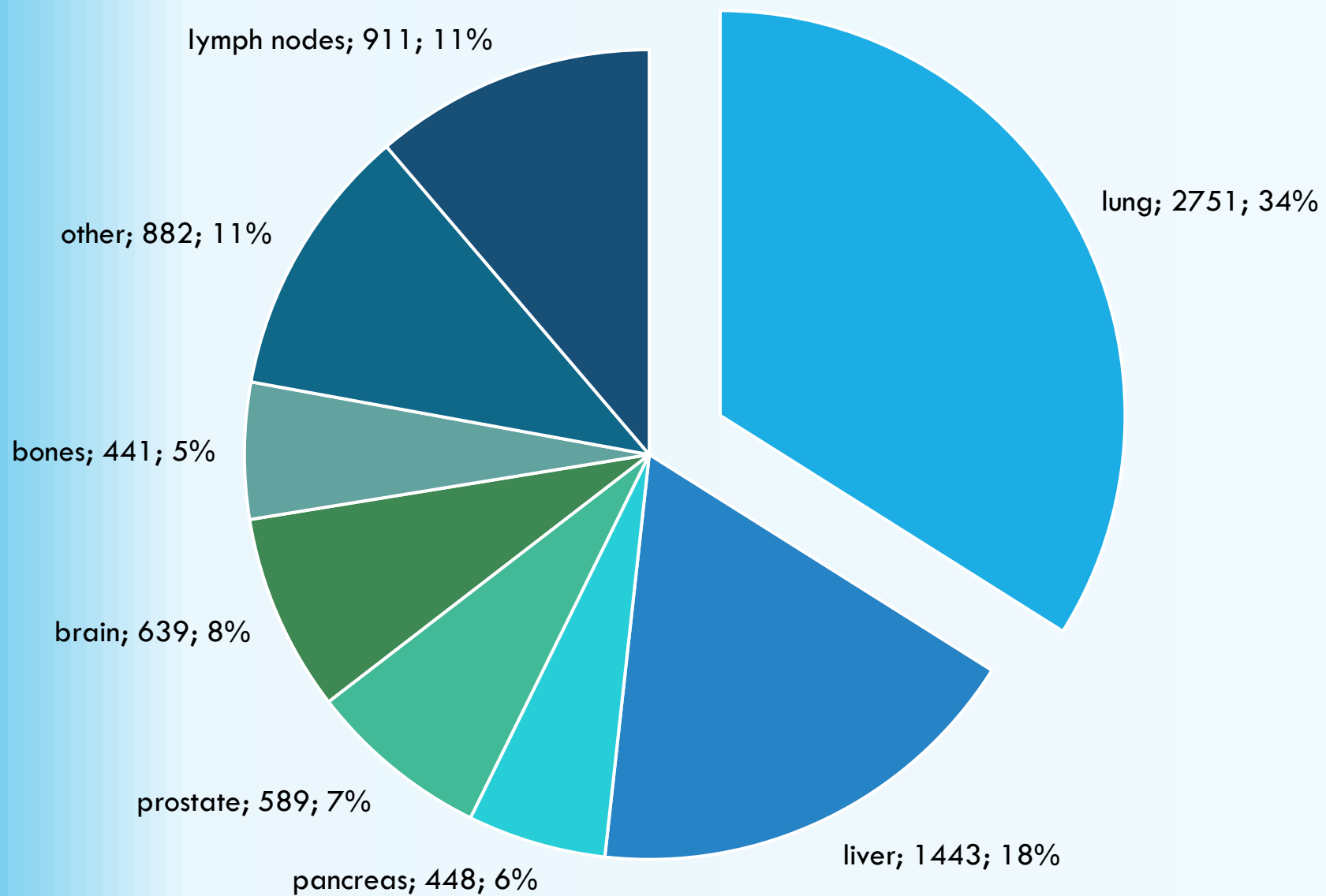
PATIENT RADIATION PROTECTION IN THE CONTEXT OF OLIGOMETASTATIC DISEASE MANAGEMENT

Kosmina Domagoj





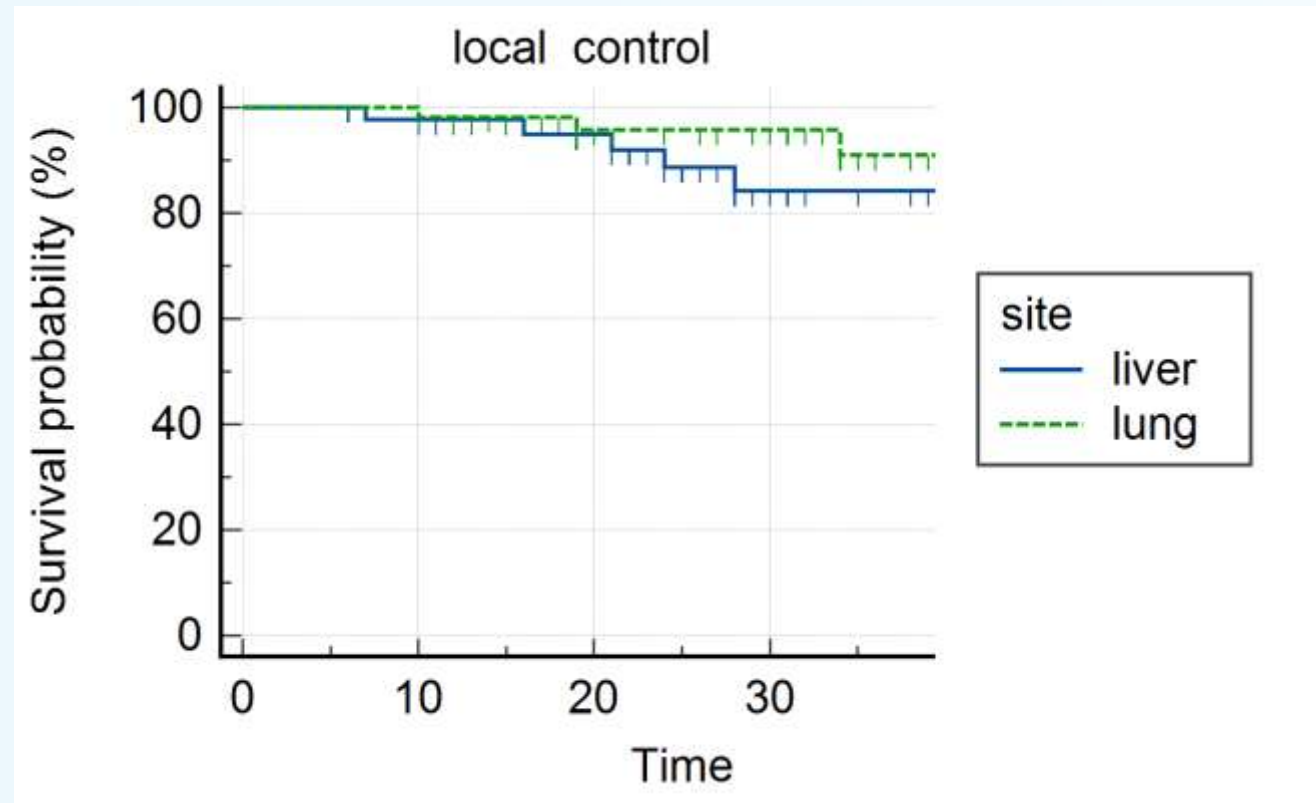
Number (%) of radiosurgery procedures by site (total: 8104)



