Location

Milling Hotel Park, Viaduktvej 28, 5500 Middelfart. Plenary room: No. 12+13.

PRE-MEETING ACTIVITIES

November 24

Note: Requires separate registration

09:30-12:00: DESIRE national user meeting *(room 12+13, plenary)*
13:00-15:00: Palliative radiotherapy WP meeting *(room no. 21)*
13:00-16:00: Adaptive radiotherapy WP workshop *(room no. 19+20)*
15:00-15:45: DESIRE/DcmCollab 101 session *(room no. 12+13)*
15:00-16:00: Kick-off meeting - WP on shared decision-making *(room no. 17)*

ANNUAL MEETING PROGRAMME

Monday November 24

16:00-16:15: Welcome to the annual meeting 2025 - *Cai Grau*

16:15-17:15: Session 1 (Opening session): Radiotherapy and late effects – what to do after transformation and structural reform?
Chairs: Jimmi Søndergaard, Aalborg & Jesper Grau Eriksen, Aarhus

- **16:15-16:30:** DBCG app - late effects registration - *Birgitte Offersen, Aarhus*
- **16:30-16:40:** What do patients think? - *TBC - Pernille Bech, Clinical Nurse Specialist, Vejle*
- **16:40-16:50:** Examples of other initiatives
    - Online registration of late effects the PRIOR reirradiation protocol - *Camilla Kronborg, DCPT*

    - Necessity breeds creativity: AmbuFlex Follow-up for Head and Neck patients in Aarhus - *Jesper Eriksen, Aarhus*
- **16:50-17:15:** Discussion: DMCGs - What data do you collect regarding late effects? What are the common denominators across diagnoses? Other initiatives? National solutions?

17:15-17:40: **AIM@CANCER – a new and visionary large-scale AI-project in radiotherapy** - *Stine Korreman, DCPT*

17:40-18:40: Session 2: Discussions groups - project presentations from abstracts *(7+3 and 10 min. joint discussion in each group).*

Group 1: (plenary room 12+13)
Chair: Maja Maraldo

- Moving towards objective cosmetic outcome self-evaluation: machine learning on photos from breast conserving treatment - *Morten Sahlertz, DCPT*
- Radiosensitivity biomarkers as rational for subclassification of Head & Neck Squamous Cell Carcinomas - *Anders Frederiksen, Aarhus*
- Robustness of Proton vs. Photon Therapy in Locally Advanced Esophageal Cancer: Lessons from the European PROTECT Trial - *Sarah Eckholdt Jensen, Aarhus*
- Radiotherapy quality assurance of patients with squamous cell carcinoma of the head and neck included in the DAHANCA 19 randomised phase III trial - *Christian Rønn Hansen, Odense*
- Simulation-free online adaptive radiotherapy for patients receiving palliative radiotherapy - *Lisette Juul Sten, Herlev*

Group 2: (room no. 19+20)
Chair: Stine Korreman

- DAHANCA FORWARD: 20 years of head and neck cancer radiotherapy data - *Sarah Wordenskjold Stougaard, Odense*
- Influence of insert position on proton stopping-power ratio estimation accuracy using photon-counting CT - *Lasse Bassermann, DCPT*
- Local recurrence with and without a tumour-bed boost: a post-hoc analysis of the DBCG IMN2 study - *Anders W. Mølby Nielsen, Aarhus*
- Validating the Danish guideline of thoracic radiotherapy for patients with LD-SCLC in a real-life cohort - *Sara Linde, Aarhus*
- Tissue Oxygenation Modulates the FLASH Effect: Evidence from a Murine Skin Model - *Anna Hansen, Aarhus*

Group 3: (room no. 15)
Chair: Jeppe Friborg

- Breaking Barriers in Breast Cancer Trials: Non-Accrual Insights from the phase III randomized clinical DBCG NATURAL and PROTON trials - *Bjarke Baisner, Aarhus*
- Does proton biological effectiveness change with dose fractionation? Insights from an in vivo study - *Cathrine Overgaard, Aarhus*

- Mapping Toxicity Data and Patient Related Outcomes in Reirradiation of Thoracic Cancers - *Cæcilie Godsk Ottosen, Aarhus*
- Simulation free palliative radiotherapy based on diagnostic images without daily adaptation - *Rune Slot Thing, Vejle*

Group 4: (room no. 21)
Chair: Ditte Sloth Møller

- Towards a pediatric-specific treatment planning proton range uncertainty - *Kyriakos Fotiou, DCPT*
- Patients' and radiotherapy personnel's attitudes towards AI in radiotherapy: a scoping review - *Frederik Voigt Carstensen, Copenhagen*
- Combining fractionation and FLASH tissue sparing - *Line Kristensen, Aarhus*
- New Treatment Options for Hepatocellular Carcinoma - *Amalie Borg Bjørn, Aarhus*
- Beyond the First Cut: Impact of repeat surgery versus boost on breast induration. A post hoc analysis from the DBCG HYPO & PBI trials - *Kristine Høgsbjerg, Aarhus*

19:00: Networking dinner

Tuesday November 25

08:30-08:35: Good morning and welcome - *Cai Grau*

08:35-09:35: Session 3: Updates from WP's
Chair: Martin Berg (TBC)

- **08:35-09:10:** Palliative radiotherapy - *Lars Fokdal, Vejle & Anna Mann Nielsen, Herlev*
- **09:10-09:20:** Adaptive radiotherapy - *Laura Kaplan, Næstved, Thomas Ravkilde, Aarhus & Mette Felter, Herlev*
- **09:20-09:30**: DESIRE - *Christian Rønn, Odense, Ivan Vogelius, Copenhagen & Stine Korreman, DCPT*
- **09:30-09:35:** Shared decision-making - *Anne Wilhøft Kristensen, DCPT*

09:35-10:25: Session 4: 5 selected oral presentations from abstracts *(7+3)*
Chairs: Ivan Vogelius, Copenhagen & Faisal Mahmood, Odense (TBC)

- **09:35-09:45**: Danish recommendations for radiotherapy quality assurance in clinical trials - *Eva Samsøe, Næstved & Christian Rønn Hansen, Odense*
- **09:45-09:55**: Artificial Intelligence for early detection of non-communicable disease risk in people with breast cancer: Multicenter Cardiac Decision Impact study (ARTILLERY-CarDI trial): study protocol - *Belinda Bøgh Irankunda, Copenhagen*
- **09:55-10:05**: Virtual MR-linac Center for Eastern Denmark: Equal Access, Shared Innovation and Expertise - *Mette Felter, Herlev*
- **10:05-10:15**: The technological landscape of paediatric radiotherapy in Denmark from 2008 to 2024 - let the past guide the present and future - *Daniella Østergaard, Copenhagen*

- **10:15-10:25**: A robustness-inclusive comparison of proton- versus photon-based whole-pelvic radiotherapy for prostate cancer within a randomised clinical trial - *Sofie Tilbæk, DCPT*

10:25-11:00: Coffee

11:00-12:30: Session 5 (interactive): Making impactful and meaningful trials for all patients
Organisers: Anne Bisgaard, Odense, Mette Felter, Herlev, Sidsel Højklint Poulsen, Copenhagen, Daniella Østergaard, Copenhagen, Ellen Lund Schaldemose, Vejle, Anders W. Mølby Nielsen, Aarhus & Laura Kaplan, Næstved

Participants will be divided into groups and discuss one of three themes:

- Theme 1: What do you do with 50 patients? *(plenary room)*
  Study designs for small patient cohorts
  Introductory talk by Ane Appelt, Copenhagen
- Theme 2: What do you do with 2000 patients? *(room no. 19+20)*
  Large database studies in Denmark
  Introductory talk by Jens Overgaard, Aarhus
- Theme 3: .. But have you asked the patients? *(room no. 21)*
  Patient involvement in radiotherapy trial design
  Introductory talk by Anne Wilhøft Kristensen, DCPT

Schedule *(parallel within each theme)*:
- **11:00-11:05:** Plenary introduction and walk to breakout rooms
- **11.05-11:30**: Introductory talks and practical information
- **11:30-12:00:** Group discussions
- **12:00-12:30:** Joint discussions

12:30-13:20: Lunch

13:20-14:20: Session 6: Emerging trials and new concepts *(7+3)*
Chairs: Claus Behrens, Herlev & Claus Andersen, DTU (TBC)

- **13:20-13:30**: Reirradiation protocols: CureLung & PRIOR - *Lone Hoffmann, Aarhus*
- **13:30-13:40**: Evaluating the clinical potential of photon-counting CT for radiotherapy - *Louis Mathias Dreyer Teller, Herlev*
- **13:40-13:50**: Exploring the performance of deep learning–based dose prediction for head and neck cancer on a DAHANCA clinical dataset - *Camilla Panduro Nielsen, Odense*
- **13:50-14:00**: The value of online adaptive radiotherapy for head and neck cancer without margin reduction - *Anne M. Lindegaard, Copenhagen*
- **14:00-14:10**: OLIGO-DK: the national longitudinal cohort study of local ablative therapy in oligometastatic disease - current status - *Michael Ruben Teindl Laursen, Herlev*

- **14:10-14:20**: The apparent diffusion coefficient changes during short course radiotherapy in rectal cancer: a multicentre study - *Anne Bisgaard, Odense*

14:20-15:25: Session 7 (Closing session): Debate on performing clinical research and implementing results in the radiotherapy clinics

Chairs: Birgitte Offersen, Aarhus & Eva Samsøe, Næstved

- With panel: Eva Samsøe, Næstved, Jimmi Søndergaard, Aalborg, Hanna Rahbek Mortensen, DCPT, Karen-Lise Garm Spindler, Aarhus, Lars Fokdal, Vejle, David Sjöström, Herlev, Ivan Richter Vogelius, Rigshospitalet & Tine Schytte, Odense

15:25: Closing remarks

15:30: Goodbye

DCCC Radiotherapy

Moving towards objective cosmetic outcome self-evaluation: machine learning on photos from breast conserving treatment

Morten Sahlertz (1,2), Ida Ravnsbæk Johannsen (1,3), Emil Alsner (1,3), Mette Holck Nielsen (4), Else Maae (5), Mette Møller (6), Mechthild Krause (7), Andreas Schreiber (8), Tine Engberg Damsgaard (9,10), Mette Eline Brunbjerg (11), Birgitte Vrou Offersen (1,2,3,12), Jasper Nijkamp (1,2)

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DCCC Radiotherapy

Introduction

Cosmetic outcome (CO) after breast-conserving treatment strongly affects long-term satisfaction, yet systematic follow-up is no longer routine. Our aim is to develop automated, selfie-based CO assessment integrated with patient-reported outcomes. Here, we evaluated whether machine learning (ML) models can classify CO from photographs alone by testing different training strategies and feature sets.

Materials and methods

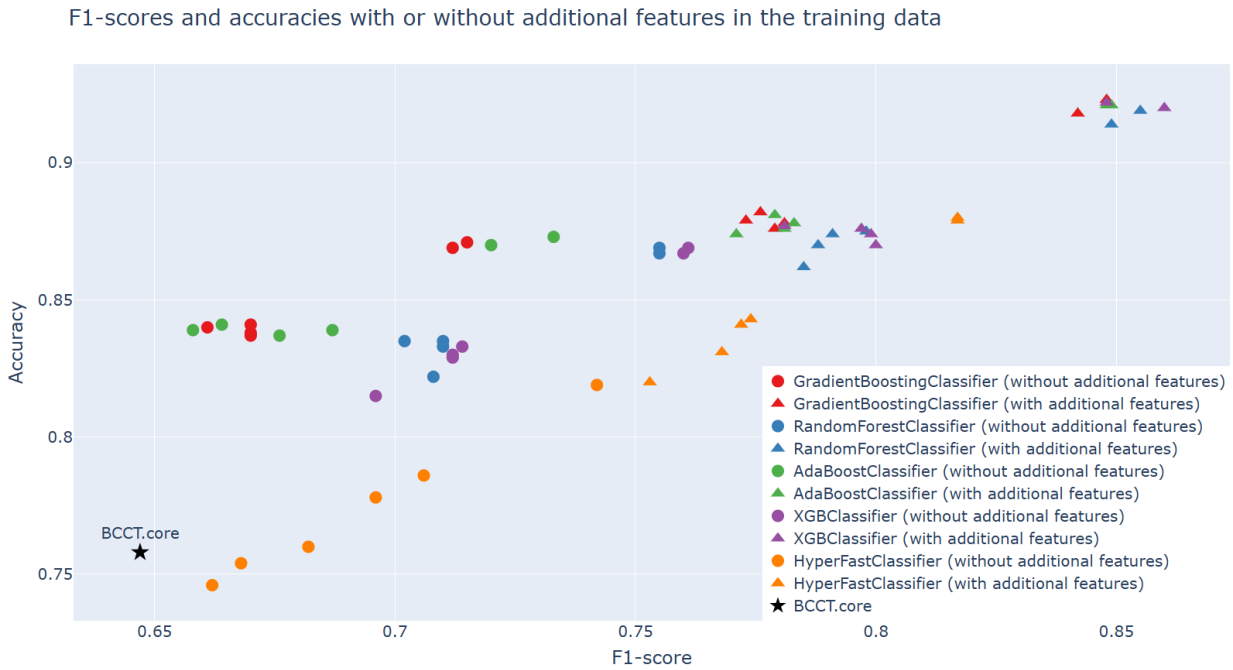
We used data from two Danish Breast Cancer Group trials (HYPO, PBI), comprising 11,114 standardized photographs of 2,359 patients across five centres, collected before radiotherapy and at follow-up (1–10 years). Clinicians rated CO on a four-level scale (Excellent, Good, Fair & Poor) based on physical examination and assessed scores for dyspigmentation, telangiectasia, induration, scar visibility, and oedema. Patient-reported outcomes included satisfaction, pain, and analgesic use. ML classifiers were trained using 122 image-derived features quantifying asymmetry and colour dissimilarity between the treated and untreated breast. The pipeline included training with and without additional clinical and patient-reported variables e.g. induration and patient satisfaction. The performance was evaluated on a test set comprising 20% of the data, split at the patient level to avoid patient overlap and randomly otherwise, using binary accuracy (Excellent/Good vs. Fair/Poor) and macro F1-score and compared to BCCT.core[1] the currently most used objective scoring method.

