Implementation of in-house pelvic radiotherapy auto-contouring in real world clinical practice

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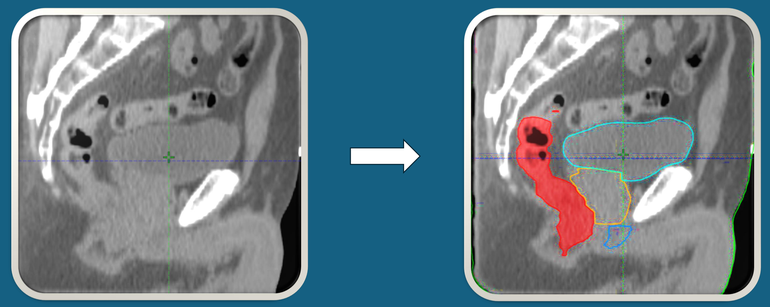
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Purpose

- Contouring of healthy tissue and tumour volumes is an essential component of radiotherapy treatment planning to maximise therapeutic dose to target organs whilst minimising radiation to organs at risk (OAR).
- Manual contouring is a time intensive process taking a median of 120 minutes in gynaecological cancers and 54 minutes in genitourinary cancers (1). Auto-contouring with artificial intelligence (AI) has the potential to reduce time and improve consistency and interobserver variability. We developed and implemented an in-house AI auto-contouring solution for clinical use.

Methods

- Our solution includes two convolutional neural network models based on the nnU-net v1 architecture.
- ***Model 1*** was trained on 160 local patients to delineate OARs and the clinical target volume (*Prostate, Bladder, Rectum, Femoral Heads, Penile Bulb*) for prostate radiotherapy.
- ***Model 2***, trained on 30 local patients, delineates OARs (*Bladder, Rectum, Sigmoid, Small Bowel*) for pelvic node radiotherapy in gynecological and prostate cancers.
- After AI segmentation, clinicians edit contours as needed before final approval and all volumes undergo peer review.
- Both models underwent prospective geometric and qualitative assessments (MD Anderson Cancer Centre Likert Scale 1-5) and timing analysis.
- A Data Protection Impact Assessment, Quality Management program and local ethical approval were implemented.



In-house AI auto-segmentation for pelvic radiotherapy has led to a significant reduction in **median** clinical time spent contouring

Model 1 (*Prostate, Bladder, Rectum, Femoral Heads, Penile Bulb*)

00:29:17 → 00:15:30

Model 2 (*Bladder, Rectum, Sigmoid, Small Bowel*)

00:50:00 → 00:12:48

Results

- Model 1 was evaluated in 15 patients and achieved median Dice Score Coefficients (DSC) ranging from 0.98 for femoral heads to 0.69 for penile bulb. All contours were rated Likert 3 or higher with a median overall score of 3. Post-implementation, median contour editing time was 15.5 (IQR 11.5-17.4) minutes, saving a median of 13 minutes compared to manual contouring.
- Model 2, evaluated in 24 patients, showed median DSCs from 0.96 for bladder to 0.72 for sigmoid contours. Median DSC for bowel contours was 0.91. All contours were rated Likert 3 or higher with a median overall score of 4. Median editing time was 12.8 (IQR 7.7-14.7) minutes, saving a median of 36.2 minutes.

Model 1

Structure	DSC (IQR)
Bladder	0.97 (0.96-0.98)
Rectum	0.90 (0.86-0.95)
Prostate	0.91 (0.88-0.93)
Right femoral head	0.98 (0.97-0.99)
Left femoral head	0.98 (0.97-0.99)
Penile Bulb	0.69 (0.62-0.75)

Model 2

Structure	DSC (IQR)
Bladder	0.96 (0.95-0.97)
Rectum	0.88 (0.85-0.91)
Sigmoid	0.72 (0.65-0.77)
Bowel	0.91 (0.90-0.92)

Tables 1 & 2 – Dice score coefficients (DSC) of delineated structures

Conclusions

An internally developed AI solution has yielded clinically effective results with significant time savings. Benefits of an in-house solution compared to procuring from a vendor include potentially lower costs and the opportunity to complete the AI cycle with continuous monitoring and model improvement. This may not be feasible in all locations due to the technical skillsets and infrastructure required.

References. 1. Montague et al., How long does contouring really take? 2024