Driving Efficiency Through Standardization

Royal Brisbane and Women's Hospital (RBWH) in Australia serves over 1 million people in the Metro North Hospital and Health Service and is the only public center providing radiation therapy in the area.
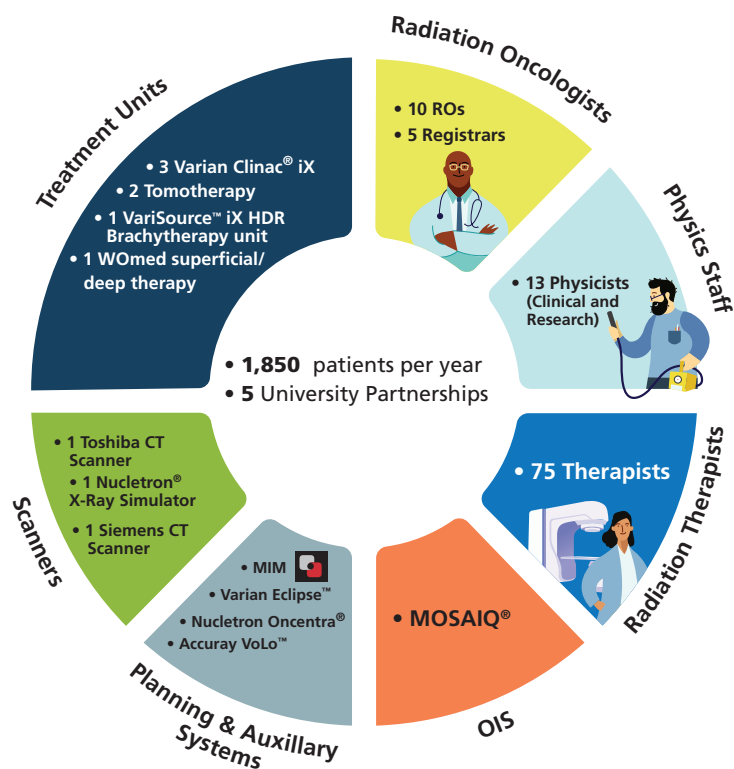
As a leading healthcare, research, and innovation hub, the hospital has partnerships with five Queensland and national universities. RBWH offers a wide variety of treatment options including total body irradiation, total skin electron therapy, SABR/SBRT, VMAT, IMRT, and Brachytherapy and is the only Queensland facility to offer TomoTherapy.

The hospital's radiation therapy staff has treated approximately 1,850 patients in the past year.

Seeking a Solution

In 2016, RBWH's radiation therapy department set out to find a deformable image registration solution to improve meaningful use of imaging data and overcome limitations with the department's existing systems. RBWH sought to implement a system that offered improvements to its radiation therapy workflow as a way to reduce the burden of time on both radiation therapists and radiation oncologists and reduce the need for repeat diagnostic imaging for patients.

A critical review led to a unanimous decision to institute MIM Software's MIM Maestro® solution in the department. This new solution proved to go beyond deformable image registration, allowing staff members to standardize and automate tasks across multiple areas including rigid and deformable registration of multiple modalities, tumor volume and normal structure contouring, adaptive recontouring, atlas segmentation, and dose accumulation for re-treatment cases.
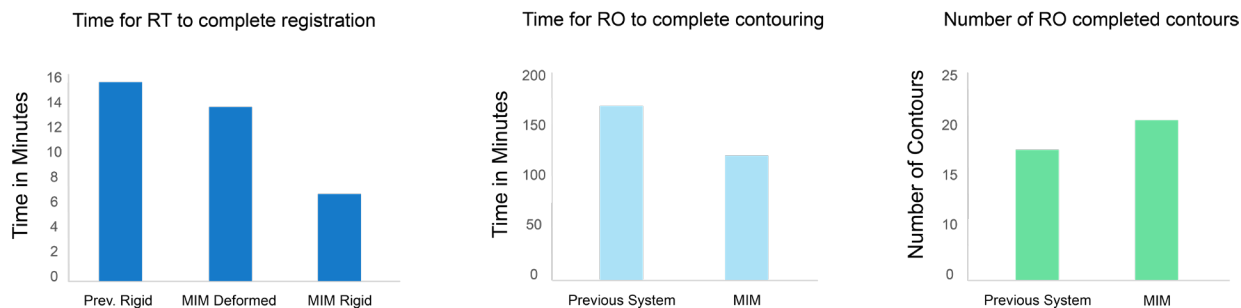

