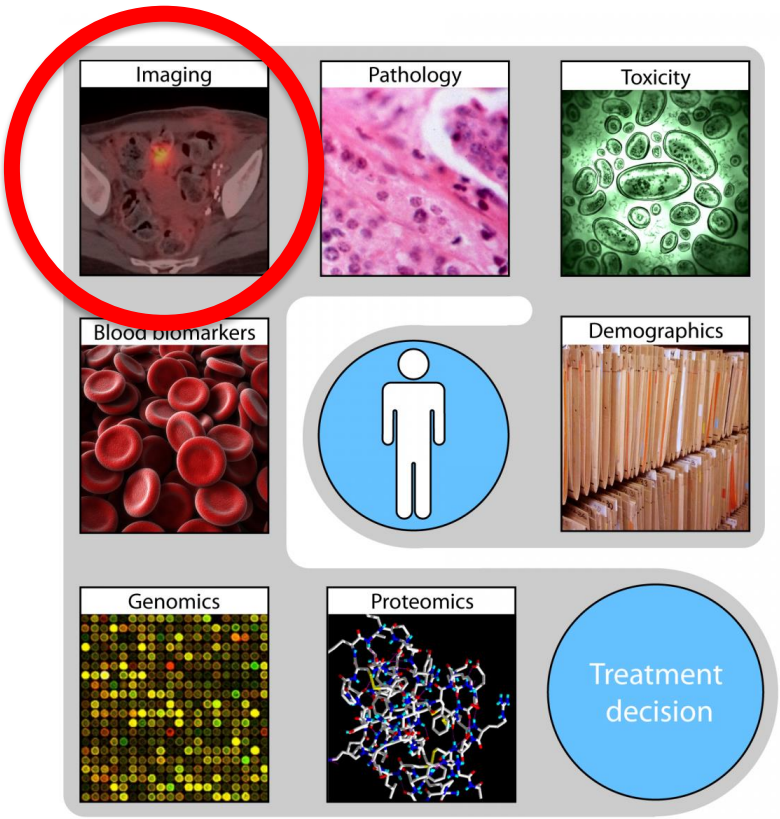
Personalized treatment

- Improve a patient's outcome
- Make better clinical decisions



Radiomics

Radiomics on cone-beam CT images

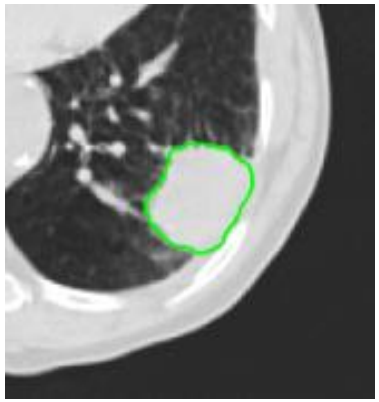
Janita van Timmeren
(janita.vantimmeren@maastro.nl)
Maastro Clinic
Maastricht University
The Netherlands

