CASE STUDY

Toyota Memorial Hospital

Driving Kaizen Workflow Improvement via MIM Software Automation

Introduction

Toyota Memorial Hospital (TMH) is a corporate hospital founded and managed by Toyota Motor Corporation in Toyota, a city in the Aichi prefecture of Japan. In addition to serving as a cancer treatment center, TMH is also the region's leading perinatal maternal and child medical center, along with services for critical care.

As one of the leading high-precision Radiotherapy (RT) centers in Japan, TMH's Radiation Oncology (RO) department was the first in Japan to implement CyberKnife® M6™. CyberKnife M6 provides high-precision radiation therapy options for patients, including stereotactic ablative radiotherapy (SABR)/stereotactic body radiation therapy (SBRT) for prostate, lung and liver, intensity-modulated radiation therapy (IMRT), and volumetric-modulated arc therapy (VMAT).

350 PATIENTS/YEAR
Typical patient volume

STAFF

2 *Radiation Oncologists*	4 *Medical Physicists*
4 *Therapists*	2 *Nurses*

LINACs

CyberKnife® M6™
Varian® TrueBeam®

TPS

Accuracy® MultiPlan®
Varian Eclipse™

Working under the umbrella of Toyota Motor Corporation, TMH is heavily influenced by principles regularly utilized within the Toyota Production System. One such principle is called "Kaizen" ("change for the better"). When implemented during manufacturing, this principle expects all line personnel to alert their supervisor if they find an abnormality in the production line, which then leads to an investigation of ways to resolve the abnormality and initiate an improvement to the current process.

The TMH RO department has found the implementation of the Kaizen principle vital to meet its goals for continually considering ways to improve its clinical workflow, and in turn, improve the standard of care for patients.

Partnering with MIM Software to Achieve Clinical Standardization and Automation

One of the key goals of MIM Software is to partner with clinical centers to enhance workflows via effective standardization and automation. TMH has found a resourceful partner in MIM Software to continually improve its practice.

TMH introduced MIM Maestro® in its Radiation Oncology department in 2016. Since then, MIM Maestro has been heavily used by the TMH team to enable improvements to clinical operations.

Over the years, MIM Maestro has become an integral part of TMH's daily clinical workflow for simple to complex tasks. MIM Maestro is routinely used in the department to accommodate diagnostic imaging, multi-modality rigid and deformable registrations between PET, MRI and CT, summing doses for retreatment assessments, and tracking tumor motion using 4D CTs – to name a few processes. MIM Workflows™ are used regularly by the department to carry out these tasks in a guided yet automated and efficient manner.

With a clinical team well trained on MIM Maestro and excellent local MIM Software support accessible via the Euro Meditech team, TMH has realized the potential of MIM Maestro by utilizing MIM Workflows customized to meet its needs.

One such example is TMH's use of MIM Maestro to generate difference maps between patient preoperative and postoperative scans. This has drastically streamlined follow-up reviews for metastatic brain tumor patients and made tumor response tracking more accurate and efficient.

"Before using MIM Maestro, reviewing pre- and post-op scans required time and great care. Now, we have the ability to use differential mapping in MIM to provide a better understanding of the impact of the treatment plan. This was never possible before."

Junji Suzuki, Ph.D
Group Manager

Identifying Clinical Inefficiencies

A critical aspect of the Kaizen principle is identifying an abnormality — a focus area to collectively improve.

For most Radiation Oncology centers, contouring of normal structures is routinely found to be the most time-consuming and inefficient step in the treatment planning workflow. As treatment planning is a multi-actor process, inefficiencies in one step also tend to affect the rest of the subsequent steps in the simulation to treatment pathway.

"The biggest bottleneck is that the quality of contours varies from person to person. Although the anatomical structure is defined, the anatomical structure contoured by each person is slightly different, especially complex structures. It is a problem that the quality of contours varies from person to person, as this ultimately affects dose constraints and clinical evaluation. Our goal is to make it easy for anyone to draw high-quality contours. Lung contouring takes about 20-40 minutes, depending on the patient. Those who understand the function of MIM Maestro experience a short contouring time, but those who do not take a long time."

Junji Suzuki, Ph.D
Group Manager

Similar to other RO centers, TMH found its contouring process to be an important part of its RT workflow to focus on improving.

Another critical aspect of the Kaizen principle is iterating through solutions to the abnormality identified to achieve an optimal solution. TMH iterated on several solutions using MIM Maestro.

Focusing on normal structure contouring as a critical area needing improvement, TMH investigated a few different options in MIM Maestro. The first method tested was MIM Maestro's atlas-based segmentation.

This method relies on a library of contoured data, from which best matches to the patient are automatically identified. Contours from the best matches are deformed to the patient scan and finalized to generate normal structures. While this method automated the normal structure contouring process, the structures required manual review, editing, and corrections prior to finalization. On average, about 15- 20 minutes were spent correcting structures per patient case. Additionally, variations in end results between clinicians further contributed to challenges in establishing department quality standards desired.

Streamlining the Entire Contouring Process with MIM Workflows™

Further improvements to these methods were found necessary to improve the accuracy of the results, reduce time spent and chances of error in manual editing, and improve standardization across users. TMH decided to investigate alternative methods. This time, a variety of automated MIM Maestro contouring and contour post-processing tools were deployed via MIM Workflows.

With an interactive visual interface, MIM Workflows make creation of scripts for routine tasks extremely accessible to end-users – with no coding experience required. Multiple iterations of a workflow were created by the TMH team to automate the creation of the left and right lungs, and bronchi.

An automatically-generated body contour was sub-thresholded based on CT values to obtain these contours. The workflow was tested by TMH across a variety of patients. Results varied based on the case processed, where in some cases, the right and left lungs and trachea connected at an unintended location. Shortcomings in initial workflows were overcome through additional fine tuning and improvements, until accurate results were achieved across a large range of cases.

The final workflow led to a drastic reduction in contour editing time, with almost no correction work needed to the structures automatically generated. This was a total time savings of over 20 minutes per patient. Overall, this has helped TMH significantly reduce lung normal structure contouring time, allowing the care team to focus on more complicated tasks, such as plan creation, treatment delivery, and patient interaction. Additionally, variability in the quality of contours among staff has also been completely eliminated.

MIM Workflows can be applied to a wide range of areas beyond contouring, and produce similar improvements in efficiency and standardization in the Radiotherapy workflow. Whether setting up image registrations, generating post-processed planning support structures, or assuring the quality of contours and plans, automation can be easily implemented via MIM Workflows to enhance productivity and patient outcomes in clinics.

Future Applications

With a foundation of automated standardization now in place, TMH is looking at continuous future improvements in its Kaizen principle by integrating deep learning artificial intelligence algorithms and MIM Workflows to delineate complicated contours accurately, efficiently, and with minimal modifications.

Contour ProtégéAI™, MIM Software's platform for deep learning auto-contouring, in conjunction with automated post-processing workflows for planning-support-structure generation and contour QA, are unique solutions that can provide substantial impact to improved treatment decisions. This leads to an optimized operational process during the treatment planning and delivery cycle, while also establishing TMH as a center of excellence for patients by providing high-quality care in a timely manner without jeopardizing staffing resources.

Toyota Memorial Hospital

© 2021 MIM Software Inc. • All Rights Reserved • www.mimsoftware.com • TD-1057 – 16 Sept 2021