Evidence Brief

ORIGIN: Radiotherapy Research - multi-modality imaging, radiomics, radiobiological modelling and photonics-enabled brachytherapy.

Why did we start?
(The need for the research and/or Why the work was commissioned)

This award leveraged funding for two projects:

1) Horizon 2020 funded project ORIGIN (Optical Fibre Dose Imaging for Adaptive Brachytherapy) which aimed to deliver more effective, photonics-enabled, brachytherapy for cancer treatment through advanced real-time radiation dose imaging and source localisation.
2) Friends of the Cancer Centre supported project to provide dedicated scientific support for the development, implementation and review of advanced radiotherapy treatments.

Movement of organs at risk (OARs) in brachytherapy and stereotactic ablative radiotherapy (SABR) can result in dosimetric uncertainties. This research investigated the need for in vivo dosimetry by defining these uncertainties and determining the minimum accuracy and optimal positions of dosimeters which monitor radiation dose in real-time.

What did we do?
(Methods)

Treatment planning studies were performed which quantified the dosimetric effect of OAR movement between planning and treatment. Patient subgroups within low dose rate (LDR) prostate brachytherapy who were likely to benefit most from in vivo dosimetry were investigated by analysing biochemical outcomes with data stratified by NCCN risk group, radiological (r) T stage, Gleason score (GS), initial PSA (iPSA) and prostate gland volume. Prostate sector analysis was performed to determine the optimal positions of dosimeters within the prostate gland. Clinical outcomes and the effect of inter-fraction OAR movement were analysed as part of the SPORT prostate SABR trial to evaluate the role for in vivo dosimetry, and an exploratory analysis of the amino acid citrulline was performed to determine its suitability in predicting patients most likely to benefit from in vivo dosimetry. The required positional certainty of dosimeters within high dose rate (HDR) cervical brachytherapy was also determined.

What answer did we get?
(Findings)

The dosimetric effect of potential OAR movement between planning and treatment was greatest for the urethra in LDR prostate brachytherapy. Survival analyses demonstrated statistically significantly greater biochemical recurrence rates among those with unfavourable intermediate-, high- and very high-risk tumours versus low-risk tumours, unfavourable intermediate-risk versus favourable intermediate-risk tumours, rT3a versus rT1c and rT2 tumours (monotherapy) and GS 8 versus GS 7 and GS 6 tumours. Prostate sector analysis demonstrated the anterior base and posterior midgland had the greatest differences in D90 from the global prostate D90. Rates of freedom from BCF were also lowest when the dominant intraprostatic lesion (DIL) was located in the anterior base and highest when the DIL was located in the posterior midgland sector. There were no differences, however, in rates of distant metastasis-free survival (dMFS) when data were stratified by location of or dose received by the sector containing the DIL. Analysis of the SPORT SABR trial demonstrated feasibility with acceptable toxicity. The positions of OARs at pre-fraction CBCT correlated better with gastrointestinal (GI) toxicities compared to their positions at the time of the planning CT. Correlations of citrulline levels with late bowel toxicity were found suggesting its potential role as a predictive biomarker to identify patients with the most potential to benefit from in vivo dosimetry

What should be done now?
(Practice/Policy Implications and/or Recommendations)

The outputs from this research has been presented at international meetings and will be published in the open scientific literature so that scientists and clinicians can access this. Further funding is being sought for the Origin project to enable the design and delivery of a clinical trial using the Origin in vivo dosimetry system initially in cervical cancer. A clinical protocol has been developed to utilise the Origin in vivo dosimetry system in the future once a commercial partner can be identified.