Treatment Units
- 3 Varian Clinac® iX
- 2 Tomotherapy
- 1 VariSource™ iX HDR Brachytherapy unit
- 1 WOmed superficial/deep therapy

Radiation Oncologists
- 10 ROs
- 5 Registrars

Physics Staff
- 13 Physicists (Clinical and Research)

- **1,850** patients per year
- **5** University Partnerships

Radiation Therapists
- 75 Therapists

OIS
- MOSAIQ®

Planning & Auxiliary Systems
- MIM
- Varian Eclipse™
- Nucletron Oncentra®
- Accuray VoLo™

Scanners
- 1 Toshiba CT Scanner
- 1 Nucletron® X-Ray Simulator
- 1 Siemens CT Scanner

"MIM has proven to be the link between our many forms of data that was missing previously. MIM's multiple functions and scripting abilities have enabled us to more accurately and efficiently perform tasks associated with the design and review of our patients' treatment."

Advanced Radiation Therapist
Royal Brisbane and Women's Hospital

Implementation

As part of the implementation process, all staff members including rotating planning users participated in one-on-one and group training with MIM Software personnel and Radiation Oncology information services specialists. A select group of staff also underwent "super user" training to accommodate an advanced understanding of the system. The process was supplemented by tailored instructional collateral and quality assurance checklists to cater to new capabilities within MIM Maestro. This included image registration checklists that would ensure a standardized method of identifying patient images, verifying registration types, and confirming fusions were locked and contained the appropriate feedback. A new portion of the dosimetry checklist was created to ensure the correct structure set was exported to the TPS. Additionally, dose accumulation requests and QA forms were established as a standard when dealing with re-treatment cases.

| Time for RT to complete registration | Time for RO to complete contouring | Number of RO completed contours |

Time taken for registrations and contours and number of completed contours in the previous system and MIM.

Evaluating Outcomes

Following training, an initial evaluation was performed to compare the time taken to complete registrations in both the pre-existing system (which lacked deformable tools) and the newly implemented system. The evaluation found the new system resulted in a 57% reduction in time for rigid registrations and a 9% reduction in time for a combined rigid and deformable registration approach. The study revealed that even when performing more complex tasks, there was a reduction in time spent on registrations while achieving increased confidence in clinical decision-making. This was directly attributed to the standardization made possible by automated scripts (MIM Workflows™).

To test the connected efficiencies imparted by the new system, the team also recorded the time taken by radiation oncologists to contour critical structures. A 22% reduction in contouring time was observed, which was attributed to both the script-driven atlas-based segmentation, customized post-processing, and the ability to view the improved registrations, making definition of both targets and OARs easier and more accurate. The radiation oncologists also reported increased confidence when defining vessels with better contrast CT registration ability. As a whole, this new process allowed RBWH to delay the implementation of administering contrast during planning scans.

These studies showed that the implementation of a system which offered automated, standardized MIM Workflows saved significant clinical time and positively impacted department revenue. The time saved in performing registrations and contouring alone was estimated to be an equivalent cost saving of roughly $176,000 AUD annually. This cost saving was calculated based on average radiation therapist and radiation oncologist salary combined with time saved in these areas, at a rate of 1,800-2,000 registrations per year.

"We have found the deformable registration capability to be of immense value. It is sophisticated and has made a major difference to our confidence in determining our target volumes."

Senior Radiation Oncologist
Royal Brisbane and Women's Hospital
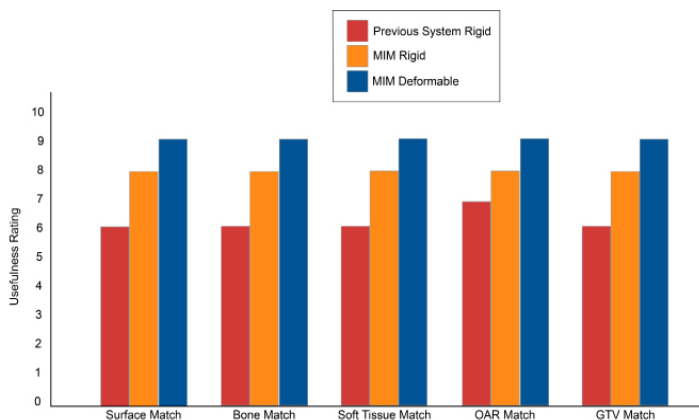
Usefulness rating on a scale of 1-10.

