

Comparing organ-at-risk exposures across two class solutions for prostate radiotherapy

A retrospective planning cohort analysis of 400 VMAT plans (60 Gy / 20 #)

Presenter: Stefania Pilla

Authors: Pilla S¹, Norris R¹, Dunne A², Warren M¹

Affiliations: 1. School of Allied Health Professions and Nursing, University of Liverpool; 2. Department of Mathematics and Statistics, University of Strathclyde

Talk 8 min · Q&A 2 min

Why OAR sparing matters in prostate radiotherapy

Common & curable

Prostate cancer is the most common male cancer in the UK; radical radiotherapy is a mainstay of treatment.

Toxicity is dose-driven

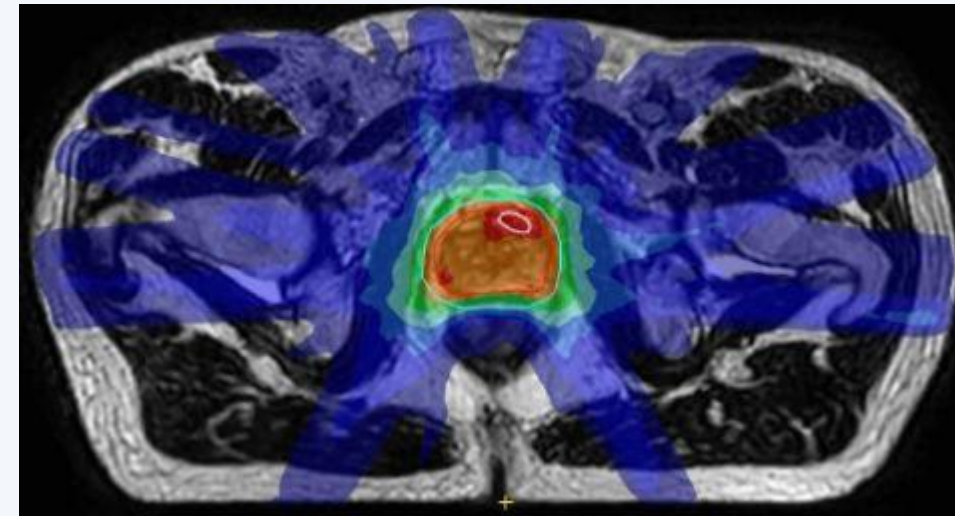
Genitourinary & gastrointestinal toxicity is linked to dose received by organs at risk (OARs): rectum, bladder, bowel, urethral bulb, femoral heads.

Class solutions

A class solution defines the dose-volume constraints & objectives that steer planning; dose-volume histograms assess conformity.

Late effects

Longer survival means more patients living with late pelvic-radiation effects — sparing OARs is a QA priority.



From old (OCS) to new (NCS) class solution

Rosemere Cancer Centre introduced a **new class solution (NCS)** for patients prescribed **60 Gy in 20 fractions**, tightening OAR constraints — especially rectum and bowel — versus the **old class solution (OCS)**. Both are based on the protocol introduced by the PIVOTALboost trial.

“Superiority” of the NCS was pre-defined as:

- Lower mean or median OAR exposure
- Greater proportion of plans meeting optimal dose constraints
- Fewer plans reaching mandatory maximum limits

OAR	Regimen 60Gy/20# 55Gy/20# and 52.5Gy/20#	Dose volume constraints		Difference in PIVOTALboost
		Optimal	Mandatory	
Rectum	V24	70%	80%	80% and no maximum
	V32	51%	65%	65% and no maximum
	V40	38%	50%	50% and 60%
	V48	27%	35%	35% and 50%
	V52	30%	30%	No optimal
	V56*	15%	15%	No optimal
Bladder	V60*	3%	5%	Continues up to V67
	V40	50%	-	-
	V48	25%	50%	-
Sigmoid, small and large bowel (DVH combined volumes) Called BOWEL	V60	5%	35%	-
	V36	78cc	78cc†	158cc maximum
	V40	17cc	17cc†	70cc maximum
	V44	14cc	14cc†	28cc maximum
Femoral heads	V48	0.5cc	0.5cc†	6cc maximum
	V52	0.0cc	0.0cc†	-
Penile bulb	V40	5%	50%	-
	V22	50%	-	-
	V48	10%	-	-

*Not for 55Gy/20#; †PIVOTALBoost optimal tolerances for bowel adopted as mandatory as achievable for majority of plans

#, fractions; cc, cubic centimetres; DVH, dose-volume histogram; Gy, Gray; OAR, organ at risk; RCC, Rosemere Cancer Centre; V, volume

One question, three objectives

Aim: Is the NCS superior to the OCS in terms of dose delivered to organs at risk?