OLIGOMETASTATIC DISEASE



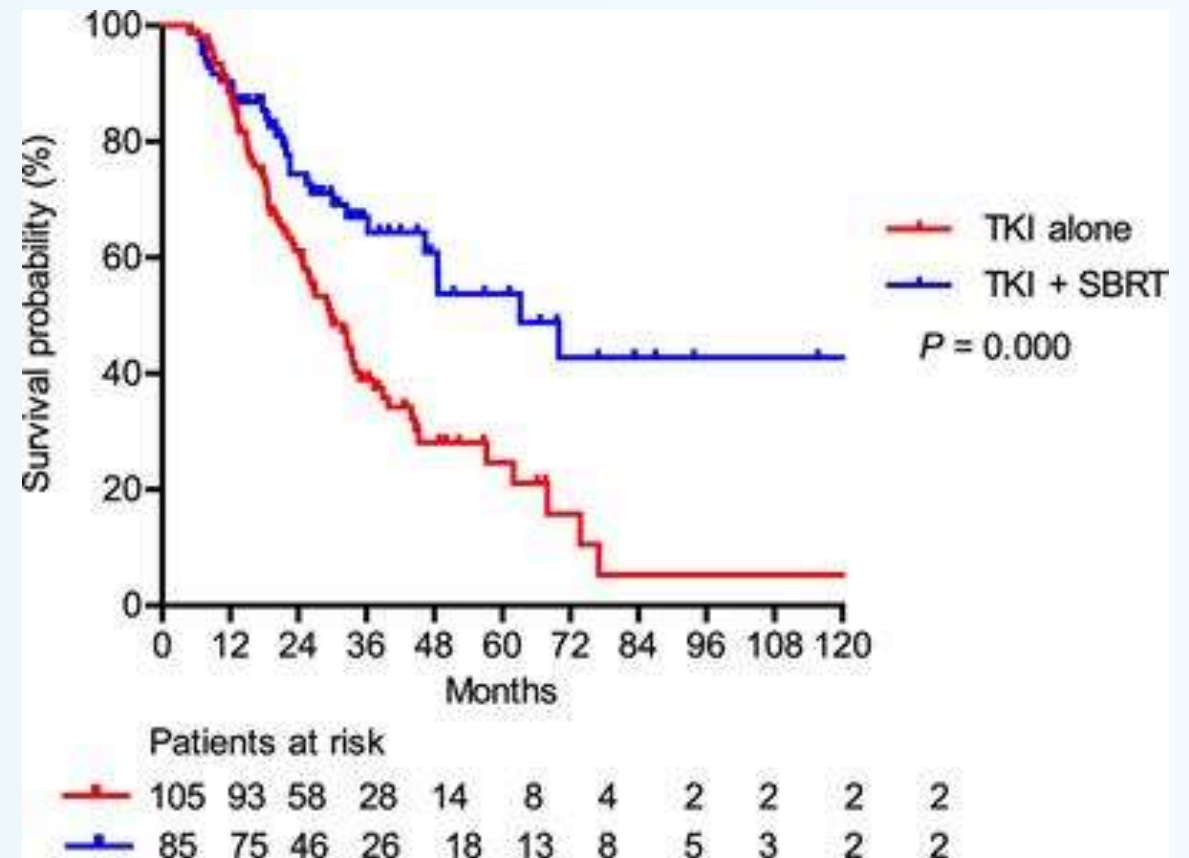
- A stage of cancer between local and systemic widespread disease
- Typically defined as up to 5 lesions in up to 3 different organ systems
- As technology evolves more lesions can be treated
- Oligoprogression + systemic treatment