Results

Models trained with both image-derived and additional features consistently outperformed image-only models. Accuracy and F1-scores improved across classifiers, indicating that CO cannot be fully explained by visual asymmetry and colour differences alone. Clinical markers such as induration and scar visibility added complementary information that captured aspects of CO not detectable from photographs. The model with additional features that yielded the highest F1-score (F1-score 0.860 & 92.0% accuracy) outperformed BCCT.core substantially (F1-score 0.647 & 75.8% accuracy).

Conclusion

Importantly, the models outperformed BCCT.core, the current standard for objective CO scoring, achieving higher F1-scores and accuracies, showing that our findings support the feasibility of reliable, image-based CO assessment, opening the possibility for integrating automated, selfie-based evaluation into clinical follow-up. However, including additional clinical and patient-reported features enhanced the predictive performance highlighting the difficulties of classifying CO directly from photos.



[1] https://www.sciencedirect.com/science/article/abs/pii/S0960977607000951

Radiosensitivity biomarkers as rational for subclassification of Head & Neck Squamous Cell Carcinomas

Anders Rønneholt-Frederiksen (1,2) Jesper Grau Eriksen (1,2), Jeppe Friborg (3), Jacob Liljia Fischer (4) Jens Overgaard (1,2)

(1) Dept. of Eksperimental Clinical Oncology, Aarhus Universityhospital, Aarhus (2) Institute of Clinical medicine, Aarhus University (3) Department of Oncology, Rigshospitalet, Copenhagen (4) Department of Orto- Rhino – laryngology, Aarhus Universityhospital

Background

Despite recent advances in genetic tumor biomarkers, radiotherapy (RT) for head and neck squamous cell carcinoma (HNSCC) is still given rather uniformly across mutation profiles. Prognostic factors such as hypoxia, cancer stem-cell markers (CD44, MET, SLC3A2) and genome-based radiosensitivity indices (RSI) may enable stratified RT, particularly for preventing high-dose T-site recurrences.

Objectives

This Ph.D. project integrates multi-modal biomarkers to (1) identify genomic and microenvironmental determinants of high-dose locoregional failure in HNSCC, (2) validate these biomarkers within a contemporary randomized trial, and (3) explore whether normal-tissue genomic variation in RSI-related genes predicts clinical outcomes after RT.

Materials and methods

Study 1 (case–control, DAHANCA19 RCT): Tumors from patients with high-dose T-site failure are compared 1:2 with matched controls (TNM, smoking, p16) yielding around 500 patients available. Exposures include stem-cell biomarkers (CD44, MET, SLC3A2), hypoxia profiling and a 10-gene RSI panel (AR, c-Jun, STAT1, PKC-β, RelA, cABL, SUMO1, PAK2, HDAC1, IRF1).
Study 2 (validation/QA, DAHANCA30 RCT): Among ~500 patients randomized (2:1) to proton versus photon RT, we assess biomarker balance between arms and relate biomarker strata to xerostomia, dysphagia (primary endpoints at 6 months), and locoregional control.
Study 3 (case–control, DAHANCA35 RCT): Next-generation sequencing of ~500 tumors in DAHANCA35 to validate the expected prognostic potential of the RSI based genome associate radiosensitivity profile.

Expected Impact

By unifying tumor genomics, hypoxia, stem-cell markers, and volumetrics within well-annotated Danish HNSCC cohorts, this project seeks to (i) delineate mechanisms of high-dose failures, (ii) validate biology-based risk groups in a modern RCT, and (iii) lay groundwork for prospective, biomarker-guided RT dose personalization—including selective dose escalation for radioresistant phenotypes.

Robustness of Proton vs. Photon Therapy in Locally Advanced Esophageal Cancer: Lessons from the European PROTECT Trial

Eckholdt S (1,2), Mortensen HR (1,2), Appelt AL (3), Byskov CS (4), Defraene G (5), Ehmsen ML (1), Haustermans K (5,6), Jensen MF (1), Møller DS (2,4), Nordsmark M (4), Populaire P (5,6), Thing RS (7), Hoffmann L (2,4)

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Introduction: Patients with locally advanced esophageal cancer are randomized to receive proton (PT) or photon (XT) radiotherapy before surgery in the European phase III PROTECT trial. Robustness of target coverage against setup and range uncertainties and respiration was assessed on planning CT (pCT) and weekly control CTs (cCTs) for 25 patients at a single study site. Accumulated target dose coverage was obtained using daily cone-beam CT (CBCT) imaging.

Materials and methods: Patients were randomized to PT (n=11) or XT (n=14), receiving 50.4Gy(RBE) in 28 fractions. The clinical target volume accounting for respiratory motion (iCTV) should reach $V95\%_{iCTV}$>99% in the nominal plan. Robustness of treatment plans was tested for setup (5mm), range (3.5%, PT only), and respiration ($V95\%_{iCTV}$>97%). pCT plans were recalculated on weekly cCT scans; adaptive re-planning (rCT) was triggered if dosimetric deviations were detected. Additionally, robustness towards respiration and setup uncertainty (PT:2mm/3.5%,XT:2mm) was examined on cCTs with acceptance criteria adjusted throughout treatment.

Synthetic CT models (RayStation) for PT and CBCT electron density curves (MIM) for XT enabled daily CBCT-based dose evaluations. Accumulated daily doses were mapped to pCT.

Results: All nominal plans achieved $V95\%_{iCTV}$>99%. Robustness analysis on cCTs confirmed acceptable dose coverage in ten PT and 14 XT patients (Figure 1A). One PT patient (pt2) showed underdosage on a single cCT and was re-planned.

Accumulated CBCT doses confirmed $V95\%_{iCTV}$>99% for all patients (Figure 1B). Deviations between the accumulated and nominal doses on pCT, cCT, and rCT were <1%, expect for PT pt2.

Conclusion: In 25 PROTECT patients, weekly cCT-based robustness evaluation confirmed adequate target coverage in 24 patients; one PT patient required re-planning. Accumulated daily CBCT doses showed iCTV coverage >99% in all patients, reinforcing the importance of weekly cCT imaging and adaptive radiotherapy.

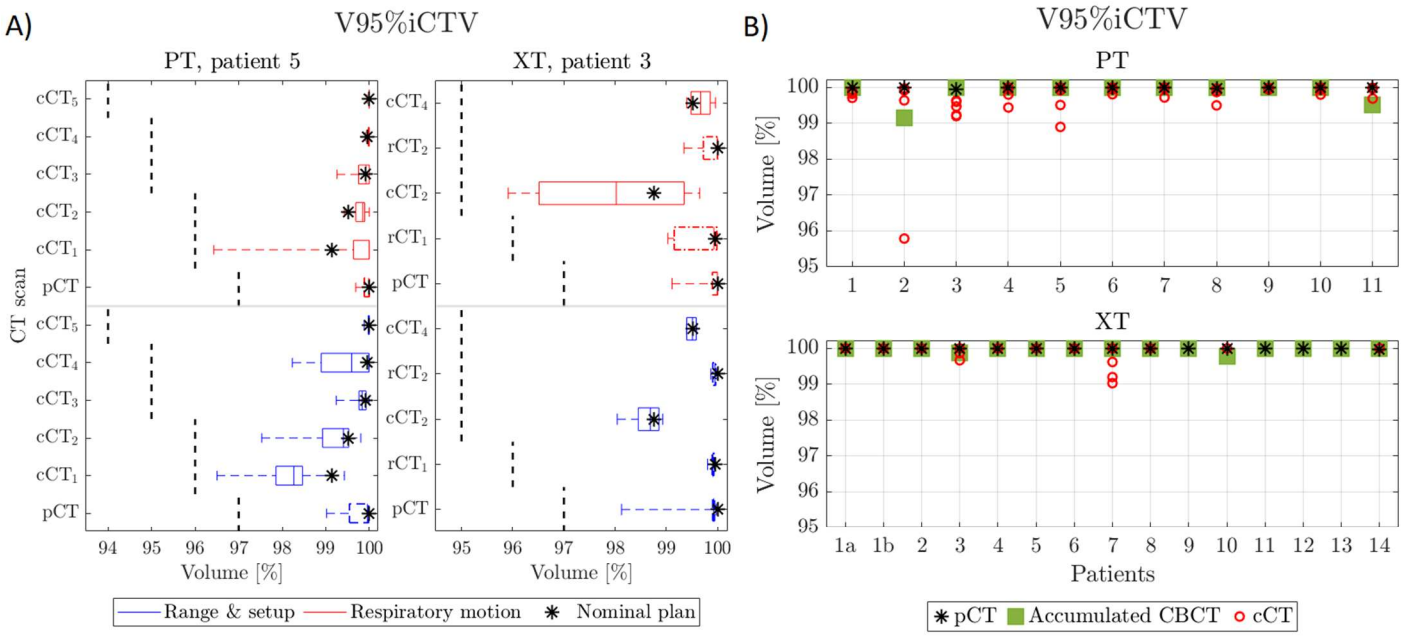

Figure 1: A) V95%$_{iCTV}$ robustness evaluation for one PT and XT patient. Blue and red boxplots represent robustness towards setup and range, and respiration, respectively. Black stars indicate the nominal plan values derived from pCT, cCT or rCT scans, with the dashed line marking the fraction-dependent acceptance criteria. B) V95%$_{iCTV}$ evaluation of the accumulated dose across PT and XT patients. Black stars denote nominal pCT values, while green squares represent the accumulated CBCT dose. Red circles indicate nominal recalculated cCT values. For XT patient 1, separate treatment plans were implemented for cranial and caudal targets.

Abstract title

Radiotherapy quality assurance of patients with squamous cell carcinoma of the head and neck included in the DAHANCA 19 randomised phase III trial

Authors

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Abstract

Introduction

Radiotherapy quality assurance (RTQA) is important in multicentre clinical trials to ensure protocol adherence and reliable evaluation of investigational drugs. This study reports the RTQA of the DAHANCA 19 randomised phase III trial comparing chemo-radiotherapy with and without Zalutumumab.

Materials and methods

Radiotherapy treatment plans from 608 patients were centrally collected in DcmCollab and evaluated using predefined DAHANCA RTQA parameters: dose coverage of CTV1, near-maximum spinal cord and brainstem doses, and overall treatment time. Deviations were classified as none, minor, or major. Associations between deviations and clinical outcomes were analysed.

Results

Of 608 patients, 462 (76%) had no deviations. Minor deviations occurred in 131 patients (22%) and major deviations in 15 (2.5%) (Table 1); most minor deviations involved prolonged treatment time or insufficient CTV1 coverage. Major deviations were more frequent in the experimental arm (12 vs. 3, p=0.02), mainly due to treatment time prolongation or inadequate target coverage. Minor deviations had no impact on

loco-regional control or survival. Patients with major deviations had poorer overall survival, but this was attributed to comorbidity rather than compromised RT quality.

Conclusion

Radiotherapy in DAHANCA 19 adhered closely to national guidelines, with only 2.5% major deviations. These deviations did not compromise loco-regional tumour control, supporting the integrity of the trial's conclusions. The findings emphasise the importance of robust QA processes and modern treatment techniques in multicentre trials.

Tabel 1 RTQA deviations

	No deviations		Minor deviation		Major deviation		p-value	
Patient numbers	462		131		15		No vs minor	No vs major
Age at randomisation	58 (31-84)		59 (40-79)		58 (49-73)		0.98	0.70
> 10 Pack years	353	76%	101	77%	12	80%	0.91	1.00
Co-morbidity present	441	95%	125	95%	14	93%	1.00	0.54
WHO Performance > 0	108	23%	31	24%	9	60%	1.00	0.00
Tumor stage III-IV	412	89%	122	93%	15	100%	0.25	0.39
T3-4	166	36%	68	52%	8	53%	0.00	0.18
N2-3	294	64%	94	72%	10	67%	0.10	1.00
Oropharynx	334	72%	81	62%	9	60%	0.02	0.38
p16 positive*	193	42%	60	47%	10	67%	0.30	0.07

*P16 missing for 12 patients

Simulation-free online adaptive radiotherapy for patients receiving palliative radiotherapy

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Introduction: The standard palliative radiotherapy (RT) workflow involves long waiting times or multiple clinic visits, which can be burdensome for patients suffering from painful spinal metastases. Simulation-free radiotherapy utilizes a recent diagnostic CT (dCT) for target delineation and treatment planning, thereby eliminating the need for a separate planning CT. When combined with CBCT-guided online adaptive radiotherapy (oART), which allows for real-time adjustments to the treatment plan, this approach offers the potential for a more efficient workflow for patients receiving palliative RT.
This study reports the initial clinical experience with the simulation-free oART workflow based on the first treated patients.