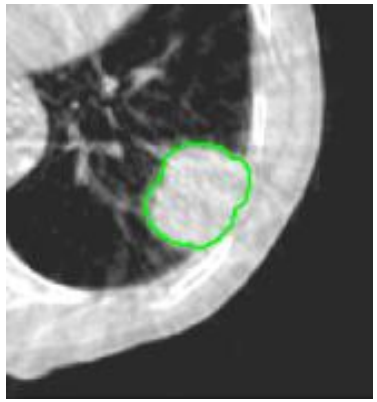
Cone-beam CT

CBCT

- Prior to radiotherapy
  - Weekly / daily
- Follow treatment

Conventional CT vs. kV cone-beam CT





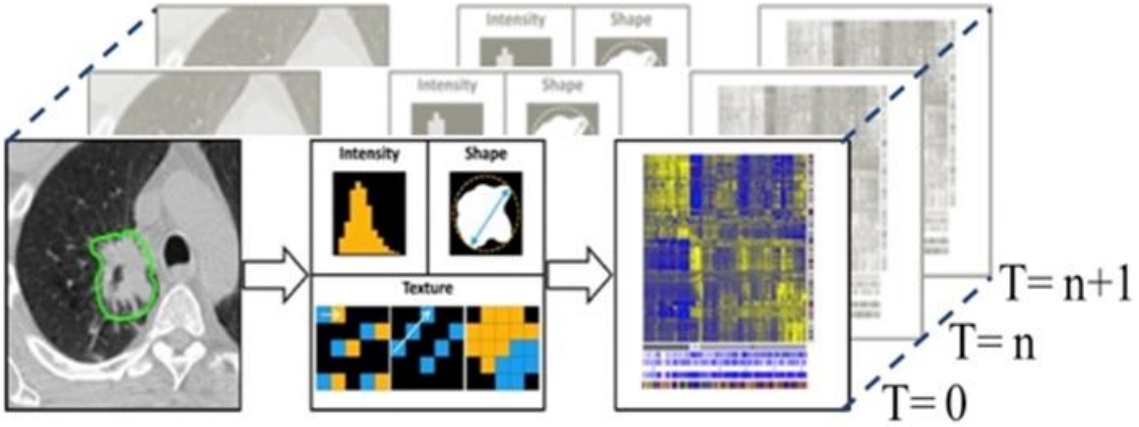
Cone-beam CT radiomics?

"Delta" radiomics

Challenges:

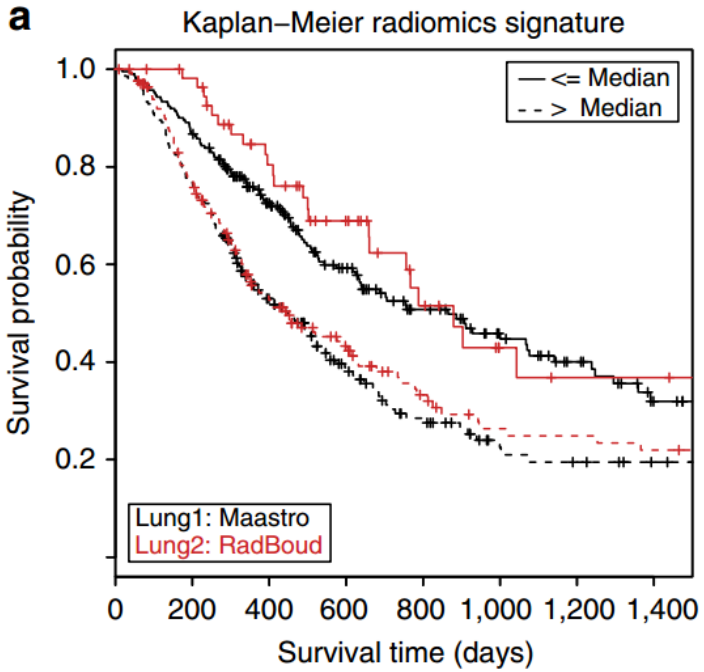
- Lower image quality
- Sensitive to artefacts

Radiomics? Quantitative and independent method to monitor response to treatment!



Radiomics signature

- Cox regression hazards model based on **four radiomic features**



Aerts, H. J. W. L. *et al*. Decoding tumour phenotype by noninvasive imaging using a quantitative radiomics approach. *Nat. Commun.* 5:4006 doi: 10.1038/ncomms5006 (2014)

Radiomics signature

- Related to proliferation
- Able to predict outcome for lung cancer and head & neck cancer using CT images

- Prognostic/predictive value of cone-beam CT images for lung cancer patients?

Methods

- 216 patients with stage II-III non-small cell lung cancer (NSCLC)

4 radiomic features derived from:

- Treatment planning CT (CT1)
- Cone-beam CT prior to the first fraction (CBCT-fx1)
- Cone-beam CT prior to the second fraction (CBCT-fx2)

Correlation and stability

Compare 4 radiomic features

Correlation: Planning CT (CT1) vs. cone-beam CT fraction 1 (CBCT-fx1)

Stability: Cone-beam CT fraction 1 (CBCT-fx1) vs. cone-beam CT fraction 2 (CBCT-fx2)

Intraclass correlation coefficient (ICC)

Model validation

Prior to model validation:

- Relationship between CT and cone-beam CT?
- Linear regression → derive correction factor
- Based on 20 patients

Validate radiomic signature on cone-beam CT:

- Compare Kaplan-Meier curves
- Harrell's concordance index (c-index)