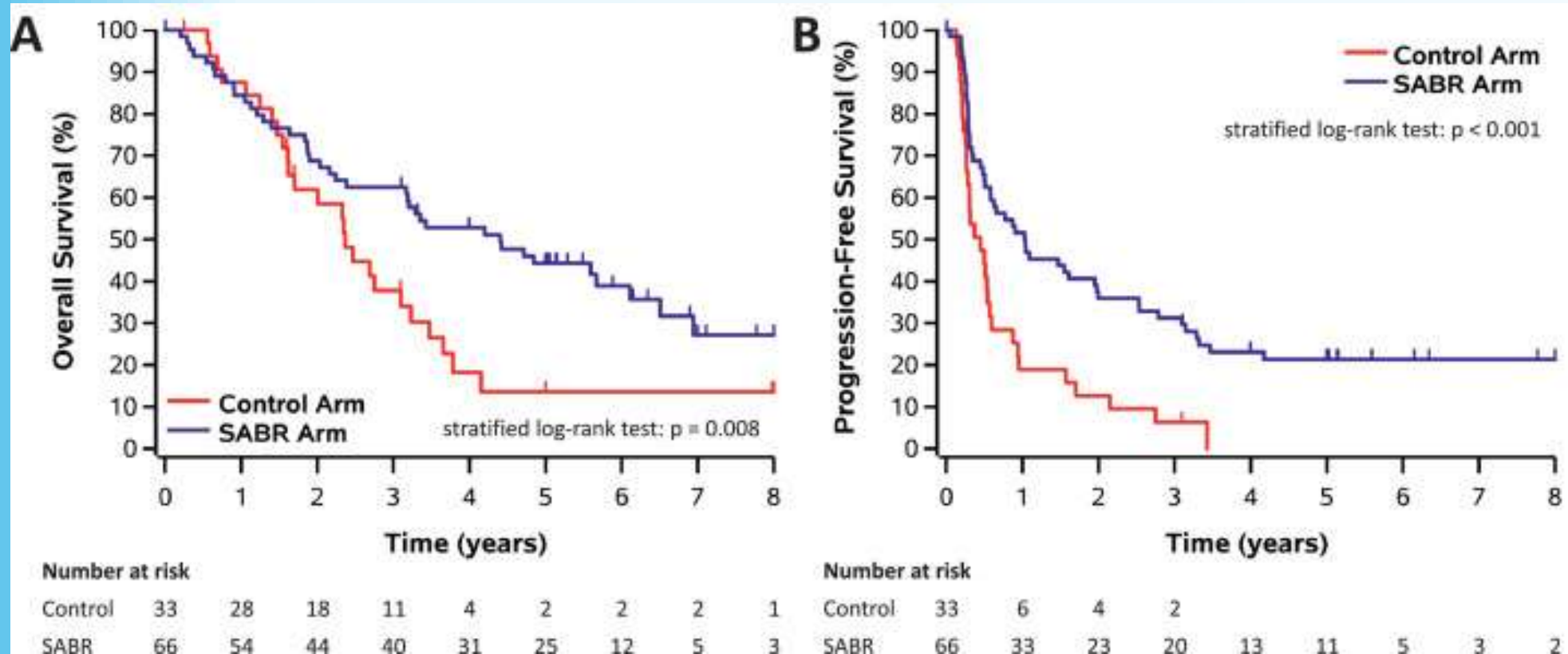
TREATMENT



- Stereotactic ablative body radiotherapy, SABR or SBRT, has emerged as a dominant treatment modality for metastatic disease
- Ablative radiation doses to cancer lesion
- Outpatient procedure, can treat from 5 mm to >50 mm lesions
- Effective and low risk of toxicity
- Can only treat what we can „see”
- Do we care about diagnostic dose?



TREATMENT



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Stereotactic Radiation for the Comprehensive Treatment of Oligometastases (SABR-COMET): Extended Long-Term Outcomes

• Stephen Harrow, MBChB, PhD, David A. Palma, MD, PhD, Robert Olson, MD, MSc, X. Melody Qu, MD, MPH, Andrew Warner, MSc, Suresh Senan, MBBS, PhD

Published: May 25, 2022 DOI: <https://doi.org/10.1016/j.ijrobp.2022.05.004>

SECONDARY CANCER RISKS VS CANCER PROGRESSION

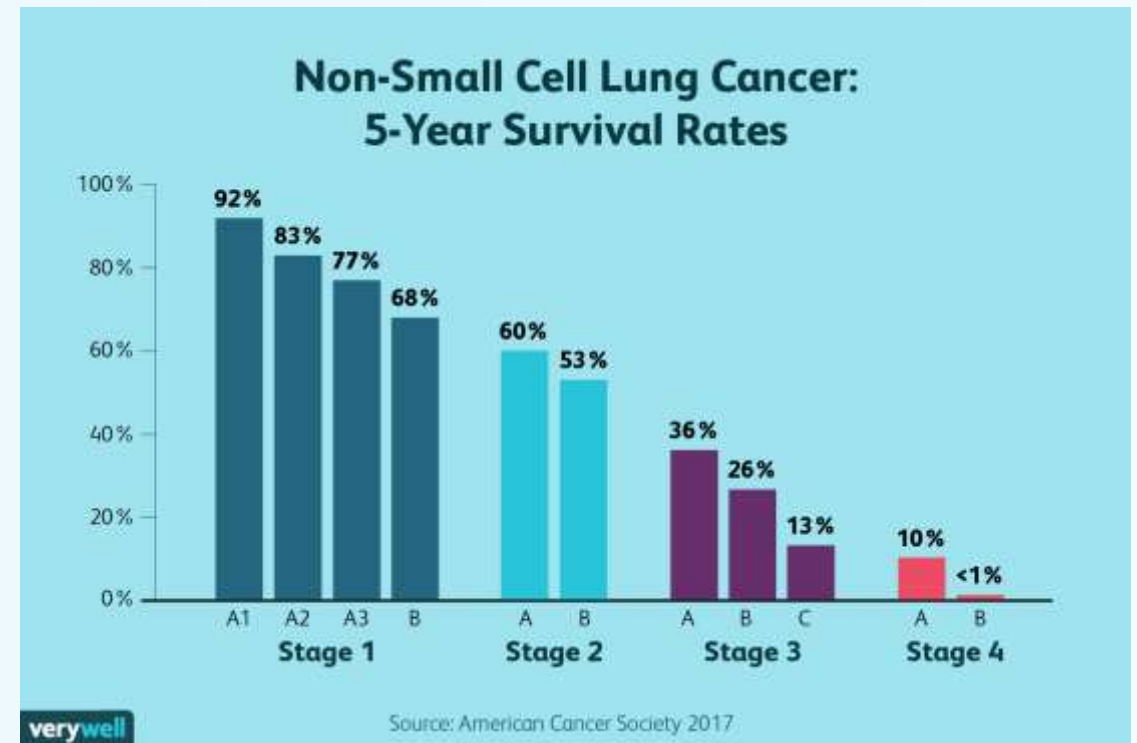


Secondary cancer risk increase with dose, to a relative increase of 50% for doses > 1 Gy

However mean time to secondary cancer measured in decades, example 22 years for breast¹

Stage 4 disease mean survival time is measured in years, sometimes months, colorectal cancer for example is ~ 1 year²

Important to detect secondary lesions early



¹ Olsson H, Baldetorp B, Fernö M, Perfekt R. Relation between the rate of tumour cell proliferation and latency time in radiation associated breast cancer. BMC Cancer. 2003 Apr 9;3:11. doi: 10.1186/1471-2407-3-11. PMID: 12697074; PMCID: PMC155538.

² Rodriguez-Bigas MA, Lin EH, Crane CH. Stage IV Colorectal Cancer. In: Kufe DW, Pollock RE, Weichselbaum RR, et al., editors. Holland-Frei Cancer Medicine. 6th edition. Hamilton (ON): BC Decker; 2003. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK13267/>

MOTIVATION



Low dose protocols are being investigated for use in follow up after cancer, primarily in the lungs