Materials and methods: Patients referred for single-fraction treatment of painful spinal metastases without significant soft tissue involvement were eligible for inclusion, provided they had an available dCT. The dCT was used for target delineation (guided by the diagnostic MRI) and treatment planning. Time-consumption of the treatments was measured. An in-house developed questionnaire was used to assess patient satisfaction. The adaptive dose plans were evaluated in terms of fulfilling clinical goals for target coverage.

Results: 39 patients were treated using the simulation-free oART workflow. The median overall treatment time was 29.5 minutes (IQR = 27.2; 36.2), staying within the allocated 45-minute time slots. The median time spent on the adaptive workflow was 14.5 min (IQR=12.0;18.43). The adaptive dose plans met all clinical goals. Patients reported high satisfaction with the treatment.

Conclusion: A simulation-free oART workflow was successfully implemented for patients with spinal metastases. All patients reported high satisfaction with the workflow. We have expanded the inclusion criteria to include treatment of non-spinal bone metastases and metastases with soft tissue components.

DAHANCA FORWARD: 20 years of head and neck cancer radiotherapy data

Stougaard SW (1,2), Zukauskaite R (3), Röttger R (4), Konrad ML (1,2), Nielsen CP (1,2), Krogh SL (1), Sommer JFA (1), Johansen J (3,5), Eriksen JG (6), Lonkvist CK (7), Sibholt P (7), Bekke S (7), Bernsdorf M (8), Smulders B (8), Tarnavski NH (8), Farhadi M (9), Samsøe E (9), Kaplan LR (9), Jensen K (5), Elstrøm UV (5), Holm AIS (6), Andersen M (10), Laursen K (10), Nielsen MS (10), Lorenzen EL (1,2), Grau C (5,6), Ravkilde T (6), Guldberg MH (5), Brink C (1), Friborg J (8), Hansen CR (1,2,5)

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Introduction

Many head and neck cancer (HNC) patients suffer from late side effects such as dysphagia and xerostomia after radiotherapy (RT). Over the last two decades, technological advancements have significantly influenced RT treatment, but the impact on dose to organs at risk (OARs) and late side effects remains unclear. This national project aims to collect and structure RT data from all Danish HNC patients treated between 2003 and 2023.

Materials and methods

This project applied automated data collection developed through the Novo Nordisk-funded DESIRE-project, which extracts data from hospitals' treatment planning systems. Collected data include CT-scans, RTPLAN, RTSTRUCT, and RTDOSE files from all six Danish centres treating HNC with RT. Relevant patients were identified using DAHANCA's registry of RT-treated HNC patients.

Collected treatment data were linked to patients' disease courses, survival, and toxicity outcomes using the national DAHANCA database. A DAHANCA AI-based model was applied for robust OAR segmentation, followed by an in-house developed outlier detection tool to ensure the quality of the segmentations.

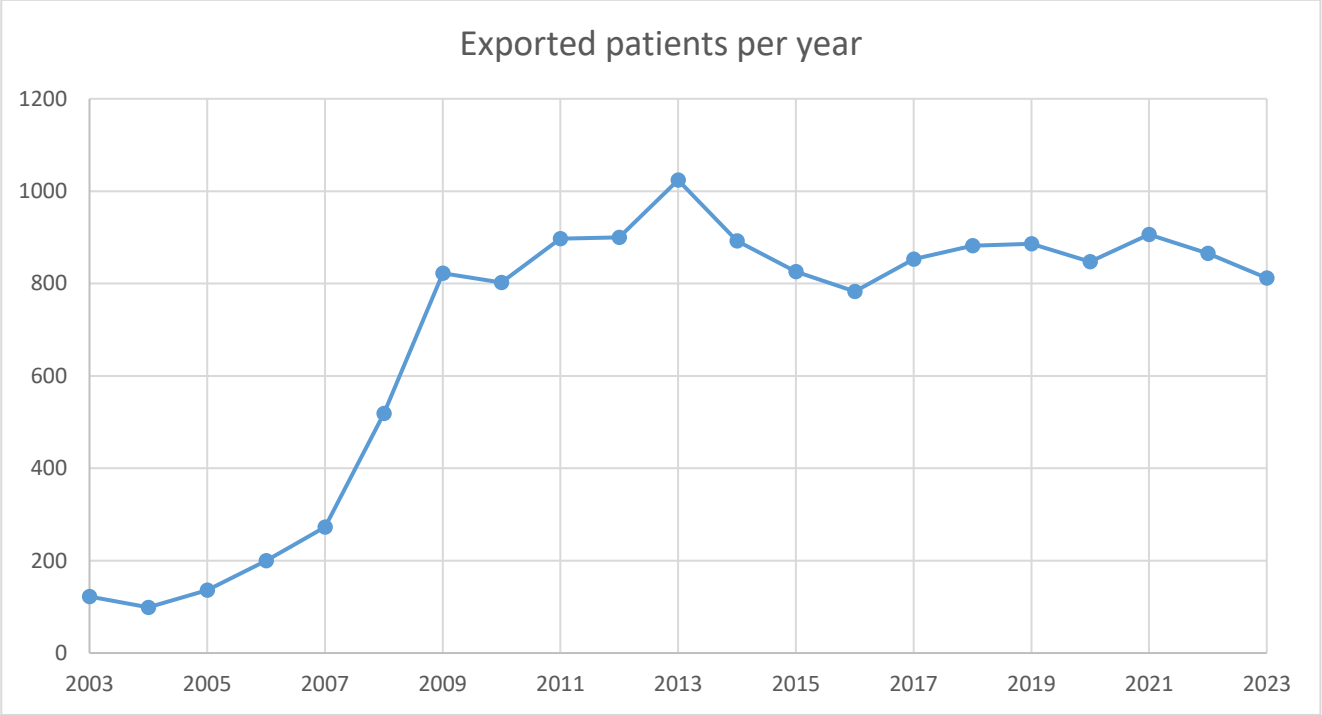
Results

Data collection was completed across all six centres. Data prior to 2007-2008 were largely inaccessible due to limited digitalisation; however, the automated collection demonstrated high reliability from 2009-2023. In total, 15,854 patients were collected, with a mean of 1.2 treatment plans per patient. The distribution of patients per centre (C1-C6) was the following: 3,372, 3,014, 2,860, 989, 1,919, and 3,700, respectively. See Figure 1 for distribution of patients per year (for centre C1-C4 and C6).

Conclusions

This project creates a unique national database enabling comprehensive analysis of the impact of RT technological advancements over two decades. The efficient and robust automated collection method demonstrates the feasibility of large-scale RT data extraction for future studies.

Table 1: Pre-liminary distribution of number of collected HNC patients per year.



The figure contains data from center C1-C4 and C6, and is thus missing data from center C5.

Influence of insert position on proton stopping-power ratio estimation accuracy using photon-counting CT

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Introduction

Stopping-power ratios (SPRs) for dose calculations in proton therapy are derived from computed tomography (CT) scans. Photon-counting CT (PCCT) has the potential to improve SPR accuracy and thus minimise range uncertainties. Previous studies indicated a reduced influence of phantom size on SPR estimations for PCCT. This study aimed to quantify the accuracy of position-specific SPR estimations based on PCCT scans using two phantoms.

Materials and methods

PCCT, dual-energy CT (DECT), and single-energy CT (SECT) scans were acquired of the Gammex Advanced Electron Density phantom and a custom cylindrical phantom (40 cm diameter). Based on the Gammex phantom, SPRs were estimated for each CT modality. For PCCT and DECT scans, the SPR estimation was based on two virtual monoenergetic images with energies chosen to minimise the root-mean-square deviation for bone inserts. For SECT scans, a Hounsfield look-up table was created using stoichiometric element information of the inserts. For evaluation, two bone inserts were positioned in the cylindrical phantom at distances of 0 cm, 7.5 cm, 12.5 cm, and 17.5 cm from the centre. SPRs were estimated, and deviations from theoretical SPR values were calculated.

Results

For all three modalities, SPR estimation was most accurate near the centre (Figure 1). Across all positions and both bone inserts, PCCT scans provided the most accurate SPR estimations. For the HE Cortical Bone insert, the SPR was most stable across the positions using PCCT, with a variation of 1.3 percentage points. For the CaCO3 50% bone insert, the SPR was most stable for DECT, with a variation of 1.5 percentage points, despite being less accurate.

Conclusions

PCCT scans achieved SPR estimation accuracy and precision comparable to, or exceeding, DECT scans. For high-density materials, the results suggest reduced positional influence on SPR estimation with PCCT scans. This has the potential to reduce range uncertainties and improve dose calculation accuracy.

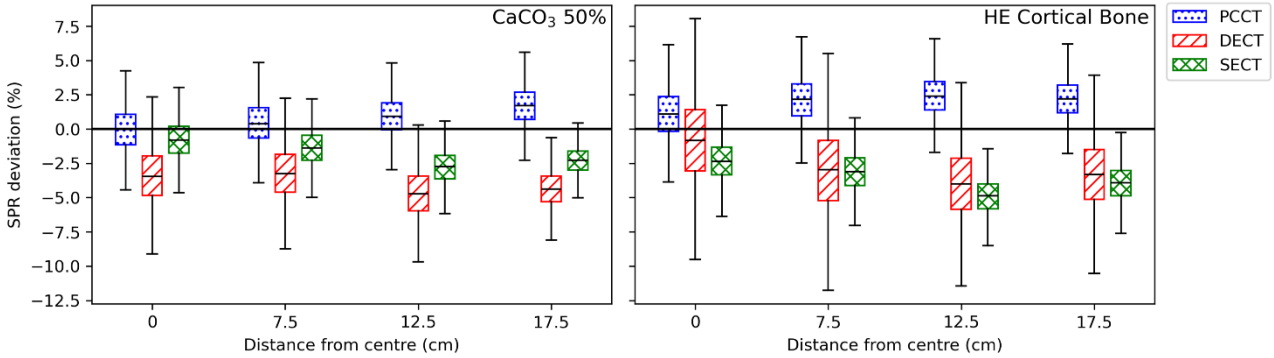

Figure 1: Difference between the estimated and theoretical stopping-power ratio (SPR) for the $CaCO_3$ 50% insert (left) and HE Cortical Bone insert (right). The inserts were placed at different distances from the centre in a circular phantom with a 40 cm diameter. SPRs were estimated for photon-counting CT (PCCT), dual-energy CT (DECT), and single-energy CT (SECT) scans.

Local recurrence with and without a tumour-bed boost: a post-hoc analysis of the DBCG IMN2 study

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Introduction

In early-stage breast cancer, a tumour-bed boost (TBB) reduces the risk of local recurrence (LR) by around 50% but increases the risk of breast induration and does not improve survival. LR incidences of 3% at 5 years and 6% at 10 years have been proposed as thresholds where benefits outweigh the potentially detrimental effects of a TBB. Therefore, this post-hoc analysis of the Danish Breast Cancer Group (DBCG) IMN2 study aimed to investigate LR rates according to prognostic risk factors to identify indications for a TBB.

Material and methods

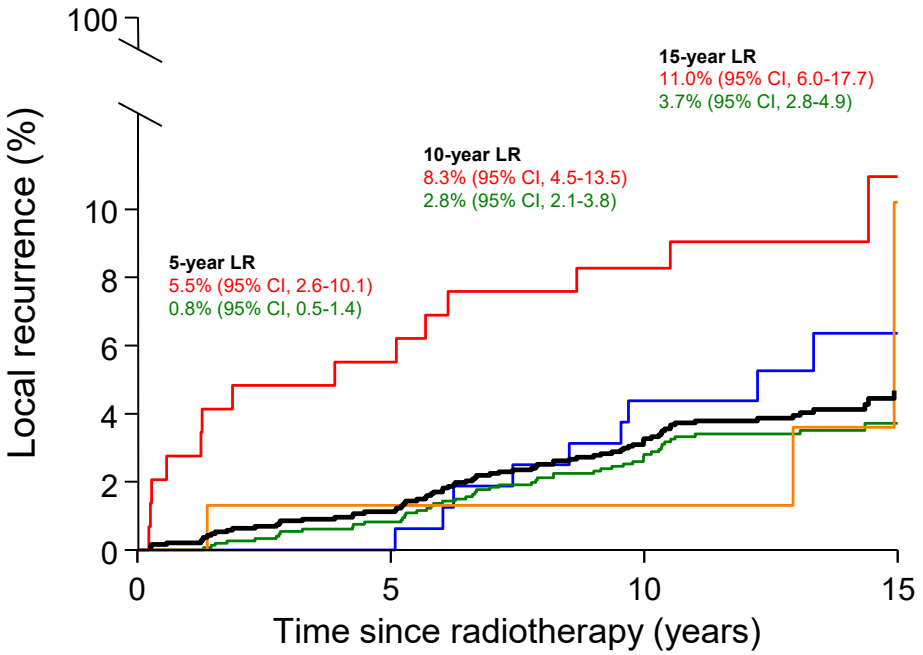
From the DBCG IMN2 study, 2,430 node-positive patients operated with breast-conserving surgery were included for analysis. They received irradiation to the residual breast and regional nodes with or without internal mammary node irradiation according to laterality. Radiotherapy was 3D-conformal. TBB was delivered sequentially as 10Gy/5Fx (41-49 years) and 16Gy/8Fx (≤40 years or margin < 2mm). Systemic therapy was given postoperatively and included anthracyclines, taxanes, aromatase inhibitors, and trastuzumab. Patients with and without a TBB were analysed separately. Prespecified subgroups included known prognostic risk factors.

