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Patient selection models

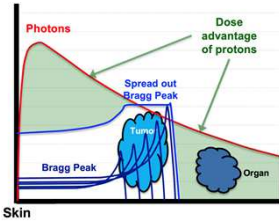
63rd AAPM Annual Meeting (on line)
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Professor Johannes A. Langendijk
Department of Radiation Oncology
University Medical Center Groningen
Groningen
The Netherlands



Introduction

Superior beam properties with protons



Translate into clinical benefits

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Improvement local control

Target dose: Photons (red bar), Protons (green bar). Normal tissue dose: Photons (red bar), Protons (green bar). Randomised controlled trials

Prevention of complications

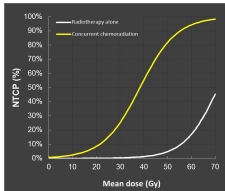
Target dose: Photons (red bar), Protons (green bar). Normal tissue dose: Photons (red bar), Protons (green bar). Randomised controlled trials ?

NTCP-models

Normal Tissue Complication Probability

NTCP-models

- Prediction models
- Relationship between dose in organs at risk and risk of complications
- Prospective data registration programs:
 - Clinical data
 - Toxicity data
 - Dose distributions



Model-based approach

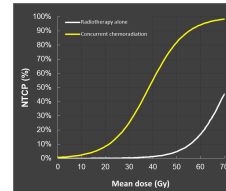
- Model-based selection
 - Identify patients** who will benefit most from proton therapy in terms of complication risk reduction
- Model-based validation
 - Alternative evidence-based method to **evaluate the benefit** of protons when used to reduce complication risk

Langendijk, et al. Radiother Oncol 2013
Langendijk, et al. Sem Radiat Oncol 2018

Model-based selection

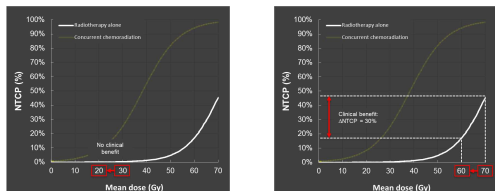
Basic conditions

- Similar target dose (similar local control)
- Lower dose to relevant OAR (Δ Dose)
- Δ Dose should translate into Δ NTCP = reduction in complication risk



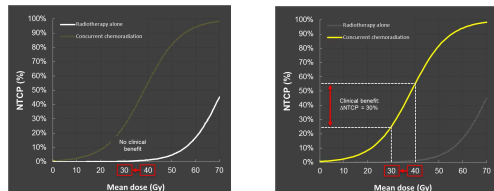
Model-based selection

From Δ Dose to Δ NTCP



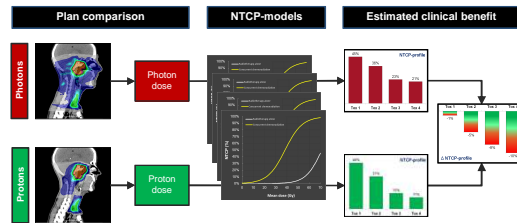
Model-based selection

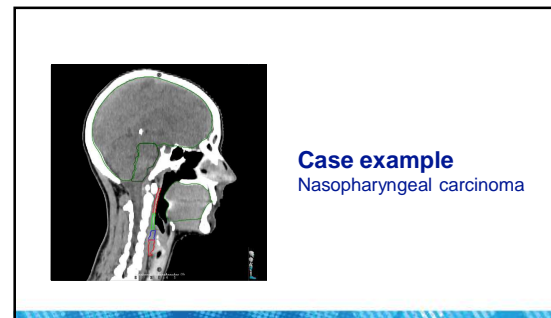
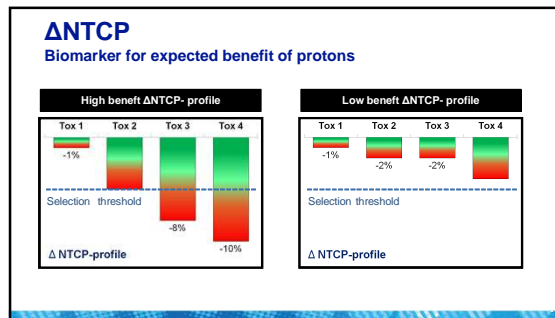
From Δ Dose to Δ NTCP