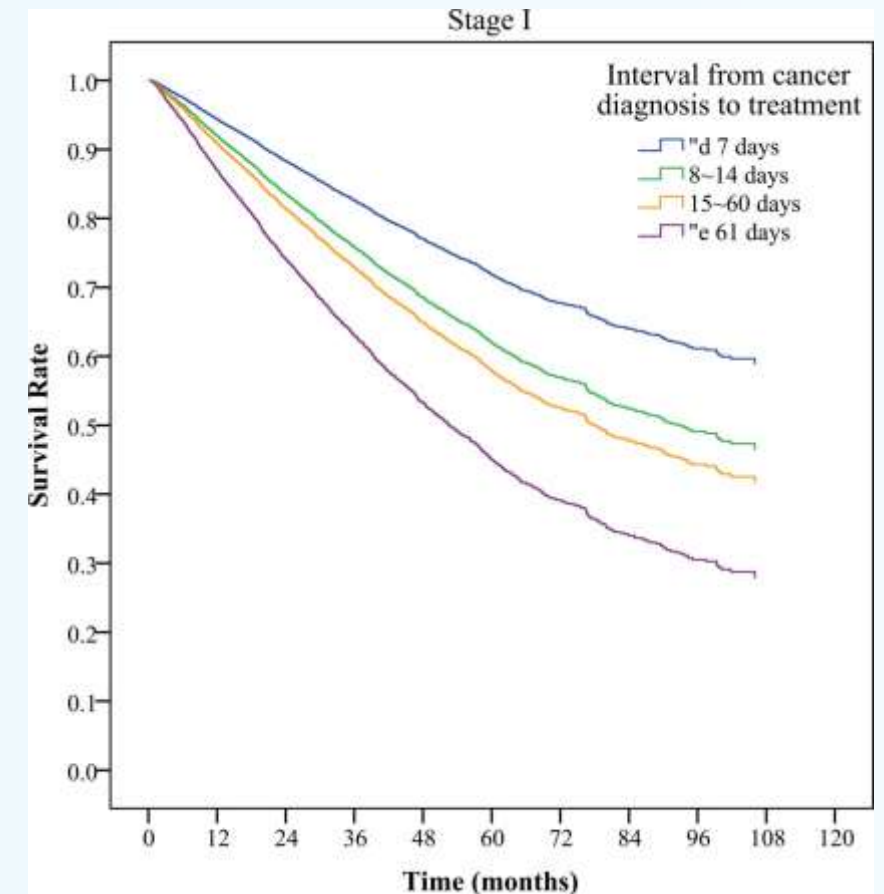
LDCT have a significantly lower radiation dose, but the tradeoff is that their sensitivity is lower (0.6-0.9)^{1,2,3}

In the context of oligometastatic disease, the risk of not detecting a lesion is by far greater than the benefit of ionising dose reduction

¹ Gobi K, Arunachalam VK, Varatharajaperumal RK, Cherian M, Periaswamy G, Rajesh S. The role of ultra-low-dose computed tomography in the detection of pulmonary pathologies: a prospective observational study. *Pol J Radiol*. 2022 Nov 4;87:e597-e605. doi: 10.5114/pjr.2022.121433. PMID: 36532248; PMCID: PMC9749781.

² Gheysens, G., De Wever, W., Cockmartin, L. *et al*. Detection of pulmonary nodules with scoutless fixed-dose ultra-low-dose CT: a prospective study. *Eur Radiol* **32**, 4437–4445 (2022).

³ Paks M, Leong P, Einsiedel P, Irving LB, Steinfort DP, Pascoe DM. Ultralow dose CT for follow-up of solid pulmonary nodules: A pilot single-center study using Bland-Altman analysis. *Medicine (Baltimore)*. 2018 Aug;97(34):e12019. doi: 10.1097/MD.00000000000012019. PMID: 30142849; PMCID: PMC6112944.



Tsai C, Kung P, Kuo W, *et al*
Effect of time interval from diagnosis to treatment for non-small cell lung cancer on survival: a national cohort study in Taiwan
BMJ Open 2020;**10**:e034351. doi: 10.1136/bmjopen-2019-034351

METASTASIS GROWTH AND APPEARANCE

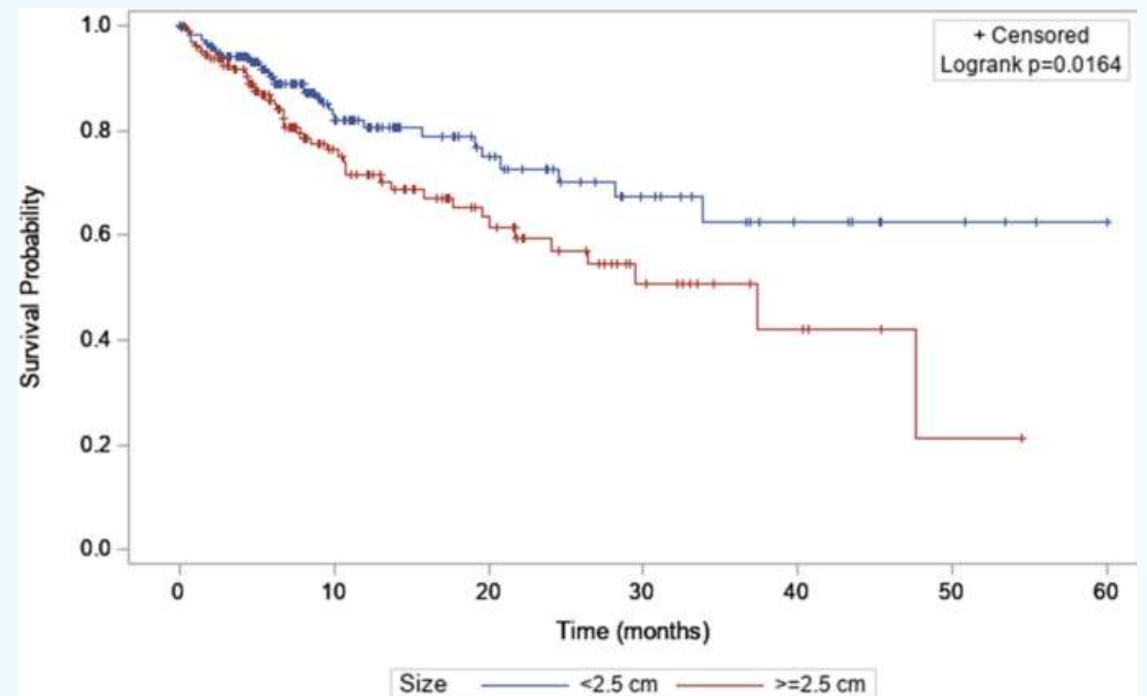


Mean volume doubling time of secondary lesions is ~ 3 months

Secondary lesions can seed new secondary lesions, even reseed the primary tumor site