Results

Median follow-up was 13.7 years, and the cumulative incidence of LR was 1.7% (95% CI, 1.2-2.2) at 5 years and 3.6% (95% CI, 2.9-4.3) at 10 years. The corresponding cumulative incidence of contralateral BC was 2.9% (95% CI, 2.2-3.6) at 10 years.
In patients ≥ 50 years, 1,871 patients were treated without a TBB. Among these, 145 patients with an ER-/HER2- tumour had a 10-year cumulative incidence of LR of 8.3% (95% CI, 4.6-13.6), Fig. 1. No other subgroups exceeded 6% at 10 years.

Conclusion

Our results suggest that node-positive patients 50 years or older with an ER-/HER2- tumour may obtain a clinically relevant benefit from a TBB. Based on these data, the DBCG has updated the Danish guidelines to recommend a 16Gy/8 Fx TBB for all patients with ER-/HER2- tumours, regardless of age.



Number at risk

ER+/HER2-	1465	1269	941	164
ER+/HER2+	160	133	107	19
ER-/HER2+	76	59	48	8
ER-/HER2-	145	106	78	18
All patients	1872	1585	1188	209

Fig. 1. The cumulative incidence of local recurrence according to IHC subtypes in node-positive breast cancer patients ≥ 50 yr treated without a TBB. ER+/HER2- (green), ER+/HER2+ (blue), ER-/HER2+ (orange), and ER-/HER2- (red). The black line depicts all patients ≥ 50 yr treated without a TBB.
Abbreviations: LR, local recurrence; IHC subtype, immunohistochemical subtype; yr, years TBB, tumour-bed boost.

Validating the Danish guideline of thoracic radiotherapy for patients with LD-SCLC in a real-life cohort

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Introduction
Standard regiment of thoracic radiotherapy for patients (pts) with limited disease small cell lung cancer (LD-SCLC) has since 1999 been 45Gy in 30 fractions (fx), twice daily delivered. In 2021 the phase II Grønberg et al. study examined 60Gy in 40fx vs. the standard regiment, finding an improved 2-year survival of the 60Gy arm. Therefore, in 2022 the Danish guideline changed to recommended 60Gy in 40fx for fit pts. To validate the guideline, we examined which pts at our institution received 60Gy compared to 45Gy after guideline implementation. Furthermore, evaluating the safety of the 60Gy regiment in our real-life cohort.

Materials and methods
From March 1st, 2022, to May 31st, 2025, 56 pts were identified to have been treated for LD-SCLC. 35 pts (62.5%) received 60Gy and 21 pts (37.5%) received 45Gy. Pts and tumor characteristics, as well as acute toxicity (esophagitis needing morphine treatment and/or a feeding tube, pneumonitis needing prednisolone treatment, or infections possibly related to radiotherapy) were compared for the two regiments.

Results
Pts that received 60Gy were younger, median age of 68 years vs. 73 years ($p=0.03$), they more often received concomitant chemoradiotherapy, 94% vs. 52% of pts ($p<0.01$), and they had a higher frequency of prophylactic cranial irradiation, 40% vs. 14% of pts ($p=0.04$). Tumor stage, GTVp volume and CTV volume did not differ, but pts receiving 60Gy had a significantly smaller GTVn volume, median volume of 4.4cc vs. 14.4cc ($p<0.01$). No differences were found in acute toxicities.

Conclusions
Two-thirds of pts with LD-SCLC received 60Gy in 40fx after guideline changed. These pts were in general of better health and with smaller nodal volume. Frequency of treatment demanding acute toxicities was no different to the 45Gy regiment. Finding the treatment of 60Gy in 40fx applicable and safe in a real-life cohort. Thereby finding the current Danish guidelines for thoracic radiotherapy for pts with LD-SCLC valid.

Name of presenter(s):

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Title:

Tissue Oxygenation Modulates the FLASH Effect: Evidence from a Murine Skin Model

Abstract summary:

Background: Although FLASH radiotherapy can spare normal tissues compared with CONV dose rates, the dependence on tissue oxygenation is not fully defined. We evaluated the FLASH skin-sparing effect under normoxia versus induced hypoxia.

Methods: Right hindlegs of unanesthetized female C3H/HeNRj mice were irradiated with CONV (0.16 Gy/s) or FLASH (231.4 Gy/s) using a 16 MeV electron beam. Hypoxia was produced by clamping to impede local blood flow ≥10 min before and during irradiation. Acute skin toxicity was assessed daily and modeled to derive dose–response metrics.

Results: With hypoxia, OER values were 1.38 (FLASH) and 2.05 (CONV). The FLASH dose-modifying factor (relative to CONV) equaled 1.43 under normoxia and 0.96 under hypoxia, demonstrating abrogation of FLASH sparing when oxygen is limited.

Conclusion: The normal-tissue benefit of FLASH requires adequate oxygenation; reducing pO_2 eliminates the observed skin-sparing effect.

Breaking Barriers in Breast Cancer Trials: Non-Accrual Insights from the phase III randomized clinical DBCG NATURAL and PROTON trials

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Objectives: About 5,000 Danish patients are diagnosed with breast cancer (BC) each year. The Danish Breast Cancer Group (DBCG) issues radiotherapy (RT) guidelines and runs trials, yet accrual can be limited by patient, socio-economic, geographic, and clinician-related barriers. We assessed reasons for non-inclusion in two phase III trials: DBCG NATURAL (≥60, relatively low risk; partial breast irradiation vs no RT) and DBCG PROTON (high predicted heart/lung dose; photons vs protons).

Methods: From Sep 2021–Dec 2023, almost all Danish RT departments maintained a screening log of non-participation; patient files were reviewed to assign reasons.

Results: NATURAL: 559 eligible; 301 not included; non-accrual per centre 54–79%. Reasons: patient preference 75%; trial not discussed/eligibility not flagged in MDT or by the physician 16%; other 8%. Offering varied widely between centres. PROTON: 215 with high heart/lung dose identified; non-accrual per centre 40–79%. Reasons: patient preference 49%; geographic barriers 24%; language 8%; doctors' preference 6%; comorbidity 4%; other 8%.

Conclusion: Large inter-centre variation and frequent patient-driven declines indicate a need for standardized patient information and a concise decision aid. Embedding prompts in MDT meetings and clinics

to systematically flag eligibility, and providing clear information on benefits/risks and logistics, may reduce non-inclusion and promote equitable access to DBCG RT trials in Denmark.

Does proton biological effectiveness change with dose fractionation? Insights from an in vivo study

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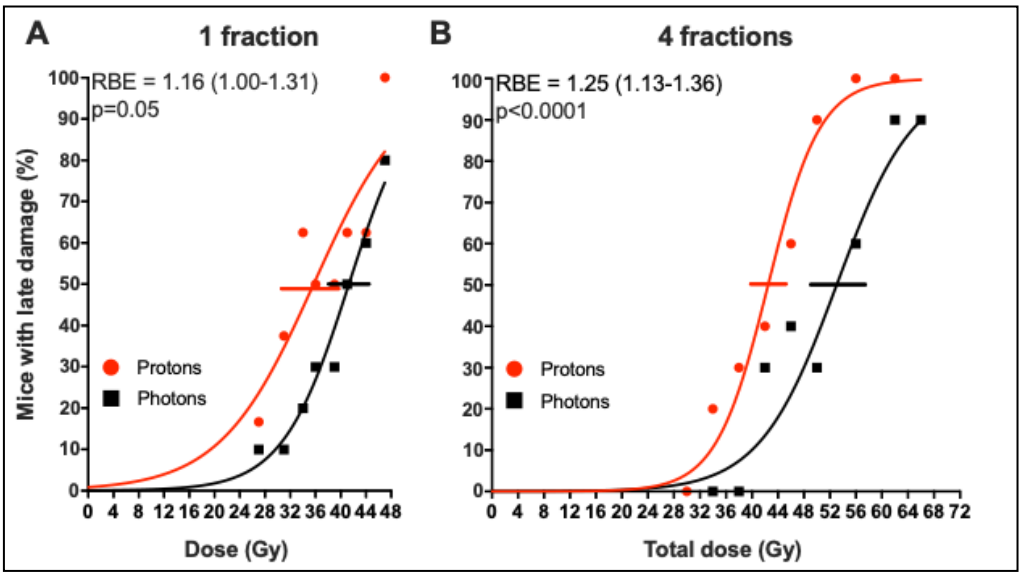
Introduction:
In clinical proton therapy (PT), a constant relative biological effectiveness (RBE) of 1.1 is commonly applied to convert proton doses into photon-equivalent doses. However, RBE is not fixed; it varies with parameters such as tissue type, biological endpoint, and dose fractionation scheme. Preclinical in vivo studies assessing proton RBE with fractionated irradiation and late toxicity endpoints are rare. This study tested if the RBE of radiation-induced fibrosis changes using four fractions rather than one fraction in a murine leg model.

Materials and Methods:
Unanesthetized mice received irradiation of the right hindlimb with either single (n=156) or four (n=176) fractions of mid-Spread-Out Bragg Peak protons or 6 MV photons. Mice were monitored every 14 days for one-year post-treatment using a joint contracture assay to evaluate severe radiation-induced late damage.

Results:
The RBE for severe late toxicity was higher with fractionated irradiation (1.25 ± 0.06; 1.13–1.36) than with single-dose exposure (1.16 ± 0.08; 1.00–1.31).

Conclusion:
Fractionated doses increase the RBE for late toxicity in vivo. These findings highlight that RBE is variable, and reliance on a constant value of 1.1 risks overdosing normal tissues.



Mapping Toxicity Data and Patient Related Outcomes in Reirradiation of Thoracic Cancers

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Introduction:

Reirradiation (reRT) is an important tool in the treatment of thoracic cancers. It is well known that reRT can cause severe and even lethal toxicity, but despite this, the relation between dose and toxicity is largely unknown. No standardized guidelines are available when initiating reRT. This upcoming PhD project aims to expand knowledge on toxicity and patient related outcomes of reRT.

Materials and Methods:

The PhD project is a part of the national CURE Lung Study.
Using a retrospective cohort, the relation between reRT dose and toxicity will be analyzed.
A prospective cohort of patients treated with reRT in multiple Danish radiation centers will be established and followed in a protocolled setting. We will collect data on baseline characteristics, previous radiation therapy, reirradiation doses and toxicity, the latter both clinically and patient reported. The initial interim analyses will be performed within this PhD project.
Finally, we aim to use data on toxicity and patient related outcomes in terms of quality of life to develop a tool for shared decision making when considering reRT of thoracic cancers.

Perspectives:

Establishing the relationship between cumulative dose to key risk organs and severe toxicity will give detailed knowledge of reRT dose limits. This can be used to individualize dose prescriptions to reduce risk of severe toxicity. Using extensive, high-quality data for mapping clinical as well as patient-reported toxicity data in reRT of thoracic cancer will help standardize and optimize reRT across the country, ensuring equal treatment options for all patients. Better data and evidence on patient experiences and toxicity will hopefully provide physicians with more knowledge and confidence in the treatment, thereby increasing the number of patients offered curative reRT.

Simulation free palliative radiotherapy based on diagnostic images without daily adaptation

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Introduction
During the last decade, research in palliative radiotherapy (RT) has mainly focused on target doses and fractionation schedules rather than patient experiences in relation to treatment. Simulation free palliative RT is a new approach where RT is planned on diagnostic CT (dCT) followed by online adaptation on the CBCT during the first fraction, to ensure acceptable target coverage. This technique is feasible, but experiences from the international community suggest that online adaptation may not be required, and that high quality palliative RT can be planned and delivered based on dCT images without online adaptation. This retrospective study investigates the potential for simulation free palliative RT towards bony metastases based on dCT images without online adaptation.

Materials and Methods
This study includes all patients who received palliative RT for bony metastases in 2024 in our clinic (247 patients receiving 338 palliative treatment plans). Diagnostic CT images were evaluated for all patients with respect to the following three parameters: 1) The CT-scan should be acquired within 28 days before the RT planning CT (pCT). 2) To allow accurate dose calculations with our existing CT to density curve, more than 100 kVp should be used for the CT-scanning protocol. 3) The entire patient outline should be in the Field-of-View of the dCT image.
Treatment plans were grouped by target localization: Cervical (n=17), thoracic (n=91) and lumbar vertebrae (n=47), extremities (n=19), pelvic bones (n=131) and other bones (n=33). Ten patients with suitable dCT images in each group were selected for retrospective dose planning, and target and OAR delineations were propagated using deformable image registration from the pCT to the dCT. Palliative plans were created using the same technique as used for actual treatment (mainly VMAT). Treatment plans based on dCT and pCT were recalculated on the first fraction CBCT image, to investigate if dCT-based treatment plans were sufficiently robust to achieve similar target coverage as the pCT-based treatment plans.