Radiomic signature

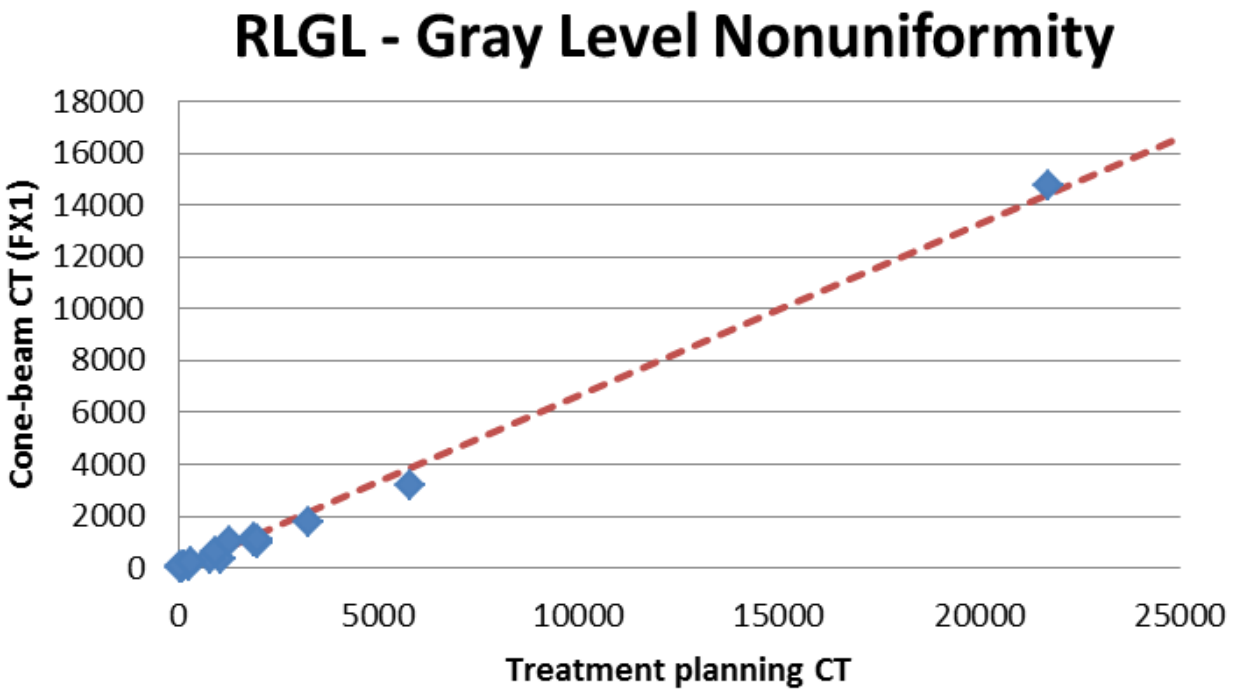
ICC

Feature name	pCT vs. CBCT-FX1	CBCT-FX1 vs. CBCT-FX2
Stats – Energy	0.92	0.91
RLGL – Gray Level Nonuniformity	0.88	0.92
Wavelet – HLH RLGL Gray Level Nonuniformity	0.86	0.91
Shape – Compactness	0.97	0.98

Correction factor

Prior to model validation

Example for one feature:



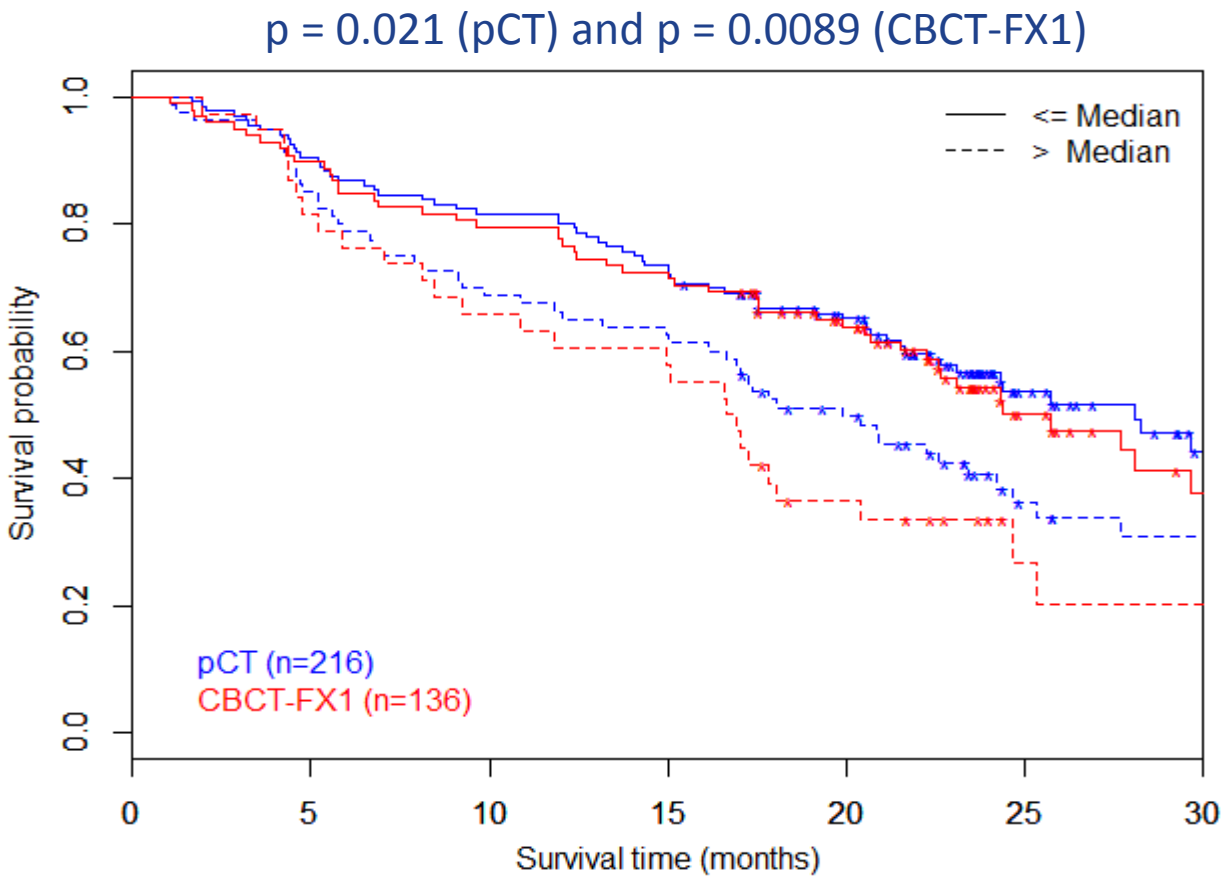
Correction factor

Prior to model validation

Feature name	Slope	SE	R^2
Stats – Energy	1.26	0.02	1.00
RLGL – Gray Level Nonuniformity	0.67	0.01	1.00
Wavelet – HLH RLGL Gray Level Nonuniformity	0.65	0.02	0.98
Shape – Compactness	1.03	0.02	0.99

Kaplan-Meier curves

Model validation



Harrell's concordance-index

c-index

0.5 → no discrimination
1.0 → perfect discrimination

pCT: c-index = 0.63
(95% CI [0.57 – 0.68], p < 0.0001)

CBCT-FX1: c-index = 0.64
(95% CI [0.57 – 0.71], p < 0.0001)

Previous external validation:
c-index between 0.63 and 0.65 for CT images

Leijenaar RT. *et al*. External validation of a prognostic CT-based radiomic signature in oropharyngeal squamous cell carcinoma. *Acta Oncol*. 2015 Oct;54(9):1423-9.

Discussion

- **Challenges:**
  - Sensitivity to artefacts
  - Limited field of view
  - Differences between (reconstruction) settings → standardization needed

CBCT "Delta-radiomics"

Potential

Results show great potential for "Delta-radiomics"

Future → Improve prognostic value of CBCT imaging using delta-features

→ Better treatment decisions
→ Improved outcome

Acknowledgements

- Maastro Clinic

Ralph Leijenaar
Wouter van Elmpt
Philippe Lambin

Thank you for your attention

Janita van Timmeren
(janita.vantimmeren@maastro.nl)
Maastro Clinic
Maastricht University
The Netherlands