Objectives:

1

Average OAR exposure

Compare mean/median dose to rectum, bladder, bowel, femoral heads and urethral bulb between OCS and NCS.

2

Odds of meeting constraints

Estimate odds ratios for achieving optimal (and mandatory) dose-volume constraints for each OAR.

3

Target coverage & homogeneity

Compare PTV D_2 , D_{98} , D_{mean} and the homogeneity index to confirm coverage is not compromised.

Retrospective planning cohort

1 Data source

1,543 clinically approved plans exported from ProKnow®; 60 Gy/20# VMAT to whole prostate (PTVp_6000), planned in Pinnacle.

2 Sampling

Balanced random sample: 200 OCS + 200 NCS plans (9 records excluded for missing values). Fully anonymised — IG approved; ethics not required.

3 Metrics

OAR % / volume at set doses; PTV D₂, D₉₈, Dmean and homogeneity index (ProKnow formula).

4 Statistics

Anderson–Darling normality → two-sample t or Mann–Whitney U (one-sided $\alpha=0.05$); binary logistic regression for odds ratios; Benjamini–Hochberg correction (21 tests).

400

plans analysed
(200 OCS · 200 NCS)

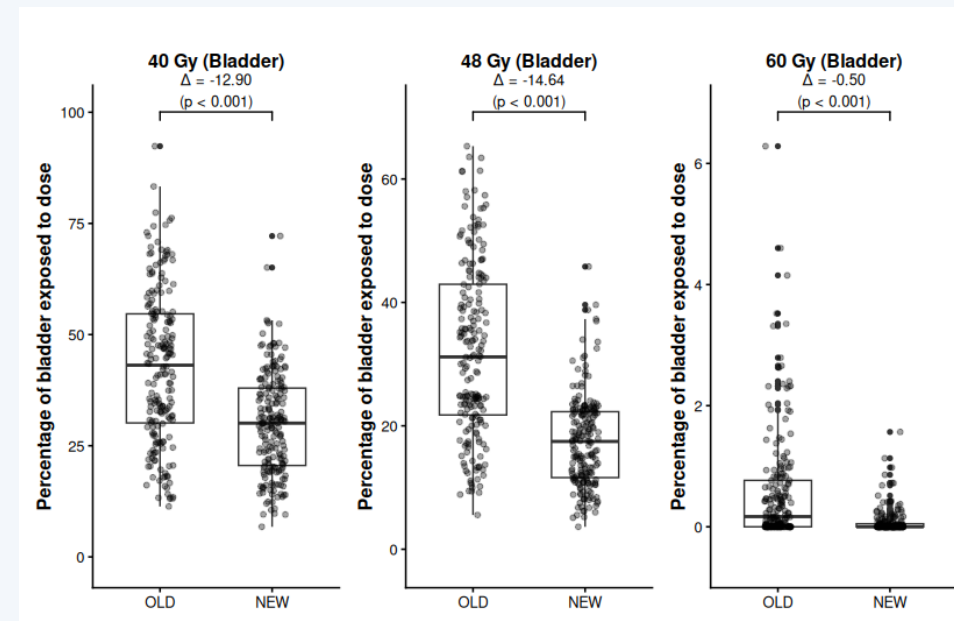
60 Gy / 20#

VMAT, 6 MV
whole-prostate PTV

NCS consistently lowers OAR exposure

Bladder

Mean reductions of 30–86% relative (V40/V48/V60); all $p < 0.001$. Narrower spread at 60 Gy → better robustness.