Results
The study is on-going, and preliminary results show that 51 % of all patients who received palliative RT against bony metastases had a dCT that could be used for palliative RT planning according to our three criteria. Treatment plans are currently being created, and the results will be presented at the DCCC meeting. The study envisions a fast workflow for verifying the dose distribution before treatment of single fraction prescriptions. For the fractionated radiotherapy schedules, it will probably be sufficient to calculate and potentially adapt the treatment plan before the second fraction, in case of unacceptable under- or over-dosage.

Conclusions
International experience has shown promising results using dCT images for simulation free palliative RT. This study evaluates how these experiences can be translated to a Danish setting, to ensure high quality palliative RT with a minimal time consumption and without unnecessary procedures.

Towards a pediatric-specific treatment planning proton range uncertainty

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Introduction

Stopping-power ratio (SPR) uncertainty in proton therapy is typically estimated from CT scans of adult-sized phantoms and applied to all patients. However, adult uncertainties may not represent pediatric patients due to differences in size and tissue composition. This study quantified pediatric size-specific proton range uncertainties and compared them with adult-based estimates.

Materials and methods

A modular ring phantom (Sun Nuclear) with diameters of 10, 20, 30, and 40 cm was scanned using a twin-beam dual-energy CT scanner (Siemens Healthineers). Both single-energy CT (SECT) and 90 keV virtual monoenergetic images (VMIs) were acquired. Tissue-equivalent inserts were scanned at central and peripheral positions for each phantom size and used to generate CT-to-SPR conversion curves. Proton range uncertainty (2σ) was calculated from: (i) imaging uncertainty (beam hardening and CT stability), (ii) modeling uncertainty (measured vs. modeled CT numbers), (iii) inherent uncertainty (tissue composition variability), and (iv) pediatric tissue uncertainty (applying adult-based calibrations on pediatric tissues). Adult uncertainties were estimated using the conventional head–body method (20–40 cm phantoms), while pediatric uncertainties were estimated using a size-specific approach of 10 cm intervals. Composite range uncertainty was determined using tissue-specific weighting factors for brain and pelvic patients applying both approaches.

Results

Pediatric-specific range uncertainties were 1.3% (SECT) and 1.1% (VMI) for brain (10-20 cm), 1.8% and 1.6% for pelvic (20-30 cm), and 2.7% and 1.9% for pelvic (30-40 cm) (Table 1). Adult range uncertainties were 2.8% (brain) and 3.3% (pelvic) with SECT, and 2.0% and 2.4% with VMI.

Conclusions

Adult-based approaches overestimated the uncertainty for pediatric patients, particularly for smaller sizes. The VMI approach reduced range uncertainty over SECT for larger patients, with diminishing benefit for smaller patients.

Table 1: Proton range uncertainties (2σ) for brain (10–20 cm) and pelvis (20–40 cm) regions. Results are shown for adult head–body and pediatric size-specific approaches using single-energy CT (SECT) and dual-energy CT (DECT, 90 keV VMI).

Region	Conversion Curve	Range uncertainty (%)	
		SECT	VMI (90 keV)
Brain	Adult head-body (20-40 cm)	2.8	2.0
	Pediatric 10-20 cm	1.3	1.1
Pelvis	Adult head-body (20-40 cm)	3.3	2.4
	Pediatric 30-40 cm	2.7	1.9
	Pediatric 20-30 cm	1.8	1.6

Patients' and radiotherapy personnel's attitudes towards AI in radiotherapy: a scoping review

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Introduction
The introduction of artificial intelligence (AI) into oncology is transforming the field of radiotherapy (RT), where highly complex workflows, image interpretation, and treatment planning offer fertile ground for algorithmic support. The use of AI has the potential to improve efficiency, precision, and personalization of care. While technical evaluations of AI in radiotherapy are advancing rapidly, less is known about the perspectives of patients planned for RT and the attitudes towards AI of the personnel, responsible for the treatment delivery and clinical decision making. Consequently, there is a need to systematically review the existing literature.

Materials and Methods
This scoping review intends to systematically summarize the available research on patient and radiotherapy personnel's attitudes towards AI in radiotherapy, to discuss the current evidence and to formulate recommendations for future research. Reporting is planned to follow the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines.
Comprehensive searches were performed in PubMed, Embase, Medline, and CINAHL, to include medical, nursing and multidisciplinary research, and with no limits on language.

Results
The searches were performed on September 11th, 2025, and yielded a total of 1,901 unique records. Using Covidence the studies were screened for relevance by two independent reviewers. Conflicts were resolved by consensus, and 61 studies were selected for full-text review. At the time of the abstract deadline, full-text review was ongoing.

Conclusions
This ongoing project aims to summarize the current literature on patients' and radiotherapy personnel's attitudes towards the use of AI in radiotherapy.

Abstract, DCCC-RT 2025

Combining fractionation and FLASH tissue sparing

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Introduction: The FLASH effect, reduced normal tissue toxicity from ultra-high dose rate (UHDR) radiation, has been shown in several single-fraction preclinical studies. Since clinical radiotherapy typically uses fractionation, understanding how FLASH interacts with fractionation is of high relevance. This study quantified FLASH's tissue-sparing effect on acute skin and fibrotic toxicity using one, four and eight fractions.

Material/Methods: Unanaesthetised female CDF1 mice received electron irradiation to the right hindleg using either conventional (CONV, 0.16 Gy/s) or UHDR FLASH (254 Gy/s) dose rates. Irradiation was delivered as a single dose, four fractions with one daily dose or eight fractions with two daily fractions with 6-hour separation. Each arm included 4-8 mice per dose. Acute skin toxicity was assessed up to 25 days post-treatment. Fibrosis was quantified up to 53 weeks post-treatment. Dose modifying factors (DMF) were estimated from the ratio of doses causing toxicity for 50% of mice.

Results: The acute skin DMF after single-fraction irradiations was 1.42 (Fig. 1A), reduced to 1.26 after four fractions (Fig. 1B) and to a non-significant 1.05 after eight fractions (Fig. 1C). Conversely, the fibrotic FLASH sparing was unaltered with increasing fractions with a DMF of 1.17 after a single fraction irradiation (Fig. 1B), 1.26 after four fractions (Fig. 1D), and preliminary data suggest an DMF of 1.12 after eight fractions (Fig. 1F). Data collection on the fractionated late damage is ongoing.

Conclusion: The fractionated FLASH sparing effect was different between the two tissue types. The acute FLASH effect of the four-fraction scheme was almost halved compared to that of single-fraction delivery, and essentially non-existent with the eight-fraction scheme. In contrast, fractionation did not negatively alter the FLASH effect for the fibrotic development. Thus, the interplay of fractionation and FLASH tissue-sparing seems highly dependent on the tissue-type**.**

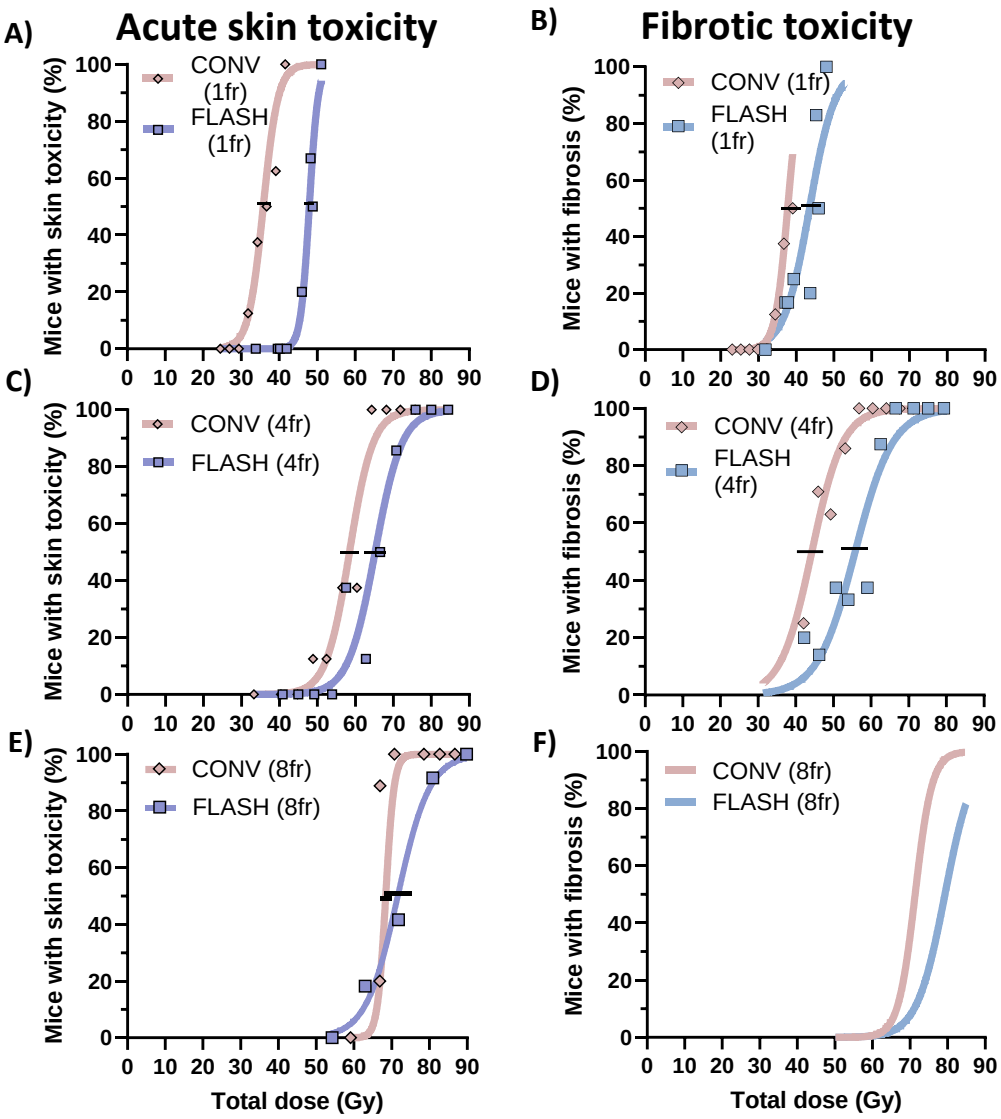

Figure 1: Dose-response relationship for acute skin toxicity and fibrotic toxicity following a single fraction (A,B), four fractions (C,D), and eight fractions (E,F).

New Treatment Options for Hepatocellular Carcinoma

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Introduction: Hepatocellular carcinoma (HCC) often arises in cirrhotic livers and has poor prognosis. Previously, radiotherapy has been limited by risk of radiation-induced liver disease (RILD), especially in fragile patients with impaired liver function or large tumors. Proton therapy enables precise dose delivery, potentially reducing toxicity while maintaining local control. Alongside, immunotherapy has been approved as first-line palliative treatment for HCC with promising results, making patient and treatment selection increasingly important.

Materials and Methods: This PhD study will carry out four studies on treatments for HCC: **Study 1: Clinical Efficacy and Toxicity after Proton Radiotherapy for Hepatocellular Carcinoma**. Safety (overall survival (OS) and RILD) and acute toxicity (CTCAE grade 3-5, hospitalization) after proton therapy will be examined in the national, prospective, single-arm phase II trial (NCT05203120).

Study 2: Retrospective Evaluation of Safety and Efficacy of Immunotherapy in Danish HCC Patients. Efficacy and safety of atezolizumab–bevacizumab in Danish HCC patients will be studied. Endpoints include time to progression, OS, and toxicity.

Study 3: Prognostic Factors for Outcome and Efficacy of Proton Therapy for Hepatocellular Carcinoma. The prognostic value of ctDNA, FIB4, CD163 and clinical parameters for development of clinical toxicity and OS will be examined.

Study 4: Health related, patient reported outcomes after proton radiotherapy for hepatocellular carcinoma. Patient reported outcomes on Quality of life will be studied to evaluate the impact of proton therapy during and after treatment.

Conclusions: This project will examine data from the first prospective phase II trial of proton therapy for HCC patients in Europe and integrate clinical, translational and real-world data, providing essential evidence on proton- and immunotherapy in a Western population to guide future strategies to improve outcomes for HCC patients.