Model-based selection procedure

Plan comparison | NTCP-models | Estimated clinical benefit

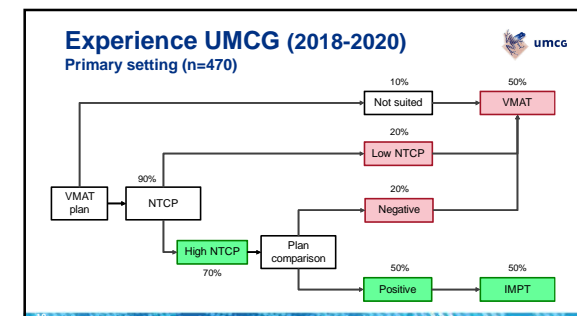
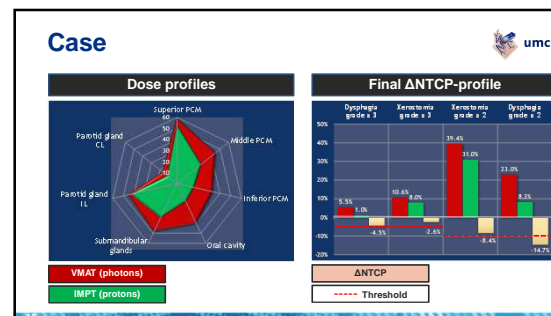
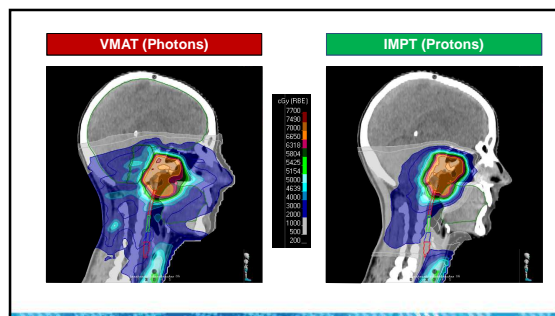
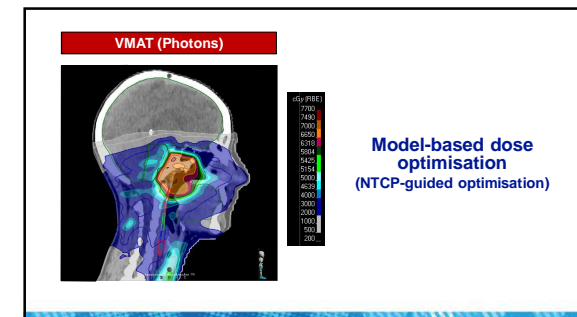
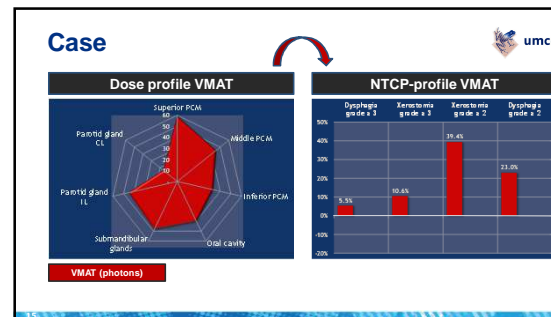
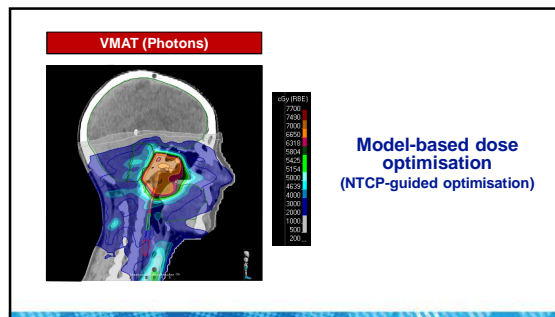


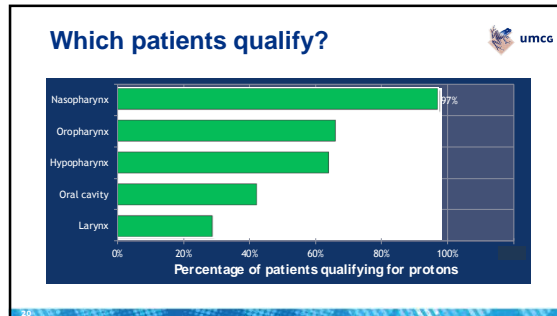


National indication protocol

Predictors	NTCP-models (6 months after end of RT)			
	Xerostomia grade ≥ 2	Dysphagia grade ≥ 2	Xerostomia grade ≥ 3	Dysphagia grade ≥ 3
D _{mean} parotid glands				
D _{mean} submandibular glands				
Baseline xerostomia				
D _{mean} oral cavity				
D _{mean} superior PCM				
D _{mean} middle PCM				
D _{mean} inferior PCM				
Baseline dysphagia				
Primary tumour site				
Delta-NTCP threshold	≥ 10%	≥ 10%	≥ 5%	≥ 5%
	Sum ΔNTCP ≥ 15%		Sum ΔNTCP ≥ 7.5%	

Van den Bosch et al. Accepted for publication in Radiother Oncol 2021





How to validate the benefit of proton therapy?

- ### Model-based approach
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- ### Model-based validation
- NTCP-model validation
 - Model-based clinical evaluation
- Langendijk, et al. Radiother Oncol 2013
Langendijk, et al. Sem Radiat Oncol 2018

