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Original research article

Prostate intensity-modulated radiotherapy planning in seven mouse clicks: Development of a class solution for cancer

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ABSTRACT

Aim: The aim of the retrospective study was to develop a planning class solution for prostate intensity-modulated radiotherapy (IMRT) that achieved target and organs-at-risk (OAR) doses within acceptable departmental protocol criteria using the Monaco treatment planning system (Elekta-CMS Software, MO, USA).

Background: Advances in radiation therapy technology have led to a re-evaluation of work practices. Class solutions have the potential to produce highly conformal plans in a time-efficient manner.

Materials and Methods: Using data from intermediate and high risk prostate cancer patients, a stepwise quality improvement model was employed. Stage 1 involved the development of a broadly based treatment template developed across 10 patients. Stage 2 involved template refinement and clinical audit ($n = 20$); Stage 3, template review ($n = 50$) and Stage 4 an assessment of a revised template against the actual treatment plan involving 72 patients.

Results: The computer algorithm that comprised the Stage 4 template met clinical treatment criteria for 82% of patients. Minor template changes were required for a further 13% of patients. Major changes were required in 4%; one patient could not be assessed. The average calculation time was 13 min and involved seven mouse clicks by the planner. Thus, the new template met treatment criteria or required only minor changes in 95% of prostate patients; this is an encouraging result suggesting improvements in planning efficiency and consistency.

Conclusion: It is feasible to develop a class solution for prostate IMRT using a stepwise quality improvement model which delivers clinically acceptable plans in the great majority of prostate cases.

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1. Introduction

Radiotherapy treatment protocols are widely used to streamline the planning process while promoting safety and consistency.[1] Advances such as the introduction of intensity-modulated radiation therapy (IMRT) and better software tools have led to a re-evaluation of planning procedures and work practices. There is interest for example in protocols which are applicable to a wide range of cases – a class solution – while meeting local, national and international guidelines and treatment criteria. A class solution is often defined as a set of IMRT objective and penalty parameters and beam arrangements that are robust enough to produce a clinically acceptable dose distribution regardless of patient size, anatomy, target volumes and organs at risk (OAR).[1] Class solutions have the potential to simplify the planning process and allow clinicians of all levels of experience to produce highly conformal plans in a time efficient manner.[2]

In the present report, we describe the development of a class solution for prostate cancer using IMRT and the Monaco planning system (Elekta-CMS Software, MO, USA). Prostate cancer is the most commonly diagnosed cancer in males in New South Wales, Australia (34%),[3] with our institute treating around 250 patients a year with prostate IMRT. Development of a class solution for this common cancer, therefore, has the potential to significantly impact efficiencies in radiotherapy planning procedures and work practices, and also has the potential to achieve improvements in consistency and quality of planning.

2. Materials and methods

All patients in this retrospective study were planned with the Monaco planning system (Elekta-CMS Software, MO, USA) at our cancer Institute. The patient cohort comprised intermediate and high risk prostate cancer patients. These patients were volumed using magnetic resonance imaging (MRI) and computed tomography (CT) fusion[4] and treated to 81 Gy as previously described.[5,6] Planning criteria and OAR constraints are summarised in Tables 1 and 2 and were based on evidence-based guidelines (EviQ recommendations).[7]

Table 1 – Acceptable plan criteria for prostate IMRT.

	PTV	CTV
Ideal	D95 > 81 Gy D99 > 76.95 Gy Mean Dose 81–84.24 Gy	D100 = 81 Gy
Minor violation (acceptable)	D90 > 81 Gy or D98 > 76.95 Gy Mean Dose 84.24–85.46 Gy	D99.0 > 81 Gy

Minor violation: allowable when organs at risk constraint cannot be met. Dx refers to the dose that covers X percent of the structure. The prescribed dose was 81 Gy. Gy: Grey.

Table 2 – Organ at risk constraints for prostate IMRT.

Organ at risk	Ideal constraint	Minor violation
Rectum, sigmoid	V40Gy < 35% V65Gy < 17% V75Gy < 10% Max Dose 2cc < 102.5%	V40Gy < 45% V65Gy < 21% V75Gy < 15%
Small bowel	Single phase max dose 70 Gy 100cc < 45 Gy	Refer to RO
Bladder	V40Gy < 60% V50Gy < 50% V60Gy < 40%	V50 Gy between 50–60%
Femoral heads	V35Gy < 100% V45Gy < 60% V60Gy < 30%	
Penile bulb	V50Gy < 95%	

Minor violations were acceptable when all reasonable efforts to achieve ideal constraints had been made. PD: prescribed dose. Gy: Grey. Vx refers to the percentage volume of a structure receiving XGy.

The study employed a stepwise quality improvement model to develop a class solution template for prostate IMRT (Fig. 1). Our aim was to develop a class solution that worked for the majority of cases and which did not require the planner to make edits. We also ensured that the processes involved were consistent with our conformity to the planning procedures of the national radiation oncology practice standards.[8] In brief, Stage 1 involved the development of a broadly based template based on a number of templates developed across 10 patients. The Stage 1 template offered a significant improvement in quality and also planning efficiency as compared to the earlier XiO planning system. Plans were tested by physicists to ensure they would pass quality assurance and delivery was timed to ensure no additional time was added to treatment. This template was rolled out across the three sites of our institute.

Stage 2 involved a phase of template refinement. Information was gathered from the Monaco team members who were planning the cases and their feedback was used to develop a series of templates which were compared across 10 patients. The best-performing template was adopted and rolled out for use across the three sites. It was requested that radiotherapy

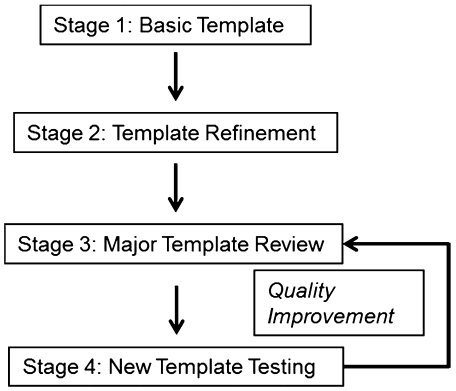

Fig. 1 – Stepwise quality improvement model for the development of a class solution for prostate IMRT.