Program of the RKF Scientific Project Day

Friday 14 July 2017, 9:30-17:00

Auditorium Radiotherapie, UMC Utrecht

The Scientific Project Day brings together physicists and researchers in the field of Medical Physics in Radiation Oncology in the Netherlands. The exciting and completely stuffed program includes nineteen research projects that will be presented in a conference like setting. Many presentations mix classical topics like brachytherapy, dosimetry, and treatment planning with fashionable elements like automation, imaging, and machine learning. After lunch Rob Tijssen will provide our physics vitamins with a hard-core lecture on speedy MRI.

Please **register (free) before June 26** by sending an email to: T.G.J.Vogel@umcutrecht.nl

MORNING

9:30	RECEPTION with coffee		
10:00	opening remarks		
10:05	Testing an MR-compatible afterloader for MR-based source tracking in MRI guided HDR brachytherapy	Ellis Beld	UMC Utrecht
10:17	Benefit of adaptive CT-based treatment planning in high-dose rate endorectal brachytherapy for rectal cancer.	Roy van den Ende	LUMC
10:30	Dose warping uncertainties for the cumulative rectal wall dose from brachytherapy in cervical cancer	Laura van Heerden	AMC
10:43	MRL beam and dosimetry testing	Simon Woodings	UMC Utrecht
10:56	Towards a time-efficient clinical workflow using fast automated treatment planning	Rens van Haveren	Erasmus MC
11:08	Automated treatment planning for the current clinic and the MR-Linac	Dennis Winkel	UMC Utrecht
11:21	Treatment plan QA for automatically generated treatment plans: a prospective study	Yibing Wang	Erasmus MC
11:34	Can a density override planning strategy mitigate the dosimetric impact of variable volume of gastrointestinal gas pockets for esophageal cancer radiotherapy?	Peng Jin	AMC
11:47	Evaluation of lung anatomy vs. volume reproducibility for scanned proton treatments under Active Breathing Control	Lydia Otter	UMCG
12:00	LUNCH		

AFTER LUNCH

13:30	HARDCORE PHYSICS **Online MR-Guidance: the need for speed**	Rob Tijssen	UMC Utrecht

AFTERNOON

14:20	resuming remarks		
14:21	Assessment of dosimetric uncertainties induced by deformable image registration methods in 4D proton treatment planning for liver tumors	Cássia Oraboni	UMCG
14:34	Automatic contour propagation for MR-linac treatment of pelvic lymph node oligo-metastases	Anita Werensteijn-Honingh	UMC Utrecht
14:47	Patient-specific and quantitative evaluation of deformable image registration in computed tomography images of lung and head and neck cancer patients	Roel Kierkels	UMCG
15:00	coffee BREAK		
15:30	resuming remarks		
15:33	Why would you buy an EPID today?	Leah McDermott, Suzanne Verhoeven	NWZ Alkmaar
15:45	T2 mapping for multi-center and longitudinal imaging of prostate cancer	Petra van Houdt	NKI
15:57	Pseudo CT generation using deep learning for MRI-only treatment planning	Anna Dinkla	UMC Utrecht
16:09	Multi-parametric functional imaging in non-small cell lung cancer	Aniek Even	Maastro
16:21	FLT en FDG-PET textural features in non-small cell lung cancer	Tom Konert	NKI
16:33	4D radiomics for non-small cell lung cancer patients using CBCT imaging	Janita van Timmeren	Maastro
16:45	Machine learning algorithms for outcome prediction in radiotherapy: advice on selecting a classifier	Frank Dankers	Radboud UMC
16:57	closing remarks		
17:00	DRINKS		