Up to 86% relative mean reduction (bladder V60 Gy)

NCS consistently lowers OAR exposure

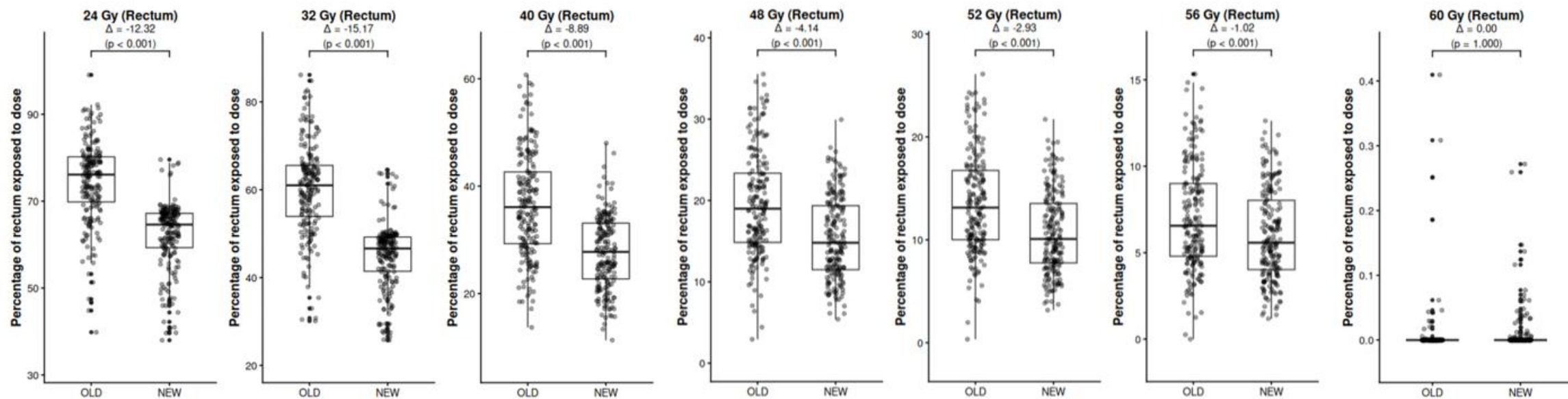
Bladder

Mean reductions of 30–86% relative (V40/V48/V60); all $p < 0.001$. Narrower spread at 60 Gy $\rightarrow$ better robustness.

Rectum

Significant absolute reductions V24–V56 ($p < 0.001$); largest at lower doses. V60 not significant (very low baseline).

Up to 25% relative mean reduction (rectum V32 Gy)



*Medians compared with Mann Whitney U. p-values corrected for multiple testing using the Benjamini-Hochberg procedure.

NCS consistently lowers OAR exposure

Bladder

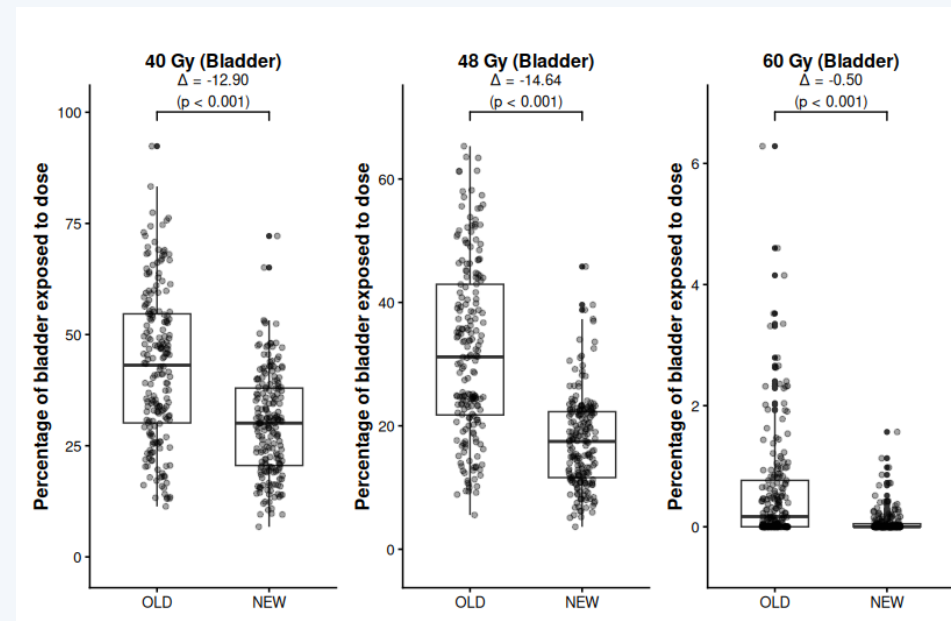
Mean reductions of 30–86% relative (V40/V48/V60); all $p < 0.001$. Narrower spread at 60 Gy → better robustness.