Measuring Clinical Impact

With the new system implemented and as a measure of clinical impact, the RBWH team asked its radiation oncologists to rate its deformable registration capabilities in terms of usefulness in matching different regions of the patient's anatomy. Across all regions, radiation oncologists ranked the new system as outperforming the original system.

With standardization being a key driver of efficiency, it was important for the team to also quantitatively analyze the increased accuracy of registrations and contouring along with the reproducibility of these results among users of varying experience levels. By using a partially automated deformation workflow, three users with varying levels of expertise were able to achieve results with minimum statistical variance. System-adapted contours were measured against a gold standard and Dice and Jaccard values were compared to demonstrate these results. In conclusion, reproducibility using automated workflows within the new system was significantly improved.
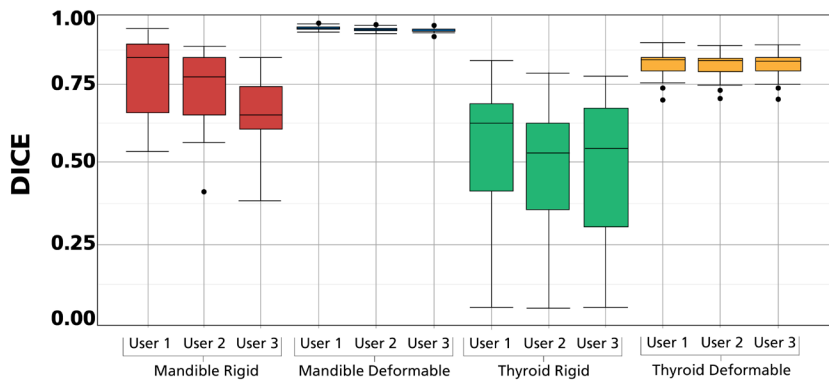
DICE values when comparing three users of varying skill levels.

Better outcomes have resulted in fewer requests for repeat diagnostic imaging of patients, thereby implying gains for the patient and the department in terms of increased productivity and reduced toxicity, recurrence, expenditure, and burden for the hospital.

RBWH's radiation therapy department has significantly benefited from the transition in systems. Since the 2016 implementation, the roles of the system have evolved, expanding far beyond the original scope of achieving accurate registrations and quick, standardized contours. The dose summation capabilities have been increasingly useful to the physicians. Approximately 14% of annual registrations have been utilized in dose accumulations for same or multi-modality phased treatments (Tomo + VMAT boost), as well as to assess treatment feasibility when replanning. The deformable registration solutions have enabled physicians to estimate prior treatment dose on current anatomy more confidently, which in turn has led to better treatment planning and delivery. Better outcomes have resulted in fewer requests for repeat diagnostic imaging of patients, thereby implying gains for the patient and the department in terms of increased productivity and reduced toxicity, recurrence, expenditure, and burden for the hospital.

Future Collaboration
With its advanced set of tools and level of customizability, MIM Maestro has also enabled RBWH's departmental research to take on meaningful projects to further patient care. As of 2019, the latest research being undertaken by the hospital is an effort to overcome current workflow challenges in adaptive therapy and improve clinical outcomes via adaptive assessments for head and neck and pelvis patients. The team is currently collaborating with MIM Software on a study that will look at the effects of implementing existing automation and adaptive features (ART Assist™), along with evolving solutions for CBCT/MVCT image improvements and Monte Carlo dose calculation.

RBWH and MIM Software strive to continue collaboration to optimize clinical practices and answer the most pressing research questions.

MIM Software Inc. provides practical imaging solutions in the fields of radiation oncology, radiology, nuclear medicine, neuroimaging, and cardiac imaging. MIM offers solutions for PC and Mac® workstations, as well as mobile iOS and cloud-based platforms. MIM is a privately held company that sells its products globally to imaging centers, hospitals, specialty clinics, research organizations, and pharmaceutical companies.