ABSTRACTS

nr	Title	Authors	Affiliation	Abstract
1	**Testing an MR-compatible afterloader for MR-based source tracking in MRI guided HDR brachytherapy**	Ellis Beld	UMC Utrecht	Special MRI sequences have been developed to visualize the HDR source inside the anatomy. Thus providing on-line QA on source position and dose delivered.
2	**Benefit of adaptive CT-based treatment planning in high-dose rate endorectal brachytherapy for rectal cancer.**	Roy van den Ende	LUMC	This study investigated the dosimetric benefit of repeat CT-based planning for high-dose rate endorectal brachytherapy (HDREBT) for rectal cancer. For each repeat CT scan, a projected initial treatment plan and a new treatment plan were compared. Replanning resulted on average in 21% higher (p=0.01) conformity. For 8/22 applications, target coverage criteria could not be met. In these cases, an intervention was required to remove air/feces between the tumor and the applicator or to correct applicator balloon setup. Repeat CT-based treatment planning should be the minimal standard practice in HDREBT for rectal cancer.
3	**Dose warping uncertainties for the cumulative rectal wall dose from brachytherapy in cervical cancer**	Laura van Heerden	AMC	It might be necessary to monitor 3D cumulative dose distribution from multiple brachytherapy applications in clinical practice. For the rectal wall dose accumulated with deformable image registration, we investigated dose warping uncertainties using a physically realistic model describing rectal wall deformation. Local absolute dose errors and geometrical errors were large. Care should therefore be taken with deformable image registration for dose warping purposes in brachytherapy.
4	**MRL beam and dosimetry testing**	Simon Woodings	UMC Utrecht	For the first-in-man treatment the MRL had to be commissioned. The beam has been quantified and dosimetry has been tested.
5	**Towards a time-efficient clinical workflow using fast automated treatment planning**	Rens van Haveren, Sebastiaan Breedveld	Erasmus MC	The aim is to create a time-efficient workflow for clinicians, so that high quality treatment plans are ready to be evaluated minutes after the delineation is finished. Currently, plans are automatically generated using the in-house developed Erasmus-iCycle optimiser, but planning times can be in the order of hours. Therefore, we propose an extension of Erasmus-iCycle to substantially reduce computation times, but maintain plan quality.
6	**Automated treatment planning for the current clinic and the MR-Linac**	Dennis Winkel	UMC Utrecht	For the MRI linac treatment on-line treatment planning is being developed. This on-line planning can also be used in the regular clinic to optimize treatment delivery.
7	**Treatment plan QA for automatically generated treatment plans: a prospective study**	Yibing Wang, B.J.M. Heijmen, S.F. Petit	Erasmus MC	In this study, we prospectively investigated the clinical usefulness of a plan QA model, that independently detected outliers in treatment plan quality for prostate cancer patients. First the dose prediction accuracy of the plan QA model was retrospectively evaluated with treatment plans from 2015 (N=43); Next, the clinical usefulness of the plan QA model was evaluated by prospectively detecting and replanning for the dosimetric outliers for the clinical treatment plans from 2016 (N=50). Results show that the model was with high dose prediction accuracy, and the detected outlier plans could be mildly improved after replanning. This emphasizes the need for treatment plan QA, also for automated treatment planning. For manual treatment planning, more clinical benefit is expected.

8	**Can a density override planning strategy mitigate the dosimetric impact of variable volume of gastrointestinal gas pockets for esophageal cancer radiotherapy?**	Peng Jin	AMC	The purpose of this study is to investigate whether a density override strategy in the treatment planning process can mitigate the dosimetric impact of the variable volume of gastrointestinal gas pockets for esophageal cancer radiotherapy. For this purpose, we retrospectively made IMRT and VMAT plans using three different density override settings and compared the resulting plans in terms of the scaled-fractional dose, the accumulated dose, and their difference from the planned dose. We found that in order to mitigate the potential overdose or underdose induced by the unpredictable volume changes of gastrointestinal gas pockets during the treatment course, the use of VMAT and density override of 0.5 in treatment planning process is preferred when a large volume of gas pockets is observed on the planning CT.
9	**Evaluation of lung anatomy vs. volume reproducibility for scanned proton treatments under Active Breathing Control**	Lydia Otter	UMCG	Proton therapy is a highly conformal way to treat cancer. For the treatment of moving targets, scanned proton therapy delivery is a challenge, as it is sensitive to motion. The use of breath hold mitigates motion effects. Due to the treatment delivery over several fractions with delivery times extending the feasible breath hold duration, high reproducibility of breath holds is required. Active Breathing Control (ABC) is used to perform breath holds with controlled volumes. We investigated whether the lung anatomy is as reproducible as lung volumes under ABC, to consider ABC for scanned proton treatments.
10	**Assessment of dosimetric uncertainties induced by deformable image registration methods in 4D proton treatment planning for liver tumors**	Cássia Oraboni	UMCG	Different deformable image registration (DIR) algorithms can result in diverse motion estimations, directly influencing 4D dose distributions and clinical decision-making. The aim of this study is to evaluate DIR-induced dosimetric uncertainties for 4D dose calculations of scanned proton plans using 4DCT-MRI data sets. These data sets consist in several time steps 3DCTs animated with motion extracted from 4DMRI, which can be defined as the ground truth (GT) for this specific application. A prior known dense motion field such as the GT constitutes an advantage over conventional sparse landmarks.
11	**Automatic contour propagation for MR-linac treatment of pelvic lymph node oligo-metastases**	Anita Werensteijn-Honingh	UMC Utrecht	MR-guided online adaptive stereotactic body radiotherapy (SBRT) with the new MR-linac holds the promise of save dose escalation and hypofractionation for the treatment of lymph node oligo-metastases. Automatic identification of target volumes and organs at risk is needed to make an online adaptive workflow possible. This study investigated the use of a commercial package for contour propagation (Admire, Elekta AB, Stockholm, Sweden) and of a newly developed workflow based on the open source Elastix image registration toolkit. Contours of pathological pelvic lymph nodes and surrounding organs at risk (bladder, rectum, sigmoid, cauda equina, femoral bones) were propagated between two MRI scans of each patient (n = 5) and compared with ground truth delineations.
12	**Patient-specific and quantitative evaluation of deformable image registration in computed tomography images of lung and head and neck cancer patients**	Roel Kierkels	UMCG	Although deformable image registration (DIR) algorithms are increasingly available in the field of radiation oncology, its use for dose accumulation of the fractionated treatment course is limited due to intrinsic uncertainties in the deformable algorithm. A tool that allows for an estimation of DIR uncertainties is therefore required. Definition of DIR uncertainties for each individual patient is only practically realistic when the tool is fully automated. In this study, we investigate and model complementary measures of DIR uncertainty for datasets of head and neck (HN) cancer and lung cancer patients.