For cancer follow up, typical interval is 3 months

What happens if lesion is missed on 1 follow up and then detected on the next



METHODS AND RESULTS

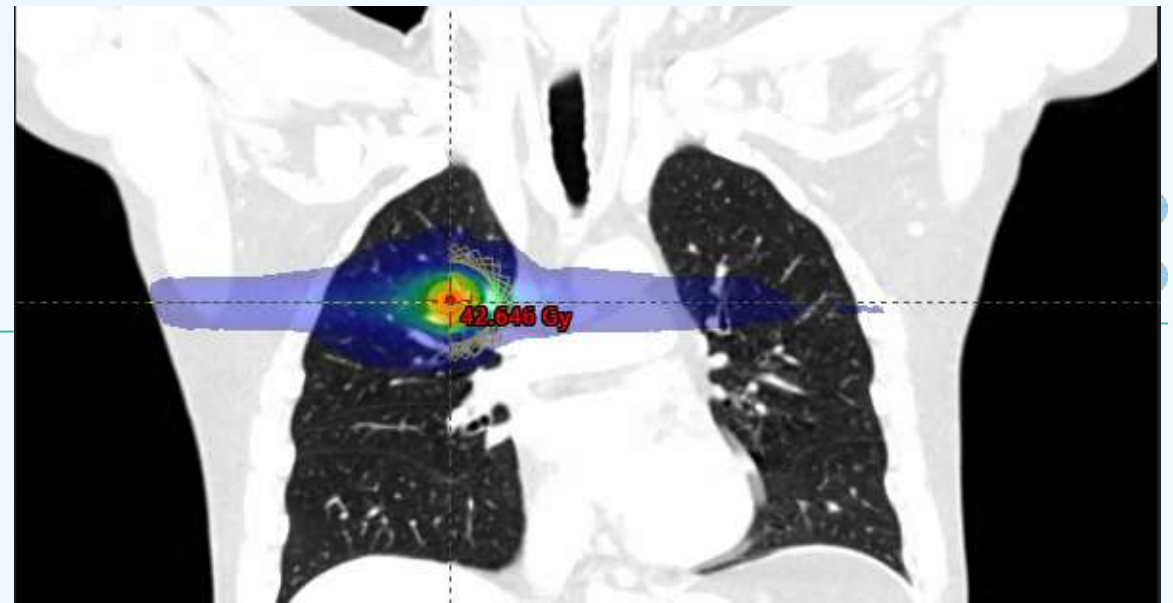
61 lung lesions from 20 patients,
DIBH, single fraction

Lesions were isotropically
expanded so their volume doubled

Forced density in new GTVs to
correspond to original

Plans were calculated using
knowledge based planning models,
both original and modified

The 1 Gy volume was compared ~
100x CTDI SDCT

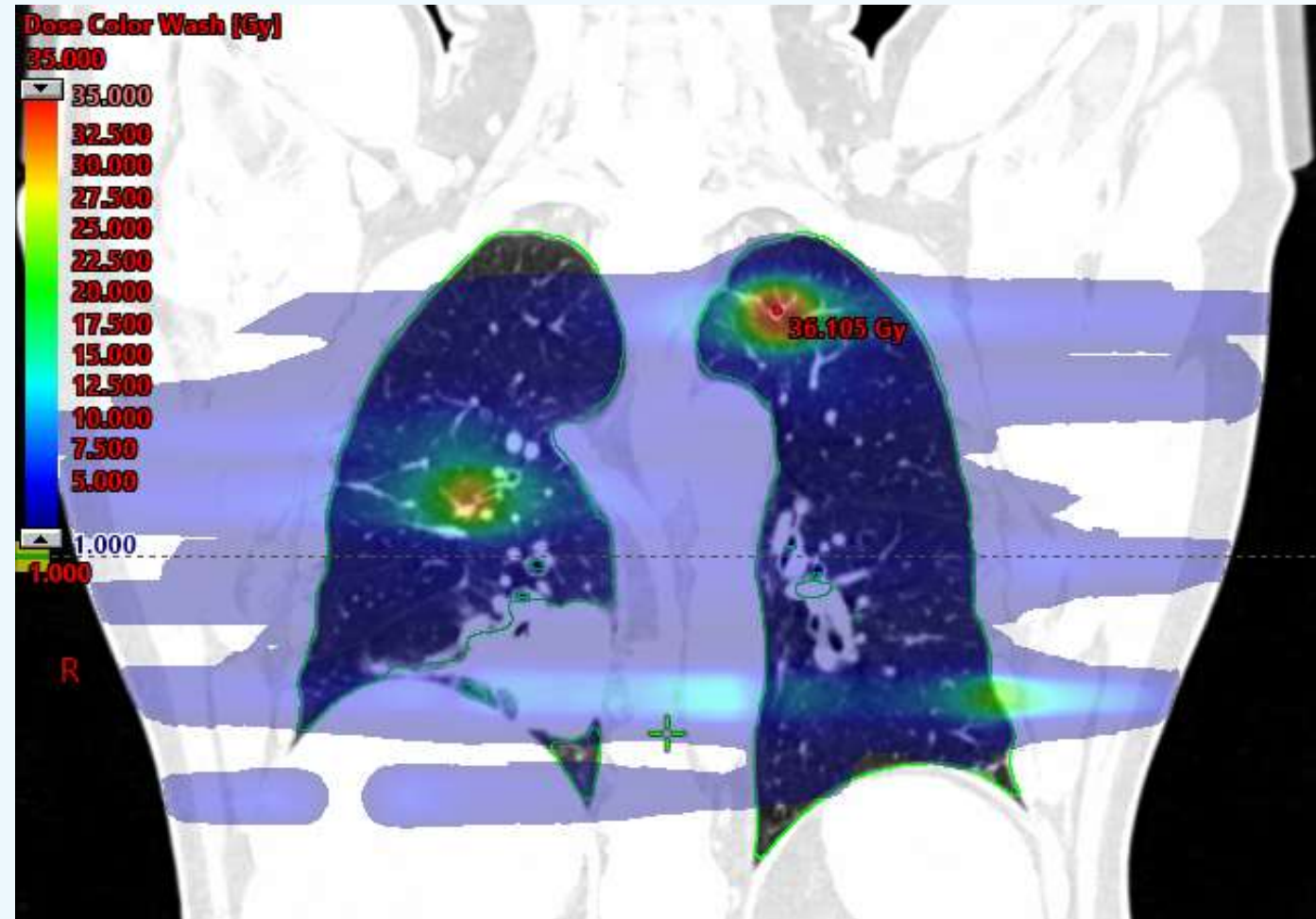


	Original	Double GTV volume
Volume (mean)	0.1 – 2.1 ccm (0.6 ccm)	0.2 – 2.2 ccm (1.2 ccm)
1 Gy volume	1582 cc	2324 cc

DRL DIAGNOSIS/DIAGNOSTIC



- Optimize diagnostic procedure based on patient **diagnosis**/complaint
- For cancer diagnosis focus on quality over lowering the diagnostic dose
- Benefit does not outweigh the risks for patients with a cancer diagnosis



CONCLUSION



Disease control is based on lesion detection – higher diagnostic radiation doses improve detection