Rectum

Significant absolute reductions V24–V56 ($p < 0.001$); largest at lower doses. V60 not significant (very low baseline).

Urethral bulb

Mean fell ~24% (V22) and ~62% (V48); both $p < 0.001$.



Up to 62% relative mean reduction (urethral bulb V48 Gy)

NCS consistently lowers OAR exposure

Bladder

Mean reductions of 30–86% relative (V40/V48/V60); all $p < 0.001$. Narrower spread at 60 Gy $\rightarrow$ better robustness.

Rectum

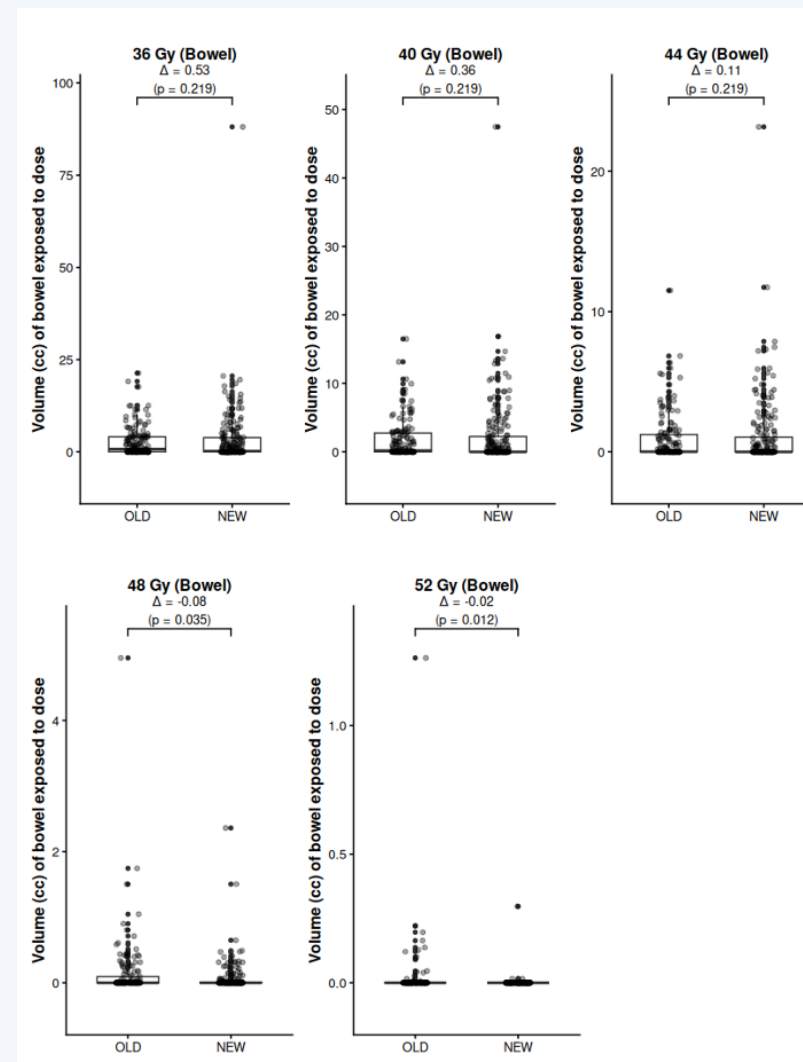
Significant absolute reductions V24–V56 ($p < 0.001$); largest at lower doses. V60 not significant (very low baseline).

