
Conference or Workshop Item:
Barrell, M., Abbott, N., Adams, R. et al. (4 more authors) (2023) Assessing plan quality in the 'PLATO anal cancer trial 5' pilot phase with automated planning. In: ESTRO 2023, 12-16 May 2023, Vienna, Austria.

https://doi.org/10.1016/S0167-8140(23)08592-4

QA have identified QA tests that check high-risk failures that should receive focused QA efforts for clinical trial design, prospective peer-review, and focused QA efforts in routine clinical practice.

OC-0420 Assessing plan quality in the 'PLATO anal cancer trial 5' pilot phase with automated planning

M. Barrell[1,1], N. Abbott[1], R. Adams[2], M. Hawkins[3], D. Sebag-Montefiore[4], A. Millin[1], P. Wheeler[1]
[1]Velindre Cancer Centre, Physics, Cardiff, United Kingdom; [2]Velindre Cancer Centre, Oncology, Cardiff, United Kingdom; [3]University College London, Medical Physics and Bioengineering, London, United Kingdom; [4]Leeds Cancer Centre, Oncology, Leeds, United Kingdom

Purpose or Objective

Treatment efficacy relies on plan quality. Within trials, plan quality may vary due to training and equipment differences, which may influence treatment outcome or trial results. This study uses automated planning to assess plan quality and variation within the PersonaLlising rAdioTherapy dOse (PLATO) Anal Cancer Trial 5 (ACT5).

Materials and Methods

A protocol based automatic iterative optimisation (PBAIO) planning solution [1], implemented in RayStation, was calibrated for anal cancer using 5 pre-trial benchmark patient plans and 10 non-trial patients. Plans were generated for the pilot phase of PLATO ACT5; a dataset of 51 patients from 11 centres. Patients with prosthetic hips, replans, or unavailable suitable planning data were excluded (n=9). All trial plans were approved by the PLATO national trials QA team.

The trial and automated plans were quantitatively compared using the ACT5 planning protocol parameters, small bowel V15Gy in cm^3, and planning target volume (PTV) conformity index (CI) and homogeneity index (HI). Statistical analysis was completed using a Wilcoxon signed rank test.

Results

At a population level, automation generally yielded higher quality plans with less variation when compared to trial plans. Automation reduced mandatory and optimal objective failures from 4 to 3 and 137 to 80 respectively. 34/46 metrics showed statistically significant ($p<0.05$) differences between automated and trial plans (Table1). Automation significantly reduced OAR dose. Genitalia D50% and D35% reduced by >5.5Gy, femoral heads (FHs) by >2.5Gy and bladder D50% by 1.8Gy. Small bowel D200cc and D150cc reduced by 5.0Gy, and V15Gy by 41cm3. These reductions did not adversely impact PTV D98%, D2%, HI or CI, which were within 0.6Gy, 0.6Gy, 0.018, and 0.017 respectively.
At a per patient level, substantial variation in the difference between trial and automated plan metrics indicated noteworthy plan quality variability (Figure1). For the genitalia and FHs, interquartile range (IQR) of the difference (trial-auto) was largest for D35%; 5.8Gy and 5.2Gy respectively. For the bladder, D50% IQR was 4.5Gy. The small bowel D200cc and V15Gy IQRs were 7.7Gy and 46cm3 respectively. Meaningful variations in PTV D98%, D2%, CI and HI were also observed (Figure1) with IQRs of up to 2.4Gy, 2.4Gy, 0.018, and 0.060 respectively.

Structure	Metric	Trial		Automated	
		Mean	StDev	Mean	StDev
Small Bowel	*D200cc (Gy)*	17.7	9.5	12.7	7.9
	D150cc (Gy)	20.3	10.0	15.2	9.2
	D20cc (Gy)	35.0	10.2	31.8	12.2
	D5cc (Gy)	40.4	7.9	38.6	10.2
	V15Gy (cc)	161.9	118.1	121.3	105.2
Left FH	*D50% (Gy)*	26.3	2.6	23.7	3.1
	D35% (Gy)	28.7	2.5	26.0	2.9
	D5% (Gy)	35.5	2.4	32.8	2.3
Right FH	*D50% (Gy)*	26.0	3.3	23.2	2.9
	D35% (Gy)	28.4	3.4	25.7	2.8
	D5% (Gy)	34.7	3.0	32.8	2.5
Genitalia	*D50% (Gy)*	23.2	5.3	17.3	3.3
	D35% (Gy)	27.1	5.5	21.4	5.5
	D5% (Gy)	42.6	9.0	39.8	11.3
Bladder	*D50% (Gy)*	32.6	5.1	30.7	5.4
	D35% (Gy)	37.1	4.7	36.2	5.2
	D5% (Gy)	48.2	5.3	48.4	5.5

Table1 - Trial and auto plan DVH data. *Italic* and underline indicate statistically significant differences.

