Artificial Intelligence for radiomic prediction of radiotherapy side effects

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Radiotherapy is very effective, but can result in side-effects in some patients.

### Patient factors
- Demographics
- BMI
- Age
- Comorbidities
- ...

### Treatment factors
- Medication
- Surgery
- Hormone therapy
- ...

### Genetics
- Genome-wide SNP data

### RT treatment
- Dose
- Fractions
- Time of day?
- RT technology

<table>
<thead>
<tr>
<th>Breast</th>
<th>Lung</th>
<th>Prostate</th>
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<td>- Erythema (short term)</td>
<td>- Cardiotoxicity</td>
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<td>- Sexual dysfunction</td>
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### Specific side-effects:
- Breast:
  - Erythema (short term)
  - Atrophy
  - Pain
  - ...

- Lung:
  - Cardiotoxicity
  - Breathing problems
  - Lung fibrosis
  - ...

- Prostate:
  - Incontinence
  - Rectal bleeding
  - Sexual dysfunction
  - ...
The REQUITE project

• Multi-national observational study
• Breast, lung and prostate cancer patients
• ~ 4500 patients from 26 recruitment sites in 8 countries
• Cohort to validate existing predictive models and biomarkers of radiotoxicity

This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement no 601826
Patient-related information
Epidemiological, demographic, comorbidities

Toxicity data
Health professional rated (CTCAE v4)

Patient Reported Outcomes (PROs)
General QoL: EORTC QLQ C30
Fatigue: MFI
Physical activity: GPAQ
Breast specific: BR23
Prostate specific: Pelvic Symptoms
Lung specific: Lung Symptoms

Breast photos
BCCT.core scored

Cancer treatment data
Radiotherapy, chemotherapy, surgery, hormonal treatment

Radiotherapy physics data
DICOM: CT, RTPLAN, RTDOSE, RTSTRUCT
dDVH (dose-volume histograms)

Vital status
Cause of death, disease progression; withdrawal reason (if applicable)
REQUITE: Big(ish) data

CRFs & PROs
> 100,000 forms

Photos
> 5,400 photos scored

Genomics
> 12 m SNPs
4,223 subjects

CT Images
> 569,000 files

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• ...

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• ...

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Physics Data – radiotherapy planning

- Manual or semi-manual delineation of tumour and organ structures
- RT plan to maximise tumour dose while sparing surrounding tissues
- Can we use AI approaches to predict which plans are more likely to result in radiotoxicity?
- Deep learning imaging approaches: Axial3D
IAX Involvement

• IAX provided travel funds to meet with Axial3D and develop a Wellcome Trust Innovator Award application

Academic perspective
• Axial3D’s expertise in machine learning image analysis will allow us to fully exploit radiotherapy dose data with greater precision
• Machine learning outcomes will enhance our radiotoxicity prediction models

Axial3D perspective
• Being part of an active research community
• Develop new products that can improve the healthcare and medical institutions
Acknowledgements

Leicester
• Chris Talbot
• Tim Rattay
• Dusan Milanovic
• Paul Symonds

Axial3D, Belfast
• Niall Haslam

North West Cancer Centre, Londonderry
• Wendy Hyland