Urethral bulb

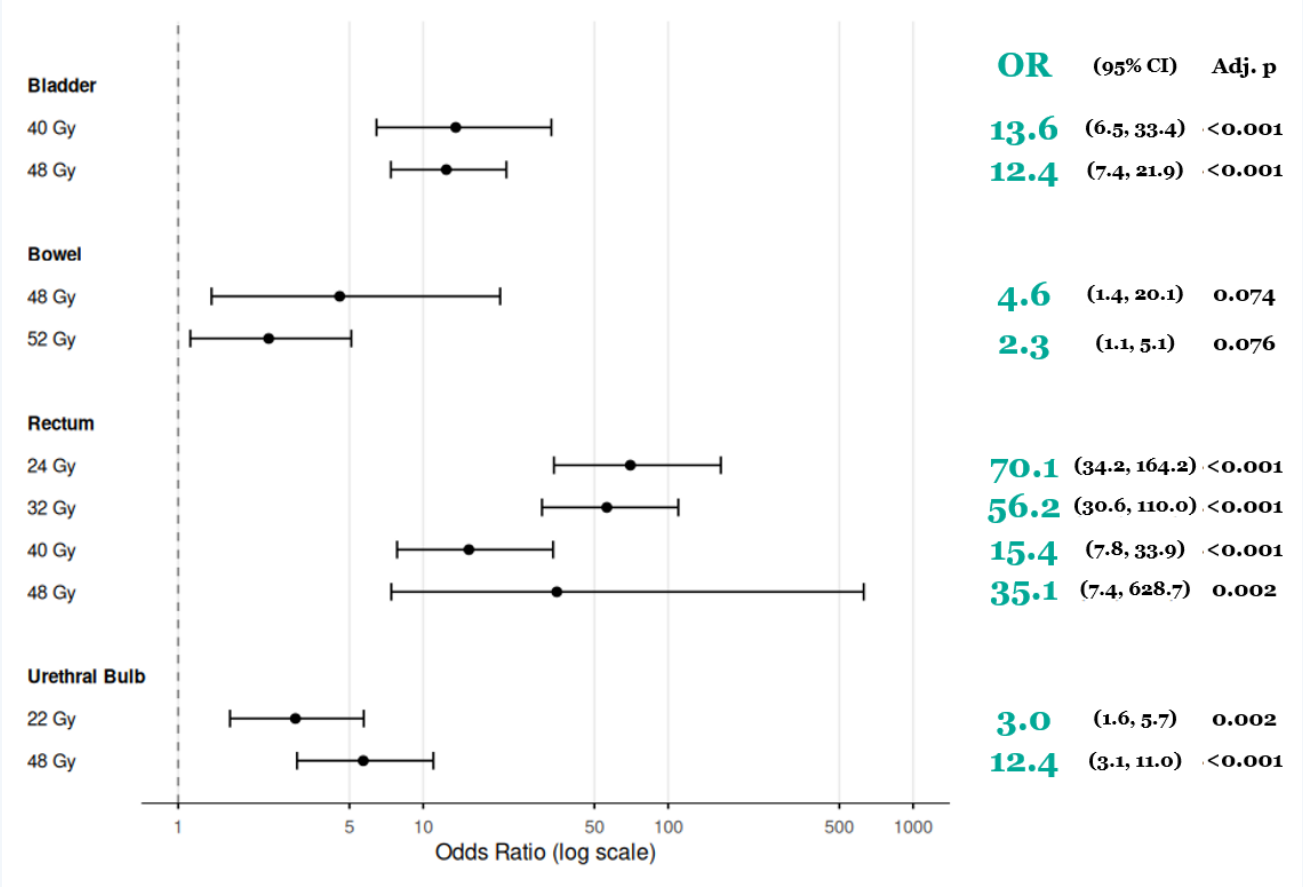
Mean fell ~24% (V22) and ~62% (V48); both $p < 0.001$.

Bowel & femoral heads

Little room to improve — very low/near-zero baselines; changes not clinically meaningful.



NCS is far more likely to meet optimal constraints

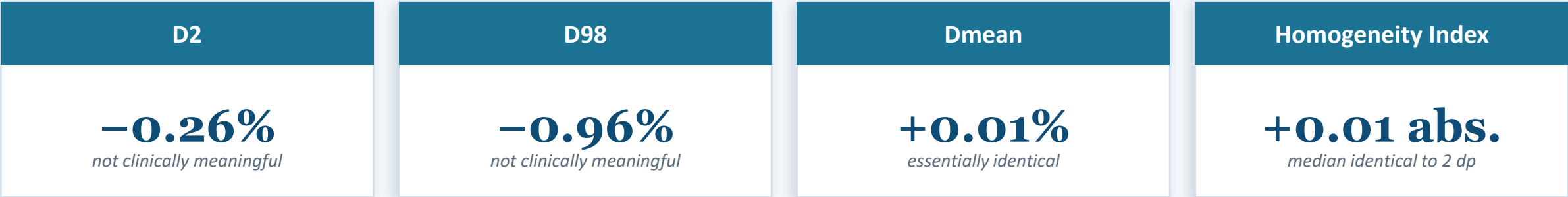


All evaluable ORs favoured the NCS. Some comparisons were non-evaluable due to complete separation or minimal variation.