13	**Why would you buy an EPID today?**	Leah McDermott & Suzanne Verhoeven	NWZ Alkmaar	Electronic portal imaging devices were designed for imaging boney anatomy in 2D. Their primary task has since been superseded by 3D imaging technology. In 2006, experts said EPIDs would become obsolete. However the EPID has other uses, such as calibration of the CBCT that replaced it, plan QA, linac QA and patient breath-hold monitoring. Can we justify this extra-function with the price tag and ongoing service costs? The Netherlands has been the overwhelming leader in the integration of imaging in Radiotherapy for the last 20 years. So we asked all 20 NL institutes about their current (1 April 2017) and intended (2020) use of EPIDs. The response was 100%, with a clear movement away from position verification (38% à 15%) towards more plan QA (25 à 53%) and linac QA (36% à 50%). Opinions were divided about the future of EPIDs (18 positive & 2 negative). They ranged from a strong belief in the future of our super-versitile, indispensable, aSi panels; to those who see it going the way of lead blocks, paper dossiers and wedges.
14	**T2 mapping for multi-center and longitudinal imaging of prostate cancer**	Petra van Houdt, Harsh Agarwal, Laurens van Buuren, Stijn Heijmink, Søren Haack, Henk van der Poel, Ghazaleh Ghobadi, Floris Pos, Folkert Koetsveld, Leon ter Beek, Hans Peeters, Peter Choyke, Uulke van der Heide	NKI	T2 mapping could be a potential biomarker for treatment response monitoring in prostate cancer. However, the application of T2 mapping has been limited by the long acquisition time necessary for accurate T2 values. Recently a multi-echo spin-echo T2 mapping technique with a k-t undersampling scheme (k-t T2) has been developed for whole-prostate imaging in a clinically reasonable time. In this study we show that the k-t T2 maps are accurate and reproducible across scanners and over time and can therefore be used in multi-center and longitudinal trials of prostate cancer.
15	**Pseudo CT generation using deep learning for MRI-only treatment planning**	Anna Dinkla	UMC Utrecht	The MRI-only treatment planning is gaining importance. New deep learning techniques may help to make the Hounsfield definitions fast and accurate.
16	**Multi-parametric functional imaging in non-small cell lung cancer**	Aniek Even	Maastro	Tumours often display significant intratumour heterogeneity. These differences in tumour cells and microenvironment influence the sensitivity throughout (radio)therapy. We aimed to combine multi-parametric functional imaging to identify high-risk subregions with characteristic phenotypes. We correlated these subregions to treatment outcome after (chemo)radiotherapy. For this purpose, imaging of metabolic activity (FDG PET/CT), hypoxia (HX4 PET/CT) and tumour vasculature (DCE-CT) were combined. Furthermore, we predicted hypoxia levels based on FDG PET/CT and DCE-CT.
17	**FLT en FDG-PET textural features in non-small cell lung cancer**	Tom Konert	NKI	International multicenter experience.

18	**4D radiomics for non-small cell lung cancer patients using CBCT imaging**	Janita van Timmeren	Maastro	Previously, quantitative radiomic features extracted from medical images acquired prior to treatment, i.e. PET, CT or MRI, are shown to have prognostic information for non-small cell lung cancer (NSCLC) patients. In clinical practice, CT images are only acquired at limited timepoints, usually prior to treatment and at follow-up a few months after treatment. On the other hand, cone-beam CT (CBCT) images are generally acquired daily or weekly during treatment for lung cancer patients, for patient positioning and verification purposes. If CBCT images are suitable for extracting reliable radiomic features, this could be performed in a longitudinal fashion: 4D radiomics. In other words, changes of radiomic features over time extracted using CBCT imaging can monitor the tumor over the course of treatment. This quantitative information can be valuable for improving the decision making of (early) treatment adaptation in a personalized manner. In the current study, we investigated the change of CBCT derived radiomic features over time and their prognostic value for NSCLC patients.
19	**Machine learning algorithms for outcome prediction in radiotherapy: advice on selecting a classifier**	Frank Dankers	Radboud UMC	Machine learning classification algorithms (classifiers) for outcome prediction are popular in radiotherapy literature. General machine learning literature provides evidence in favor of some classifier families (random forest, support vector machine, gradient boosting) in classification performance. In this study, we compare classifiers in radiotherapy datasets to guide researchers in selecting a classifier.