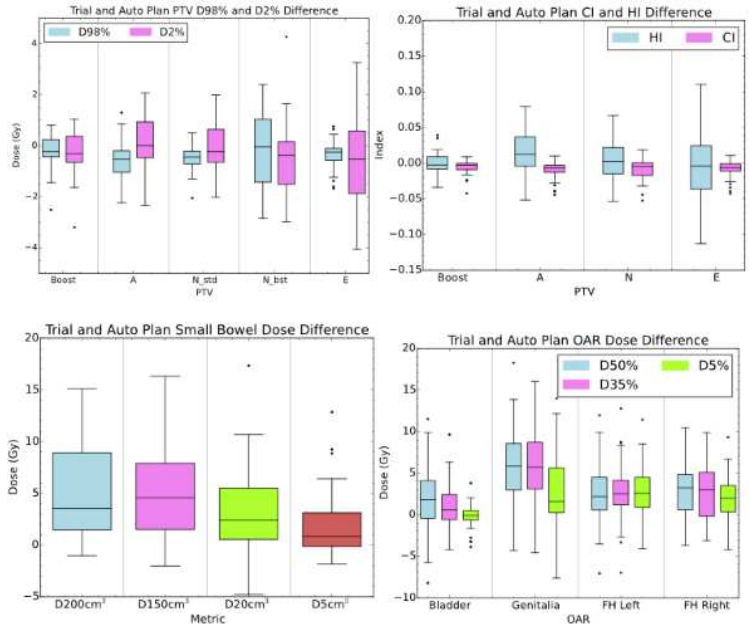

Figure 1 – Difference between auto and trial plan dose metrics (trial-auto)

Conclusion

Automated planning highlighted significant variations in plan quality within the pilot phase of PLATO ACT5. Evaluating plan quality in this manner may encourage improvements in training, QA and future trial approaches. This may reduce variation and improve overall plan quality.

References

[1] P. Wheeler et.al, "Utilisation of Pareto navigation techniques to calibrate a fully automated radiotherapy treatment planning solution", Phys Img Radiat Oncol, vol. 16, no. 10, pp. 41-48, 2019

OC-0421 Development and QA of IGRT procedures for node-positive prostate cancer patients in the PEARLS trial

O. Naismith[1], S. Alexander[2,3], A. Webster[4], E. Miles[5], S. Hassan[6], J. Murray[7,8]

[1]Radiotherapy Trials QA Group (RTTQA), The Royal Marsden NHS Foundation Trust, London, United Kingdom; [2]Radiotherapy Trials QA Group (RTTQA), The Royal Marsden NHS Foundation Trust, Sutton, United Kingdom; [3]The Institute of Cancer Research, Radiotherapy, Sutton, United Kingdom; [4]Radiotherapy Trials QA Group (RTTQA), University College London Hospital (UCLH), London, United Kingdom; [5]Radiotherapy Trials QA Group (RTTQA), Mount Vernon Hospital, Northwood, United Kingdom; [6]The Institute of Cancer Research, Clinical Trials and Statistics Unit, Sutton, United Kingdom; [7]The Royal Marsden NHS Foundation Trust, Radiotherapy, Sutton, United Kingdom; [8]The Institute of Cancer Research, Clinical Oncology, Sutton, United Kingdom

Purpose or Objective

PEARLS (ISRCTN 36344989; CRUK/19/016) is a multicentre randomised Phase II/III trial for node-positive prostate cancer. The experimental arm gives extended field IMRT to the prostate, pelvis (PP) and para-aortic (PPP) region, with an integrated boost to involved lymph nodes.

Treating this cohort of patients is new for many RTTs. Image verification must consider both prostate and nodal targets, however, this is complicated by motion of the prostate independent of bony anatomy. Comprehensive IGRT guidance and an innovative QA programme were therefore developed to support implementation of the trial. This work presents QA initiatives, investigates the range of IGRT and immobilisation, with an interim review of initial patients treated in the trial.

Materials and Methods

IGRT guidance was developed with multi-disciplinary input from a range of UK centres, and considered multiple treatment and imaging platforms. For PP/PPP arm patients it included management of deviations between prostate and bone (a surrogate for nodal targets) with threshold limits set (≤5 mm; >5 mm but ≤10 mm; >10 mm) for escalation. A pre-trial facility questionnaire (FQ) was sent to all centres enrolled to participate in the trial. The FQ assessed the centres' experience of prostate IGRT. A novel approach was the introduction of IGRT workshops and one-to-one sessions to share experiences and agree procedures. An IGRT verification log was developed to collect setup deviation information for all recruited PP/PPP patients.

Results

15 centres are open and actively delivering treatment, and another 18 are progressing with QA. Interim QA results from 18 centres and the RT delivery feasibility from 28 patients are reported. 2 IGRT workshops were well attended by >100 people; 5 centres had one-to-one sessions with the QA team. PPP IGRT techniques from the first 18 centres' FQ submissions are summarised in **Figure 1**.