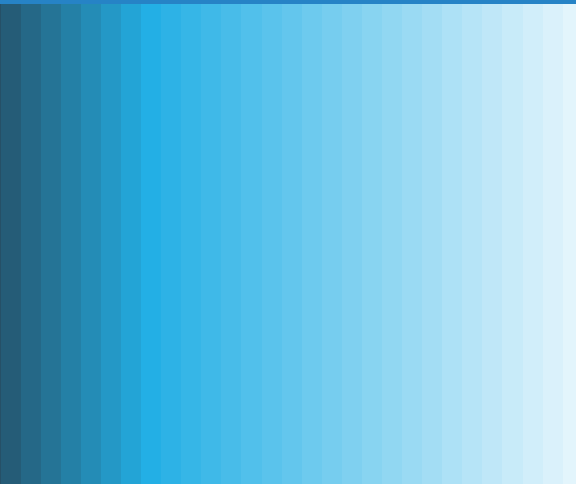
Aside from cancer biology risk factors, lower sensitivity of LD-CT can increase total patient radiation dose do to follow up SABR

HIGHER QUALITY DIAGNOSTIC IMAGING CRUTIAL FOR DISEASE MANAGMENT
– smaller lesions, better disease control and less total dose to the patient

DRL's should take patient diagnosis into consideration – not just localization



OCCUPATIONAL RADIATION PROTECTION IN INTRAOPERATIVE RADIOTHERAPY



INTRAOPERATIVE RADIOTHERAPY

Low energy (50 kV) dose after tumor resection

Primary locations:

- Breast
- Brain
- Liver
- Rectum
- Spine

Is used for tumor control, iatrogenic dissemination

Replaces some adjuvant radiotherapy

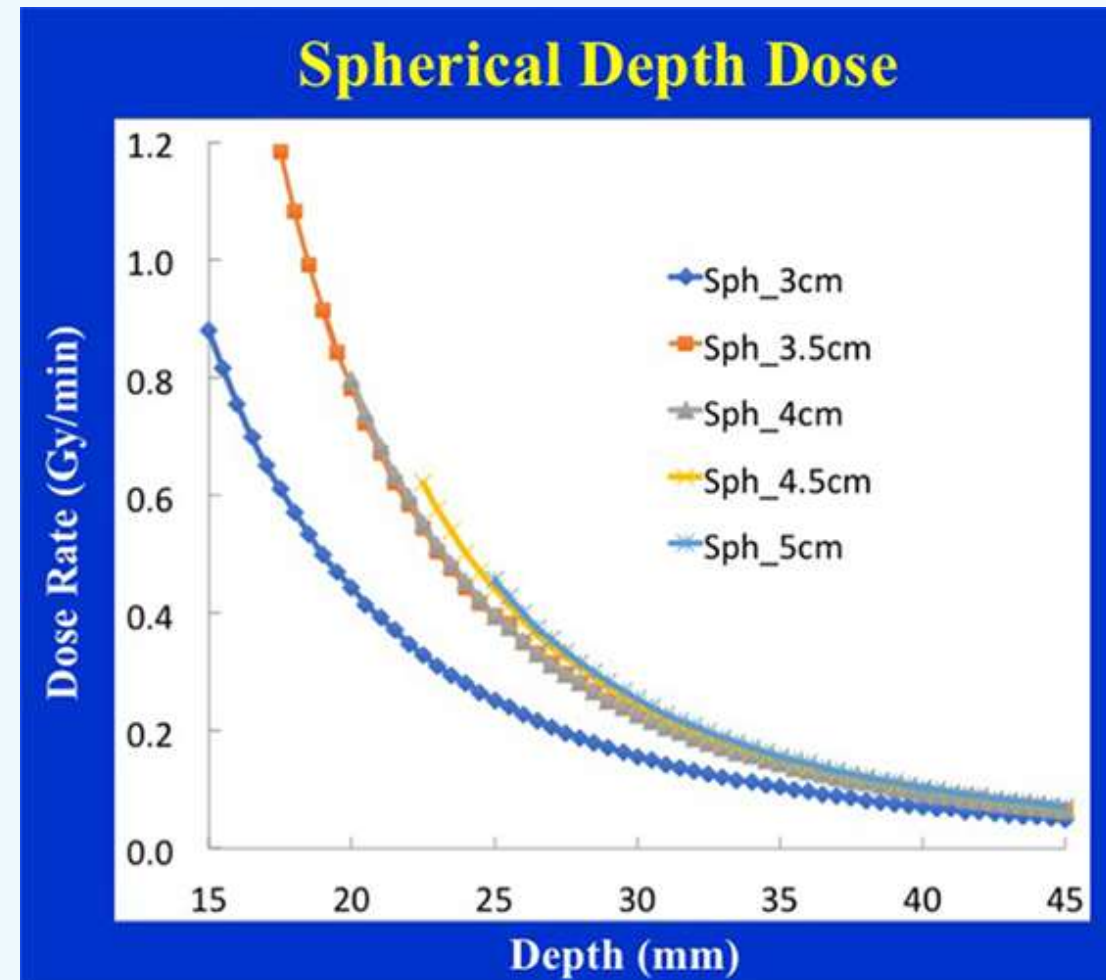




DOSES

50 kV energy

- Cca +30% additional DSB compared to MV external beam therapy
- Typical doses 20-25 Gy to the surface of the applicator
- 30-40 min treatments
- Fast dose fall off in water (soft tissue)
- Dose rate 0.6-0.8 Gy/min at applicator surface
 - Soft tissue attenuates 99% of dose at 2 cm depth
- Treatment occurs in a shielded (2mm Pb shield walls and door) with no staff present in the room during treatment
- Successfully performed, treatment poses no occupational safety risk