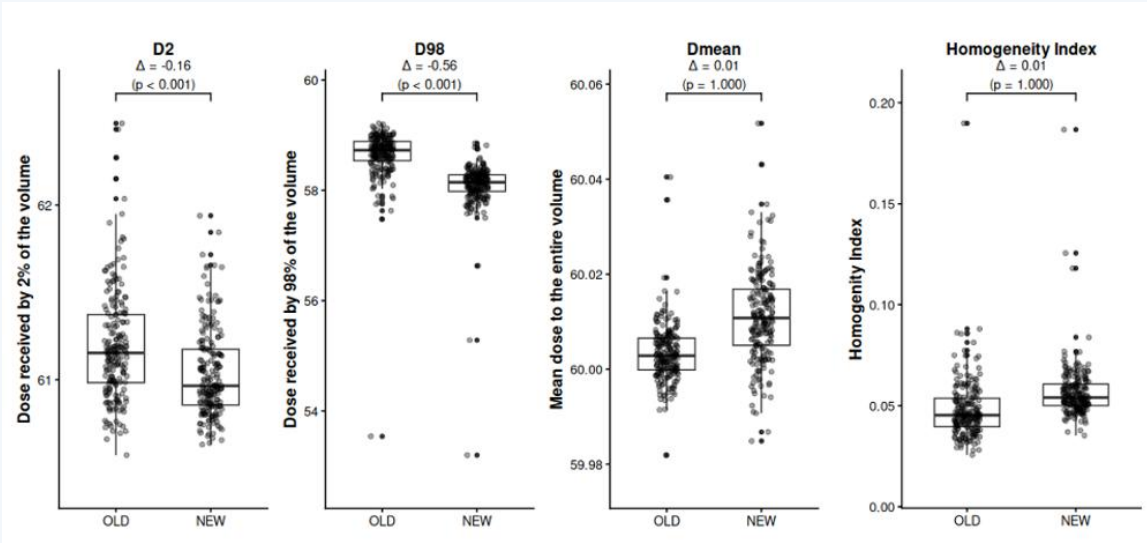
p-values were corrected for multiple testing using the Benjamini-Hochberg procedure.
Adj, adjusted; cc, cubic centimetres; CI, confidence interval; OR, odds ratio

Target coverage & homogeneity preserved

Sparing did not come at the cost of the target dose.



Exposure	Relative mean difference (NCS vs OCS; %)	Relative difference in median (NCS vs OCS; %)	p-value*
D ₂	-0.26	-0.31	<0.001
D ₉₈	-0.96	-0.99	<0.001
D _{mean}	0.01	0.01	1.000
Homogeneity Index	18.05%	19.27%	1.000



Medians compared with Mann Whitney U. p-values corrected for multiple testing using the Benjamini-Hochberg procedure.
D2, dose received by 2% of the volume; **D98**, dose received by 98% of the volume; **Dmean**, mean dose to the entire volume.

Interpretation, strengths & limitations

Strengths

- Large, real-world sample from routine practice
- Randomly drawn; near research-grade size via ProKnow[®]
- Statistical vs clinical significance kept distinct
- Consistent, direction-of-effect findings across OARs

Limitations

- Single centre → limited generalisability
- Retrospective; no data on the OCS→NCS transition
- No demographics, confounders or toxicity/outcome data
- Next step: matched case-control on PTV/rectum/bowel size

CONCLUSION

The new class solution is superior

- Consistent, significant OAR dose-sparing
- Greater likelihood of meeting optimal constraints — clinically meaningful, not just statistical
- No compromise to target coverage or homogeneity
- **These data endorse the switch from OCS to NCS at Rosemere Cancer Centre**

Thank you — questions welcome

With thanks

Acknowledgements

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Key references

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