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Beyond the First Cut: Impact of repeat surgery versus boost on breast induration. A post hoc analysis from the DBCG HYPO & PBI trials

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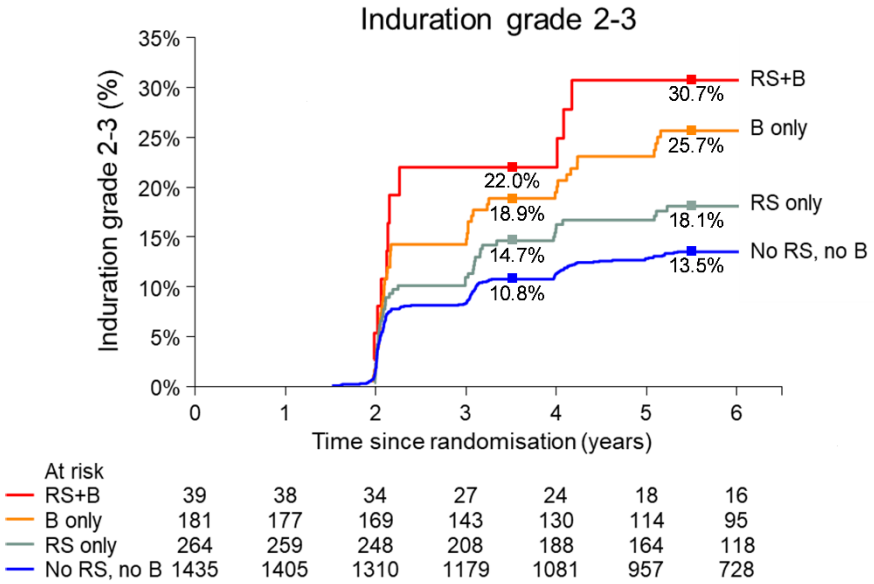
Purpose: Following breast-conserving surgery (BCS), patients with narrow margins may undergo repeat surgery (RS) or receive a tumour-bed boost to reduce local recurrence risk. Both interventions may increase the risk of late toxicity as breast induration and worse cosmetic outcomes. This post hoc analysis assessed the impact of RS and boost on breast induration and cosmetic outcomes.

Materials and methods: Post hoc analysis of 1,919 Danish patients enrolled in two randomised phase III trials, the DBCG HYPO (accrual 2009-2014) and PBI (accrual 2009-2016) trials. All received BCS and whole-breast irradiation (WBI). RS was defined as reoperation within 60 days; boost was delivered as 10 or 16 Gy. Patients were categorised into four groups: RS+boost, boost only, RS only, and neither. Breast induration was graded clinically (0–3), and cosmesis evaluated on a validated 4-point scale (0-3). Cumulative incidence was estimated using competing risk analysis; hazard ratios were adjusted for clinical covariates.

Results: Overall, 303 patients (16%) had RS and 220 (11%) received a boost. At 5 years, the cumulative incidence of grade 2–3 induration was highest in RS+boost (30.7%), followed by boost only (25.7%), RS only (18.1%), and neither intervention (13.5%). Adjusted analyses confirmed boost as the main risk factor (HR 2.90 for RS+boost; 2.38 for boost only), whereas RS alone showed a non-significant trend (HR 1.36). Both RS and boost were associated with worse cosmetic outcomes compared with neither intervention, but no significant differences were observed between RS and boost alone.

Conclusions: Tumour-bed boost was associated with a higher risk of breast induration than RS, with no cosmetic advantage. RS may therefore be preferable to boost when managing narrow margins, balancing oncological safety with late toxicity.



Danish recommendations for radiotherapy quality assurance in clinical trials

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Introduction
Radiotherapy quality assurance (RTQA) is crucial for clinical trials since poor adherence to protocol guidelines may compromise patient outcomes and thus validity of trial results. Denmark has a long tradition of national collaboration through the Danish Multidisciplinary Cancer Groups (DMCGs), which provides a unique foundation for harmonisation of RTQA across centres. This work presents the Danish recommendations for RTQA in clinical trials.

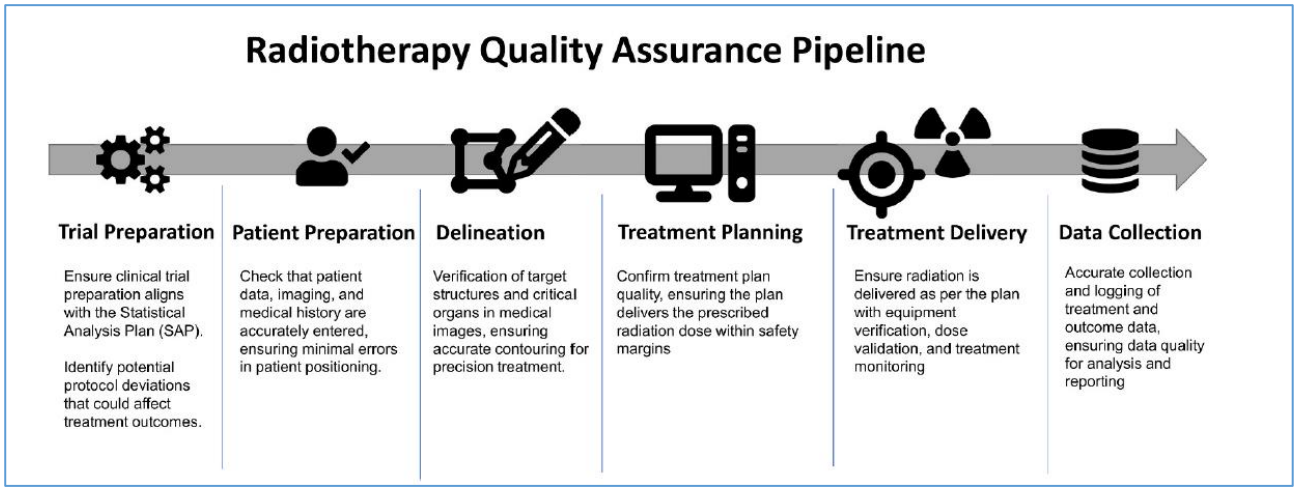
Materials and methods
The recommendations were initiated through a national workshop with broad participation from Danish centres and cancer groups. Experiences from landmark Danish trials such as the DAHANCA-, DBCG-, and NARLAL-trials were synthesised with international guidelines to define a pragmatic and comprehensive QA framework. The resulting checklist covers pre-trial, on-trial, and post-trial phases, addressing delineation, treatment planning, treatment delivery, data collection, and handling of deviations.

Results
The recommendations emphasise the early integration of QA into trial design, centre credentialing, and the use of national infrastructure, such as the radiotherapy database DcmCollab for digital plan exchange and central review. Danish experience shows that pre-trial contouring and planning audits increase protocol

compliance, while retrospective QA provides valuable insight into treatment delivery across centres. The proposed framework balances the need for robust QA with feasibility in a clinical setting.

Conclusion

Danish centres have demonstrated that national collaboration enables high-quality RTQA in large-scale trials. The presented recommendations and checklist aim to support future trials in Denmark and internationally, ensuring consistent radiotherapy delivery and strengthening the scientific validity of trial outcomes.



Abstract Title: Artificial Intelligence for early detection of non-communicable disease risk in people with breast cancer: Multicenter Cardiac Decision Impact study (ARTILLERY-CarDI trial): study protocol

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Introduction
Breast cancer (BC) is the most common cancer in women, with rising survival rates. However, survivors face increased risk of developing cardiovascular disease (CVD) due to BC treatment and shared risk factors. Radiotherapy (RT) planning computed tomography (CT) scans can detect coronary artery calcifications (CAC), a validated CVD risk marker. The ARTILLERY-CarDI trial will utilize this and estimate the CVD risk based on CAC-lesions on these scans.

Objective
The primary objective is to assess if the CAC-based CVD risk impacts (1) BC treatment decisions and CVD risk management, and (2) patient satisfaction with these decisions. Secondary objectives are to assess whether CVD risk estimation and disclosure impacts patient's lifestyle, decisional conflict, and patient-reported outcomes, (PROs), like anxiety and quality of life.

Methods
The CarDI trial is a multinational, prospective decision impact trial, aiming to enroll 1.000 BC patients ≥ 35 years referred for adjuvant RT, in 6 hospitals in 4 European countries. The first patient will be enrolled in Q1 and follow-up time is 6 months.
The intervention consists of CAC scoring on RT planning CT scans, both manually and by use of artificial intelligence. The CAC score will be used to categorize patients into low (0–10), moderate (11–100), or high (>100) CVD risk. CVD risk and management, according to the ARTILLERY manual, is communicated to the patient. In a 2nd multidisciplinary meeting BC treatment change (if any) is discussed.
Patient-reported outcomes (PROs) will be collected through validated questionnaires, at baseline, 1 and 6 months.

Expected impact
Integrating CAC scoring using AI into standard RT planning may allow for precise, fast and early recognition and management of elevated CVD risk, and support more personalized survivorship care for BC patients. Importantly, PROs may clarify if this will improve awareness and care without an increase in anxiety or affected quality of life in patients. Furthermore, estimating CVD risk may improve decision-making in BC treatment and CVD risk management.

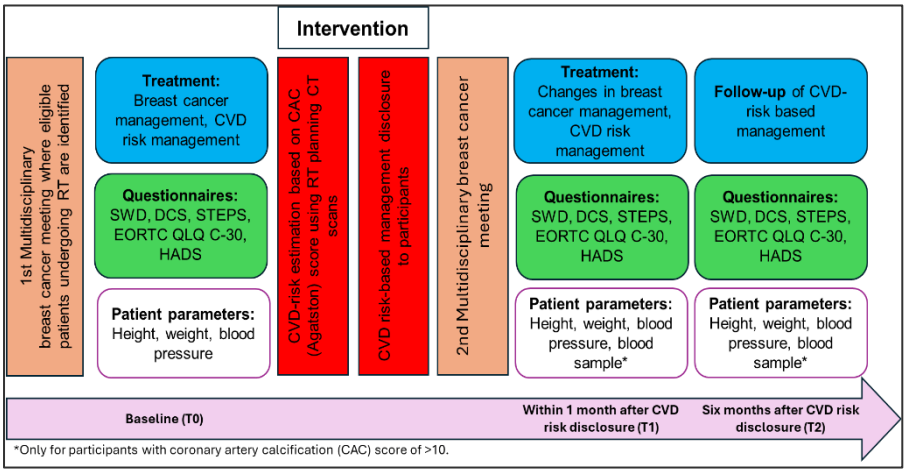

Figure 1: Scheme of the CarDI trail

Virtual MR-linac Center for Eastern Denmark: Equal Access, Shared Innovation and Expertise

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Introduction

MR-linac-based radiotherapy is a highly specialized treatment technique that requires expertise across multiple disciplines. To ensure high clinical quality and equitable patient access, we aim to unify expertise in a virtual regional MR-linac center in the Eastern part of Denmark.

Materials and methods

In 2024, specialists from Rigshospitalet (RH) and Herlev Hospital (HGH) jointly presented the vision for a virtual MR-linac collaboration to the management of the radiotherapy departments. The short-term vision enables physicians and physicists to carry out adaptive and non-adaptive treatments at HGH, through remote access to the treatment planning and delivery systems at RH. Collaboration with on-site treatment personnel at RH is run through a video meeting. The long-term goal is to establish a fully integrated patient pathway with shared clinical and technical resources in a virtual setup.

Results

Between February and April 2025, three non-adaptive treatments of patients with liver targets were successfully completed. Working groups focused on establishing common ground for the treatment pathway. In June 2025, 23 representatives met for a one-day workshop to discuss visions for a fully integrated virtual center. Since August, four patients with targets in the kidney, liver, pancreas, and adrenal gland have received remote adaptive treatment. All treatments were performed successfully, with no lag in the remote connection and within standard appointment slots. The experience gained is evaluated and refined through weekly multidisciplinary meetings as we move forward and expand indications (e.g., the STAR-Lung protocol).

Conclusions

The virtual regional MR-linac center represents an innovative model for modern healthcare workflows, providing solutions to future challenges such as recruitment and financial constraints. It ensures efficient utilization of high-cost, high-technology resources while maintaining high standards of patient care.

The technological landscape of paediatric radiotherapy in Denmark from 2008 to 2024 – let the past guide the present and future.

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Introduction: Survival rates in pediatric cancer have increased significantly over recent decades, reaching 80–85% due to better treatment. However, some childhood cancers have not seen the same improvements and their need for multimodal treatment – including radiotherapy – persists. Despite technological advances in radiotherapy, the implementation in pediatric settings appears delayed compared to adults. The aim of this study was to map the technological development of radiotherapy from 2008 to 2024 to guide future research.

Methods: We analyzed data from the Danish Childhood Cancer Registry (DCCR) and its radiotherapy sub-registry from 2008 to 2024. Radiotherapy data included technique, IGRT modality, motion management use, fractionation, and dose per course. Patients under 18 years at diagnosis and who received radiotherapy were included. Photon and proton therapy plans were retrieved from national and international sources. Descriptive temporal analyses were performed using RStudio.

Results: Of 557 pediatric patients receiving radiotherapy, 146 underwent two or more courses. VMAT and proton therapy usage increased over time, though the timing of adoption varied by diagnosis (fig.1). For example, we found delayed use of conformal techniques until after 2017 for kidney tumors. Daily IGRT became standard from the mid-2010s, with CBCT overtaking other modalities. DIBH was mainly applied to lymphoma cases early on, with broader adoption in other diagnoses emerging post-2017.

Conclusion: This nationwide registry study maps the evolution of pediatric radiotherapy in Denmark over 16 years. Despite widespread adoption of modern RT techniques, implementation varied across tumor types, likely due to protocol constraints and clinical caution. The findings underscore the importance of clinical trials for safe integration of advanced technologies in pediatric radiotherapy. The DCCR radiotherapy registry enables data-driven improvements in practice and highlights the need for continued evidence generation to support technology adoption in this vulnerable population.