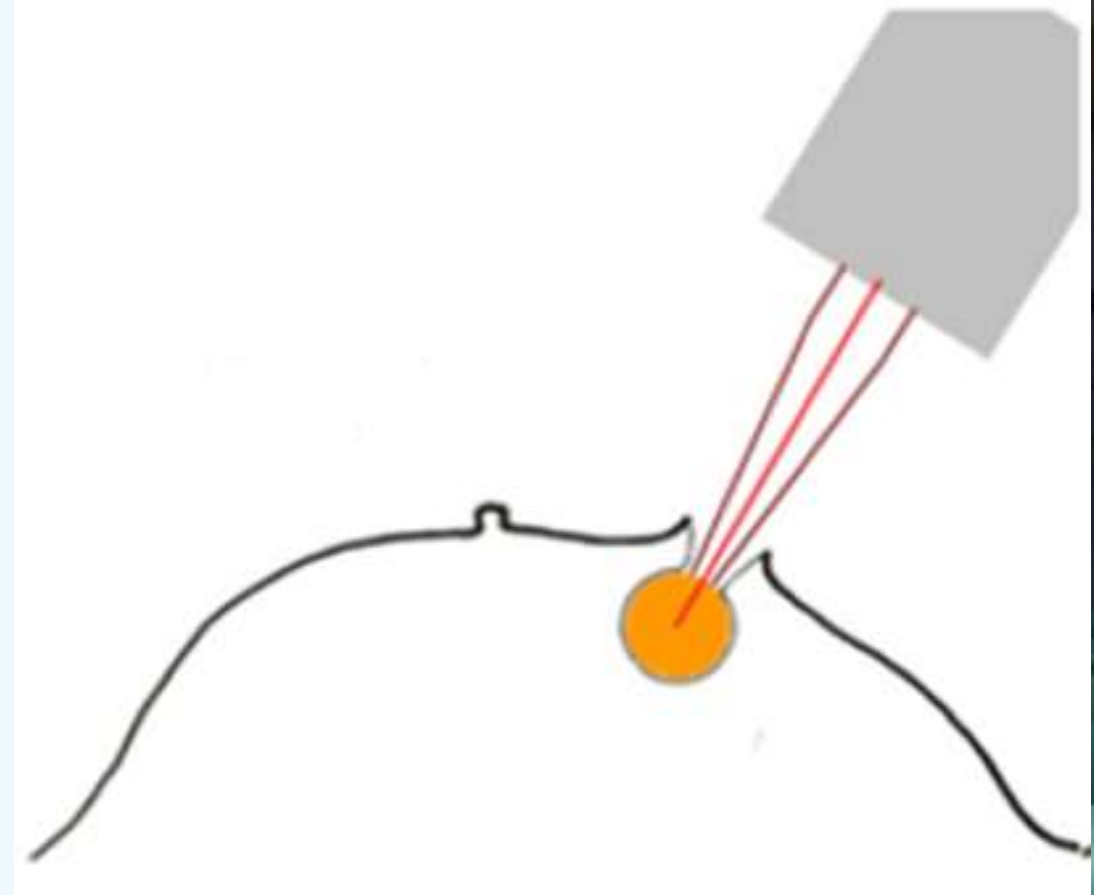


OCCUPATIONAL RISKS

BUT operating theater is not always empty during IORT treatment:

REASONS:

- Anesthesia drip needs to be adjusted (3 min)
- Surgeon forgot phone (2 min)
- Anesthesiologist forgot her papers (4 min)
- Is it safe?
 - Treatment pause is possible, but do you prolong the patient treatment?
- Dose rates at ~ 1 m from patient range from 0.03 mGy/min to 2.8 mGy/min, depending on the site and depth of applicator
- High dose rates happen when breast applicator is used, and part of applicator is close to skin



OCCUPATIONAL DOSES



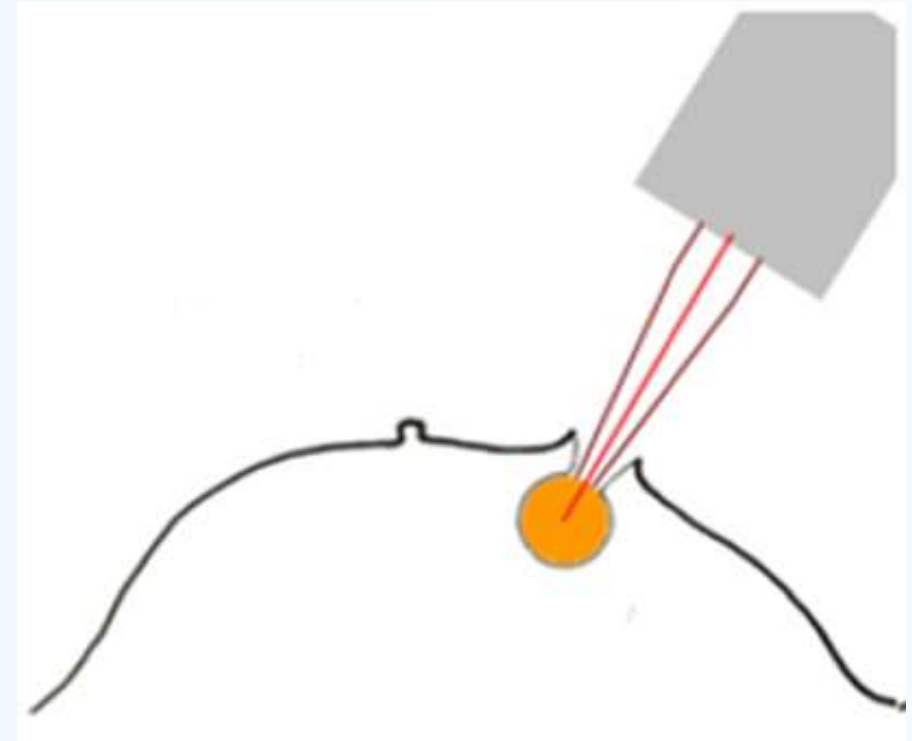
Staff can receive significant doses even with a short stay

A 3 min stay near the patient can lead to a additional dose of 140 μSv

While not significant, can accumulate over working lifetime, even if incidental

Recommendation:

- Always pause treatment when staff is entering theatre
- Staff entering to wear lead aprons
- Identify potential risk patients (breast) and apply shielding to patient skin
 - 0.5 mm lead equivalent lead rubber shielding reduces dose rate by a factor of 20
 - Wet surgical gauze wrapped around the breast in 1 cm thick layer reduces dose by factor of 6



