Introduction
The clinical goal for every patient undergoing radiation therapy is an individualized treatment plan that is optimal for his or her case. To help clinicians achieve this goal consistently, Radiation Oncology Queensland (ROQ) has adopted RapidPlan™ knowledge-based planning.

Variation in the quality of external beam radiation treatment planning is a recognized issue, acknowledges Kenton Thompson, ROQ head of radiation therapy services, citing a 2012 study. When presented with a hypothetical prostate patient and working with predefined CT images and anatomical structures, 125 planners produced plans that varied widely in their ability to meet the specified clinical goals. (Nelms, et al, Variation in external beam treatment planning quality, 2012) “Statistically, the quality of the resulting plans bore no clear correlation to the treatment planning system used, the delivery technique such as IMRT or volumetric arc, the education or experience of the planner, or the confidence expressed by the planner,” says Thompson, summarizing the conclusions of the study.

What then are the options for reducing the variation and improving plan quality? Improving optimization algorithms could help but that would not completely eliminate human error in input and evaluation. “The objective is to produce optimal plans, with the best trade-off between sparing the organs at risk and covering the target. This is where knowledge-based planning can help,” says Thompson.

Knowledge-based planning captures actual clinical practices based on past plans and makes this information available to the user for developing new optimum treatment planning models. This allows future patients to benefit from the knowledge gained from past patients.

The promise of knowledge-based planning
Knowledge-based planning has been the subject of research in recent years. Researchers demonstrated a tool, derived from a retrospective study of 42 intensity-modulated radiation therapy (IMRT) plans, that increased normal tissue sparing and reduced inter-clinician variability. (Moore, et al, Experience-Based Quality Control of Clinical Intensity Modulated Radiotherapy Planning, 2011). “They concluded that impressive clinical gains can be realized compared with subjective, experience-based judgment. By implementing the system measure into their planning process, they were able to ensure that all plans were of high quality and organs at risk (OAR) were spared adequately,” says Thompson.

The Varian solution for knowledge-based planning is RapidPlan. Essentially, RapidPlan uses dose volume histogram (DVH) estimation models to estimate the dose distribution for new patients based on their contoured anatomy and dose. These DVH estimation models have been developed for specific disease sites by leading academic centers with large databases of quality plans.

Leaping the learning curve
In addition to potentially improving quality, consistency, and efficiency, ROQ considered RapidPlan to be a promising learning opportunity for all treatment planners. Treatment planning is an art and a discipline that takes time to develop. “Sometimes it can take months or years to truly be able to create high-quality plans for each individual patient, especially in complex situations,” says Thompson. “Clinicians often talk about using their experience gathered over months or years to make clinical judgments. Sometimes they even refer to making these decisions as intuition.” ROQ, however, was striving for a more objective planning process. RapidPlan seemed like a logical approach, but ROQ needed to test it for themselves, with their own treatment planners.

Assuring quality and consistency in treatment planning with RapidPlan at Radiation Oncology Queensland
Reducing optimization times
First, ROQ tested the learning curve with 10 treatment planners, who covered the spectrum of IMRT planning experience. Each planner created four new plans for five common prostate data sets. For the first plan, the planners used manual input and had complete freedom to choose the beam arrangement and the optimization objectives. For the second plan, they used a clinical template that provided the beam arrangement and starting points for the optimization objectives. For the third and fourth plans, they used a RapidPlan model, one from CancerCare Manitoba and one from Washington University in St. Louis. “Our hypothesis was that, as you reduce input, you reduce the experience required. And this, in turn, reduces variation, improves efficiency, and improves quality,” says Thompson.

Across the board, planning was slowest with manual input, faster with the clinical template, and fastest with the RapidPlan models. “Manual input takes approximately 3.5 times longer than utilizing a RapidPlan model. Using the clinical template as a starting point takes about 1.3 times longer than using a RapidPlan model,” says Thompson, summarizing the results. Additionally, he reports no significant difference between the two RapidPlan models. “Regardless of which RapidPlan model you employ, it should be quicker than manual input or utilizing a clinical template.” RapidPlan also closed the gap in planning time between the least and most experienced planners. For manual input, planning time ranged from 7 to 27 minutes. With RapidPlan, it ranged from 2 to 5 minutes.

Closing the variability gap in OAR sparing
Increasing efficiency is important, but the highest priority is decreasing variability in organ-at-risk sparing. “In our analysis, patient factors dominated both planner and method, demonstrating the need for individualized treatment planning. However, when we looked at the distribution of mean doses for bladder and rectum across patients, we found the smallest variations among the RapidPlan plans,” says Thompson. In general, across all plans, dose distributions to the bladder varied less than those to the rectum. However, that variation was less with RapidPlan than with either the manual or template plans.

Conclusion
In summary, ROQ found that using RapidPlan produced high quality plans, more consistently and more efficiently than the other common methods of planning—starting from a clinical template or starting with manual input. Planners of all skill levels and experience produced acceptable plans, optimized for tissue sparing, more easily and in shorter time with RapidPlan.

“We think RapidPlan benefits all planners, even the most experienced,” says Thompson. It is useful for supporting new planners and helping them get up to speed quickly on department techniques. It helps all planners improve confidence and consistency. And it enables expert planners to create models, benchmark plans, and ensure that the quality is maintained and improved. Furthermore, “RapidPlan is a means for clinicians to share knowledge and have an impact on more patients. It is a tool for researching new techniques and ensuring that quality is high from the start. And,” concludes Thompson, “it is a tool to drive positive change.”