Figure 1 Treatment techniques pr. Diagnoses groups, fraction dose ≤2Gy/F

A robustness-inclusive comparison of proton- versus photon-based whole-pelvic radiotherapy for prostate cancer within a randomised clinical trial

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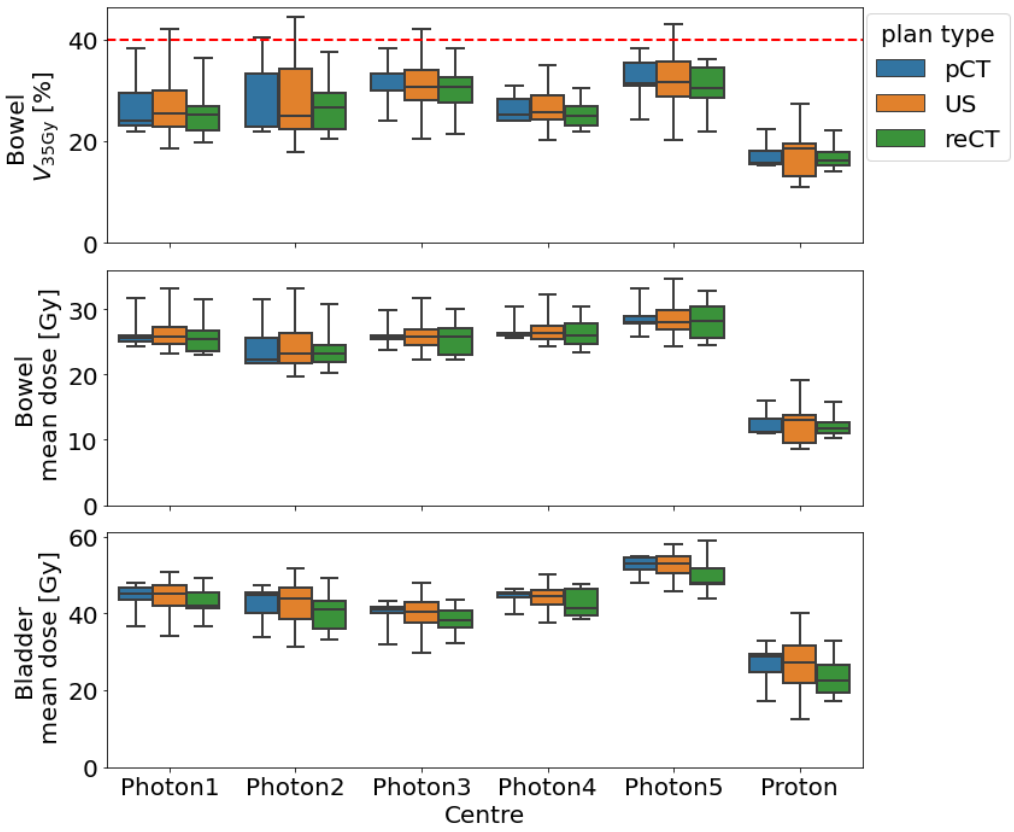
Introduction
Proton therapy offers potentially improved normal tissue sparing compared to photon-based whole-pelvic radiotherapy (WPRT) for high-risk prostate cancer, but its sensitivity to anatomical and setup variations raises concerns about robustness. The aim of this study was to evaluate – within the setting of a multicentre randomised clinical trial – whether the dose-volume advantages of proton therapy persist when subject to inter-fractional variation.

Materials and methods
Five patients treated with WPRT at a national proton centre were included. Comparative photon plans were created independently by five photon therapy centres. Nominal proton and photon plans were evaluated alongside recalculated plans on two repeat computed tomography scans per patient and with robustness scenarios simulating geometric uncertainties. Dose-volume metrics for target volumes and organs at risk; bowel bag (V_{35Gy}, mean), anorectum (V_{75Gy}, V_{30Gy}, mean), and bladder (V_{70Gy}, mean), were compared between the two modalities using linear mixed effects models accounting for patient and centre variability.

Results
Target coverage was consistently robust for both modalities across all plan types. Proton therapy resulted in significantly reduced bowel V_{35Gy} by 11.2 percentage points (95% CI [4.1:18.4], p = 0.01) and bowel mean dose by 13.9 Gy (95% CI [9.5:18.4], p < 0.001). Bladder mean dose was also lower with proton therapy by 18.4 Gy (95% CI [4.4:32.5], p = 0.02). These advantages remained consistent across nominal (pCT), recalculated (reCT), and uncertainty scenario (US) plans. No consistent modality-related differences were observed for high-dose normal tissue metrics.

Conclusions
Within this robustness-inclusive multicentre comparison study, proton-based WPRT maintained target coverage comparable to photon therapy and consistently reduced low- and intermediate-dose exposure to normal tissues, while demonstrating preserved robustness under the influence of inter-fractional variation.


Bowel V_{35Gy} [%]
Bowel mean dose [Gy]
Bladder mean dose [Gy]
plan type
pCT
US
reCT
Photon1
Photon2
Photon3
Photon4
Photon5
Proton
Centre

Evaluating the clinical potential of photon-counting CT for radiotherapy

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Introduction.
Most patients treated with radiotherapy (RT) undergo CT as part of treatment planning, yet conventional CT has limited soft tissue contrast. Consequently, supplementary MR or PET/CT is required for target and lymph node delineation in about one third of patients. While multimodality imaging improves target definition, it introduces co-registration uncertainties, increases patient burden, and consumes additional healthcare resources. Photon-counting CT (PCCT) represents a paradigm shift in CT technology. PCCT provides higher spatial resolution, improved contrast-to-noise ratio, and elimination of electronic noise. In addition, it enables virtual monoenergetic imaging (VMI) and iodine mapping, which enhance soft tissue visualization and lymph node assessment. These advancements may allow CT alone to rival multimodality imaging for RT planning. As the only RT center in Denmark with direct clinical access to PCCT, we are conducting national delineation studies in anatomical regions where multimodality imaging has become standard. To systematically evaluate the clinical value of PCCT, we have developed a workflow combining contouring with image rating through an expert-derived Likert scale. This combined approach provides both an objective benchmark of image quality and a qualitative assessment of the images' ability to support accurate target definition. In this abstract we focus on the development through expert consensus of the Likert scale for image quality evaluation.

Materials and methods.
Five patients with prostate cancer underwent MRI, dual-energy CT, and PCCT. Virtual monoenergetic images [40, 70] keV were reconstructed with Qr/Br kernels at varying sharpness levels. Eight anatomical structures (per ESTRO ACROP guidelines) were selected as critical for delineation. For each structure, three representative images were chosen for each level of a 5-point Likert scale (1 = impossible differentiation to 5 = sharply demarcated border). In total, 120 images were reviewed by 10 Danish radiation oncologists and 1 radiologist, who independently selected the best image to represent each level, establishing a consensus-based Likert scale for evaluating image quality.

Results.
A structured workflow has been established for evaluating the clinical feasibility of new imaging modalities in RT planning. A 5-point Likert scale was successfully developed, enabling systematic assessment of image quality and clinical relevance for prostate RT delineation.

Conclusion.
We have developed an expert-informed scale for evaluating CT image quality in RT planning. This framework provides a robust basis for assessing the clinical utility of PCCT reconstructions in prostate cancer and organs at risk. Although first applied to prostate cancer, the approach is generalizable to other tumor sites and imaging modalities, supporting structured evaluation of novel imaging in RT.

Abstract title

Exploring the performance of deep learning–based dose prediction for head and neck cancer on a DAHANCA clinical dataset

Authors

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Abstract

Introduction

Radiotherapy (RT) for head and neck (H&N) cancer requires complex planning due to the proximity of the tumour and organs at risk. Deep learning–based dose prediction offers potential for plan optimisation and quality assurance (QA). However, generalisability outside single-institution settings remains a challenge. This study developed a deep learning model for H&N dose prediction and validated it on a large Danish multi-centre cohort.

Materials and methods

A hierarchically densely connected U-Net was trained on 430 H&N cancer patients treated with photon RT (66 or 68 Gy) at Odense University Hospital (2020–2023) according to DAHANCA guidelines. External

validation was performed on 605 patients from six Danish centres (2016–2023). Model performance was assessed using dose–volume metrics, voxel-wise analysis, 3D gamma analysis (3%/3 mm), and expected toxicity evaluated with NTCP models and a Normalised Toxicity Index (NTI).

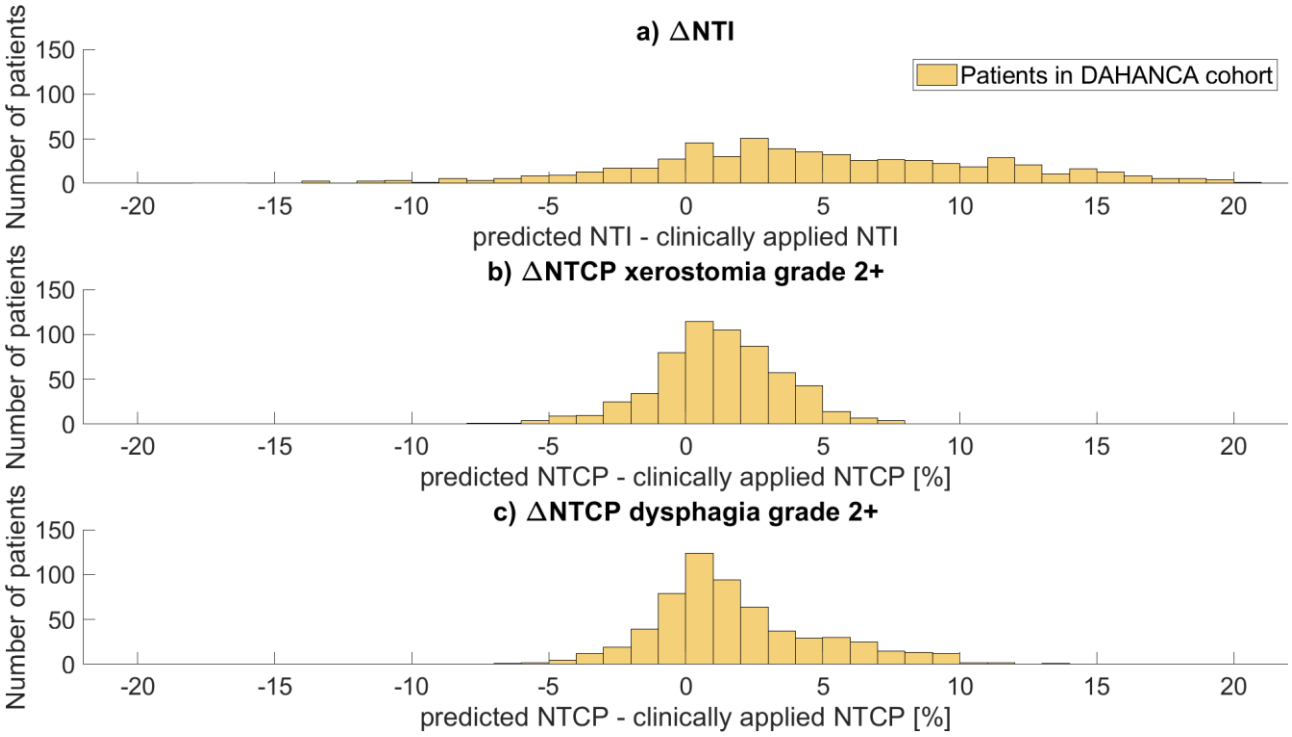
Results

In the test dataset, the median dose difference (Dmean) between predicted and clinical plans was 0.5% for targets, with a gamma pass rate of 92.4%. In the Danish multi-centre cohort, the corresponding values were 0.3% and 94.3%. The median difference in NTI was 4.1%, (fig 1a) and NTCP differences were 1.2% for xerostomia and 1.2% for dysphagia (fig b and c). Model performance was consistent across all centres despite differences in planning systems and practices.

Conclusion

This study demonstrates that dose prediction models trained on single-centre data generalise well across Danish treatment centres. Integrating dose prediction into clinical practice could support automated QA and standardised plan optimisation, strengthening the delivery of high-quality RT in Denmark.

Figure 1



The value of online adaptive radiotherapy for head and neck cancer without margin reduction

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Introduction
Adaptive radiotherapy (ART) is a strategy that allows continuous adjustment of the treatment plan. This is relevant in head and neck cancer (HNC) patients, where anatomical changes during radiotherapy (RT) are common. However, ART is resource intensive, and clinical data are limited. We therefore conducted a prospective feasibility trial (DART-HN) with online ART in HNC. Dosimetric results are presented in this abstract.

Material and methods
Patients with non-metastatic HNC referred for curative intended RT were offered inclusion (ongoing). All included patients were planned for daily ART. Treatment was delivered on Ethos (Varian Medical Systems). For each fraction, two plans were generated: A scheduled (original plan recalculated on the daily anatomy) and an adapted (re-optimization of the plan to the daily anatomy). The two plans were reviewed online and the best plan chosen for treatment. Treatment time (first scan to treatment delivered) and mean doses to selected organs at risk (OAR) were extracted for all fractions. Mean doses were normalized to planned dose and summed over the treatment course. Adapted vs. scheduled doses were compared by a paired t-test.