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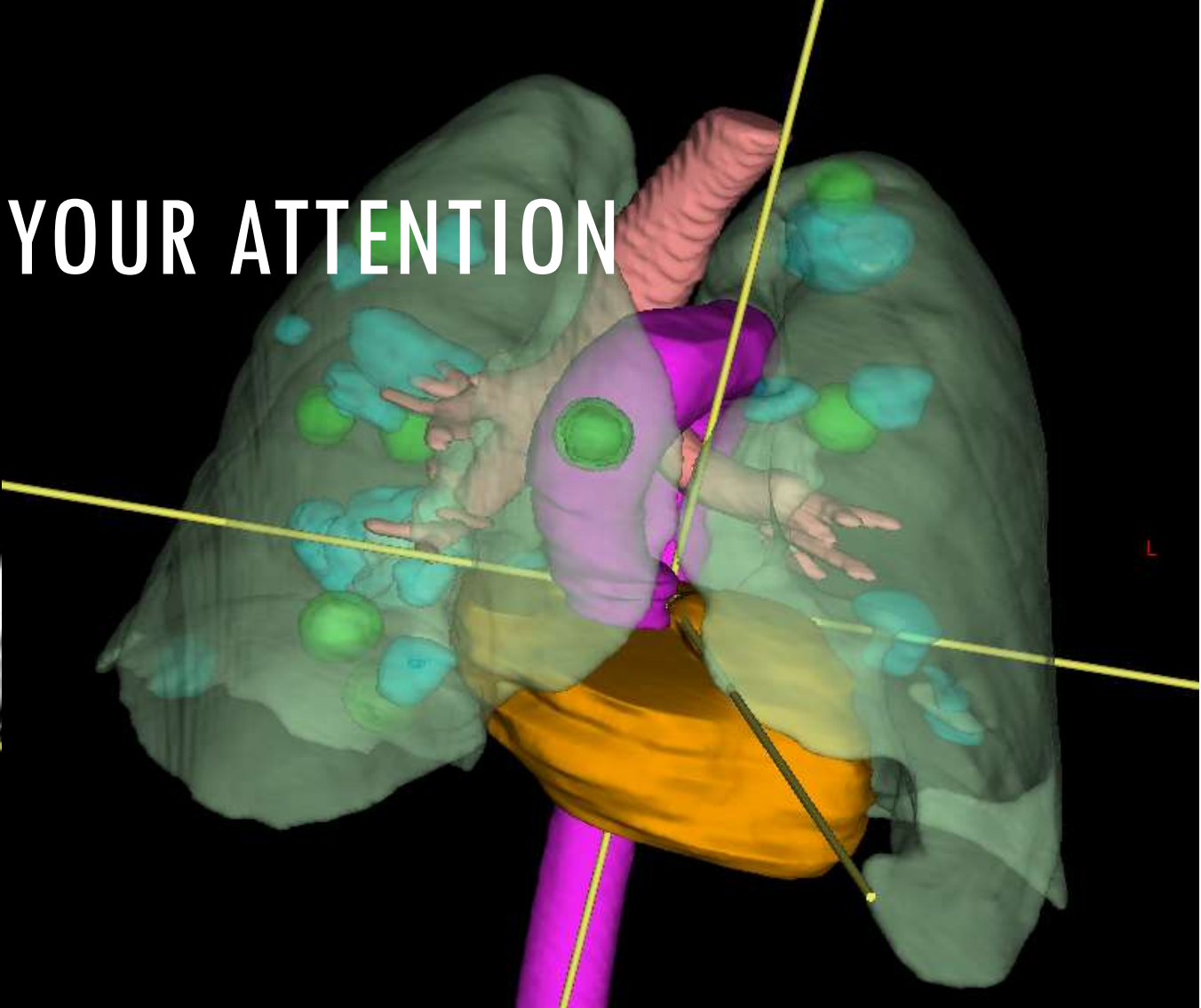
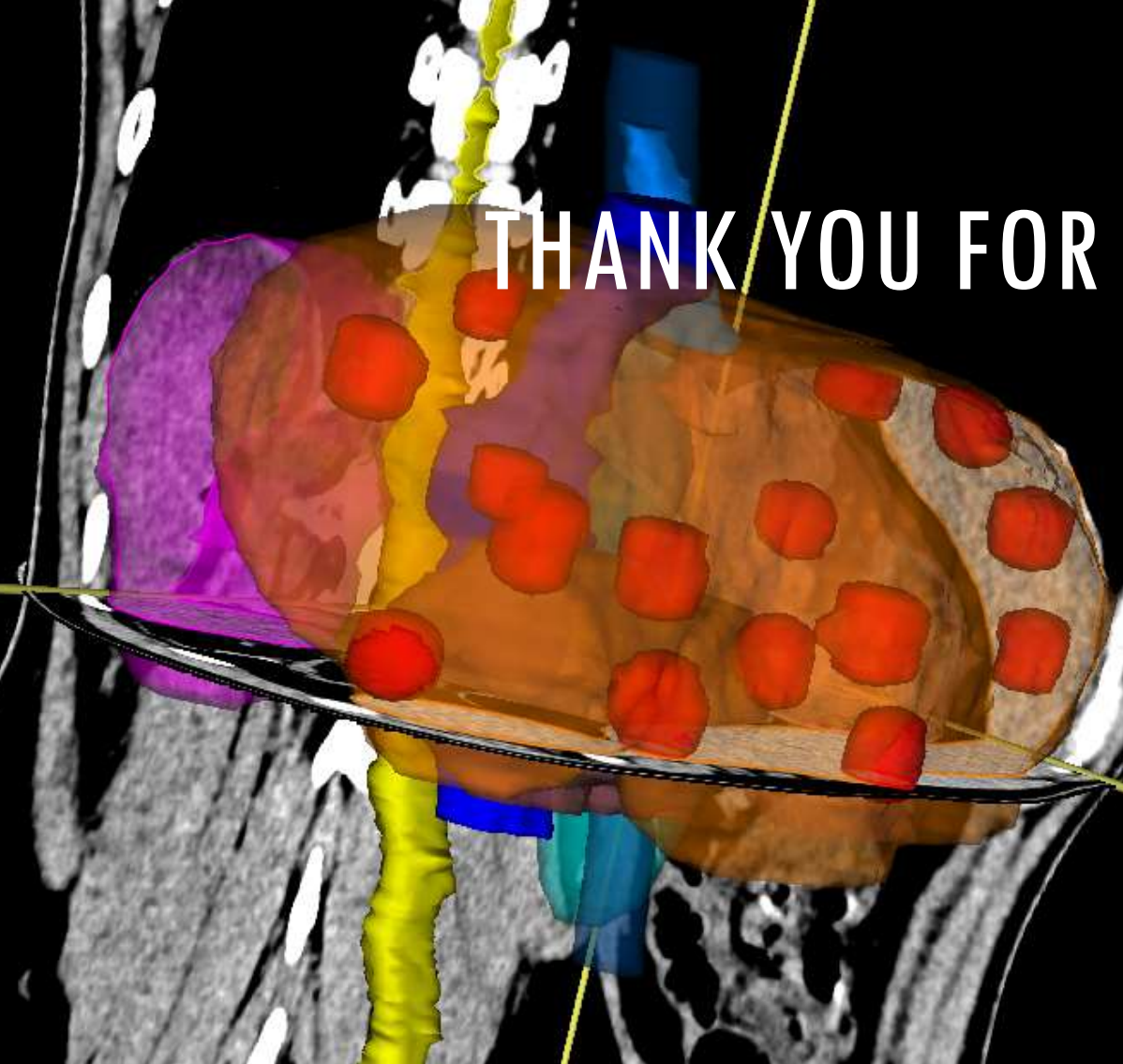
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THANK YOU FOR YOUR ATTENTION



RADIOCHIRURGIA
ZAGREB