Results
Nine patients were included in the analysis. One patient withdrew from protocol midway due to positioning difficulties. A RT technologist-driven workflow was developed. Mean fraction duration per patient ranged from 31.9-48.1 minutes. Mean dose differences were minor and non-significant for most OARs (Ipsilateral parotid gland (PG) 0.94%, p=0.41; contralateral PG 3.1%, p=0.27; middle pharyngeal constrictors muscle (PCM) 1.03%, p=0.80; lower PCM 0.29%, p=0.94). A trend toward reduction was seen for the superior PCM (2.47%, p=0.053), while a significant reduction was observed for the oral cavity (6.1%, p=0.026) (Figure 1).

Conclusion
Daily online ART for HNC is feasible. Dosimetric benefits were modest. A significant dose reduction was found for the oral cavity, while small non-significant changes were found for the other OARs.

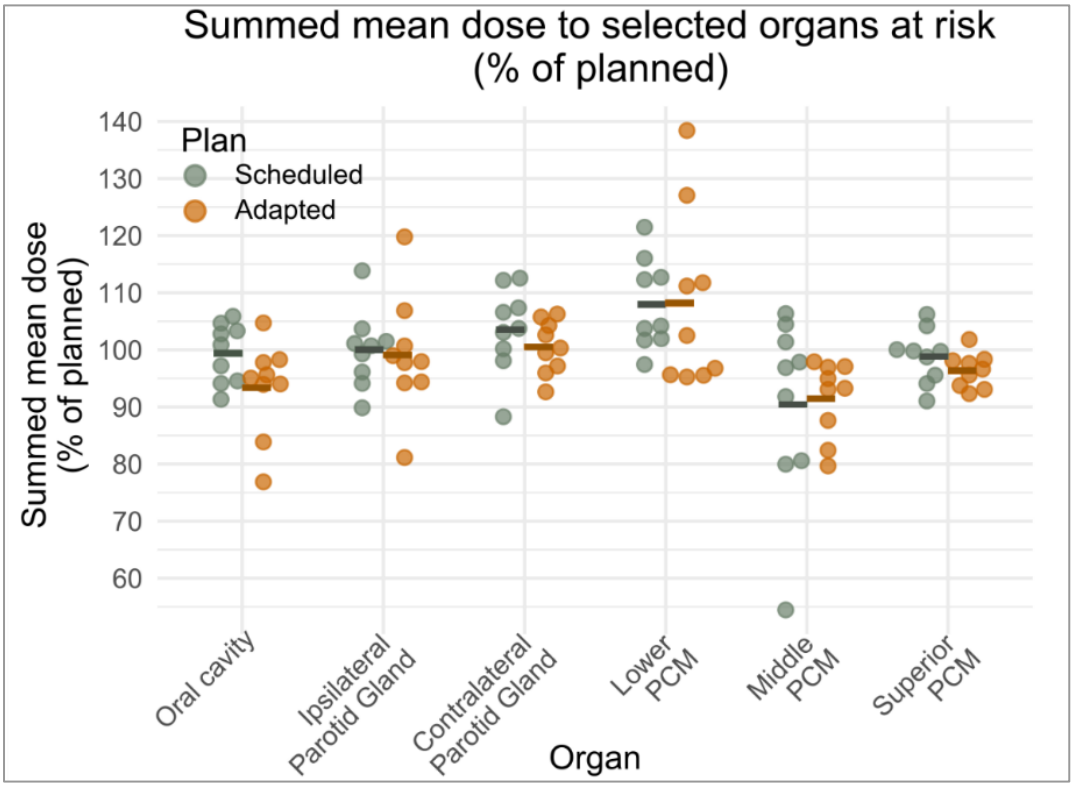

Figure 1: Summed mean dose to organs at risk (% of planned) for scheduled (green) and adapted (orange) plans. Mean is marked with a horizontal line.
Abbreviations: Pharyngeal constrictor muscle (PCM).

Abstract title: OLIGO-DK: the national longitudinal cohort study of local ablative therapy in oligometastatic disease – current status

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Introduction
Local ablative therapy of oligometastatic disease is considered standard of care in some primary cancers and metastatic sites, where it is clinically implemented in daily practice. We report the status of the ongoing OLIGO-DK study which aims to document current practice and improve our understanding of the long-term clinical outcomes for patients with oligometastatic disease receiving local ablative therapy.

Materials and methods
The OLIGO-DK study was initially designed as a combined interventional and observational trial. It was redesigned as a observational cohort study with embedded trials following the first interim analysis, as the interventional aspect proved difficult to clinically distinguish from standard-of-care. Specific experimental or translational subgroups, such as SBRT for bone metastases, can be investigated within embedded trials.

Eligible patients have metastatic cancer with 5 or fewer metastases and have been referred for local ablative therapy of all active metastatic sites by a multidisciplinary conference or team of specialists. All ablative therapies are eligible including surgical resection, thermal ablation, and stereotactic radiotherapy.

A key design feature is the centralized study unit, which handles electronic inclusion and all follow-up for toxicity and quality of life. Standardized registration ensures consistent data collection, while radiotherapy data and evaluation scans are collected pragmatically through standard follow-up.

The primary endpoint is the time to failure of local ablative therapy strategy and secondary outcomes include overall survival, progression-free survival, toxicity, and changes in quality of life.

Results
The first patient was enrolled in April 2024 at Herlev Hospital. As of September 2025, 121 patients have been enrolled in the Capital Region. The study is approved nationally and will initiate inclusion in other regions this year.

Currently, the cohort consists primarily of patients with colorectal cancer (41%), malignant melanoma (16%), and renal cell carcinoma (12%) who were treated for mainly 1 (67%) or 2 (20%) metastases. Most metastases were in lungs (39%) or liver (34%) and were treated with surgery (46%) or stereotactic radiotherapy (43%), see Figure 1.

Conclusion
Following acceptable implementation and accrual in the Capital Region, the OLIGO-DK study is expanding into a nationwide study.

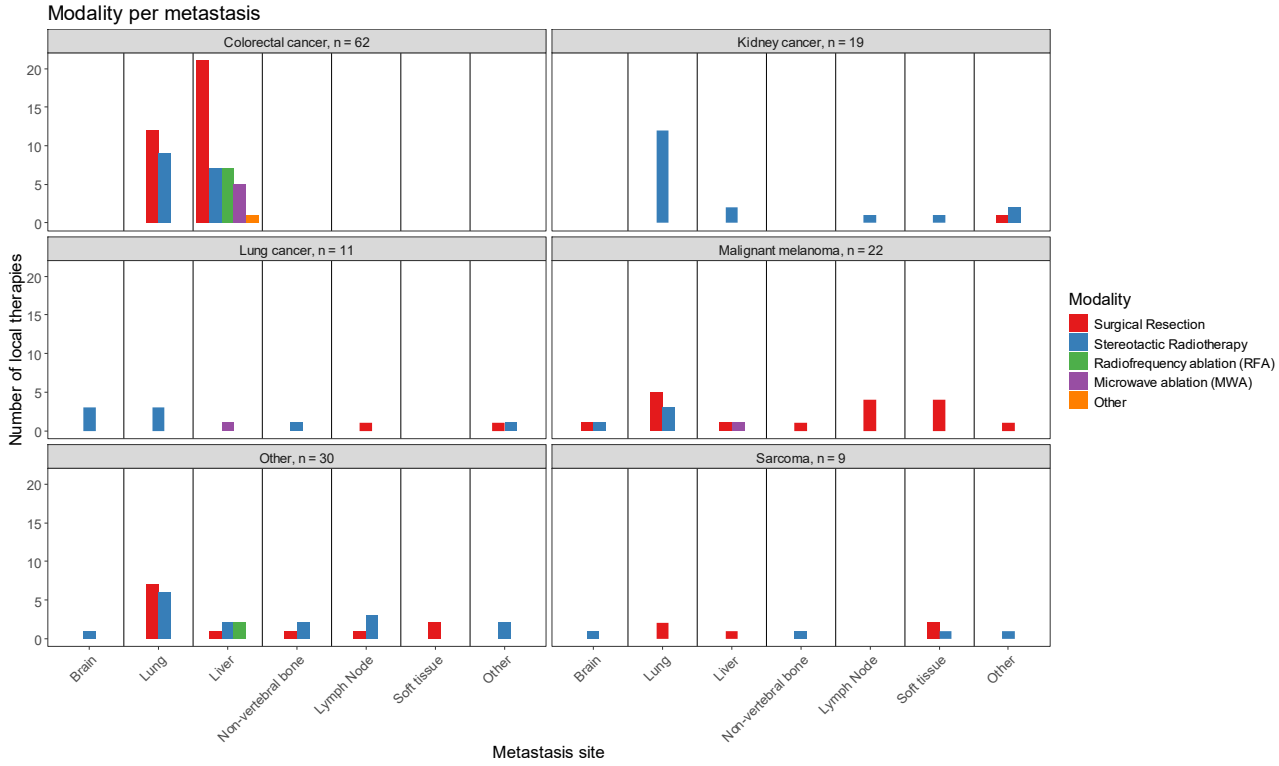

Figure 1. Distribution of primary metastatic sites and local ablative therapy modality, stratified by primary cancer of currently included patients.

Title:
The apparent diffusion coefficient changes during short course radiotherapy in rectal cancer: a multicentre study

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Introduction

The apparent diffusion coefficient (ADC) derived from diffusion-weighted MRI (DWI) is a potential biomarker for response to neo-adjuvant radiotherapy in rectal cancer, enabling personalized treatment. The current study aims to determine whether longitudinal ADC changes can be detected during short-course radiotherapy in a multi-centre cohort of patients with rectal cancer treated on a 1.5 T MRI-linac, for potential response prediction.

Materials and methods

This retrospective study included patients with rectal cancer across three centres prospectively enrolled in the ongoing MOMENTUM trial (clinicaltrials.gov, NCT04075305 [1]). Patients with primary tumours who received curative intent short-course radiotherapy (5 fractions of 5Gy) on a 1.5 T MRI-Linac were selected for analysis (n=135).

DWI was acquired at each fraction prior to beam-on. Regions-of-interests (ROIs) were semi-automatically delineated on DWI for each fraction. ADC voxel-values were extracted using b-values in the range [150, 500] s/mm^2. For each patient, the ADC time-trend across fractions was extracted using linear fitting.

Results

At a cohort-level, the ADC increased during the course of radiotherapy, while the individual time-trends showed a decrease in some patients (Figure 1.a-b). The median (range) ADC change during radiotherapy was 20% (-24%-248%) (Figure 1.c). For 80 patients, the relative ADC change was larger than a repeatability coefficient of 17% reported in a previous study [2] (increase: 77, decrease: 3).

Conclusions

This multicentre study examined ADC values derived from longitudinal DWI collected using a 1.5 T MRI-Linac. We observed ADC changes during treatment, suggesting that longitudinal DWI can reflect radiotherapy-induced changes. These findings encourage future multicentre studies linking ADC to clinical outcomes in rectal cancer.

References

1. de Mol van Otterloo SR et al. Front Oncol. 2020;10.
2. Eijkelenkamp H et al. Phys Imaging Radiat Oncol. 2025;33:0–3.

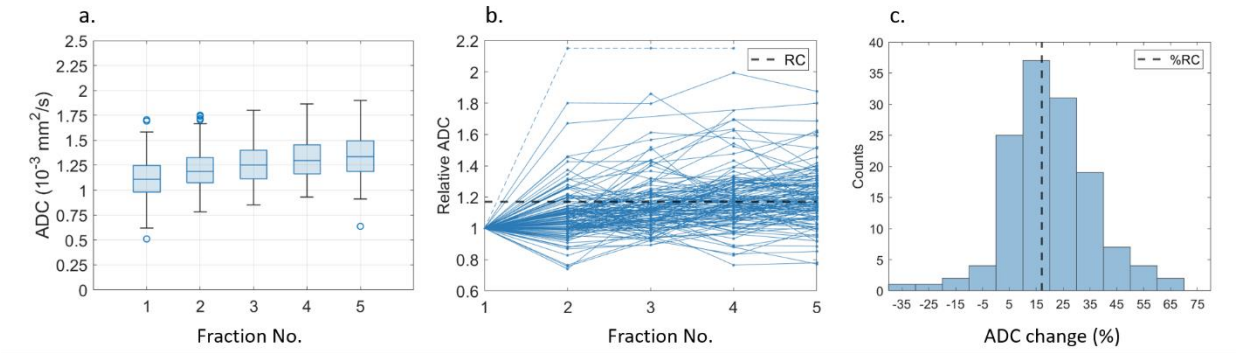

Figure 1: ADC changes during short course radiotherapy for patients with rectal cancer. Boxplot showing the median ADC values for all patients and fractions (a). Relative ADC values (ADC divided by the value at fraction 1) as a function of days since the first fraction (b). Each line represents a patient, and the dotted black line indicates the repeatability coefficient reported in a previous study [2]. The dotted blue line indicates a patient with an ADC change above the scale limit. Distribution of ADC changes (%) between fraction 1 and 5 ((Fx.5-Fx.1)/Fx.1) for all patients (c). For each patient, the ADC change was calculated based on regression constants from a linear fit to the ADC as a function of days since the first RT fraction.