MOLECULAR IMAGING AND NUCLEAR MEDICINE

Molecular Radiotherapy Dosimetry

Practical Dosimetry Achieved

WHY DOSIMETRY?

New Molecular Therapies Expand the Oncologist's Toolkit

Molecular Radiotherapies provide a distinct advantage over other systemic therapies: their distribution can be seen and measured, enabling personalization. Absorbed dose has shown to be a useful biomarker of response to radiation therapies. As a result, it has significant potential use in clinical decision-making to achieve the best possible patient outcomes. But is access to patient-specific absorbed dose practical?

IMPLEMENTATION

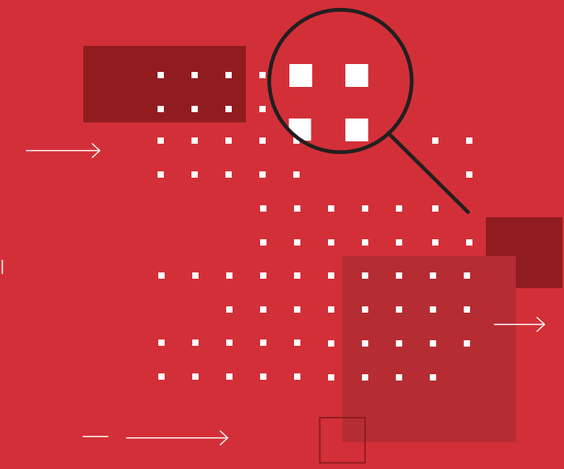
Accurate Dosimetry Performed at Scale

MIM SurePlan™ MRT has been helping institutions drastically reduce the clinical requirements for dosimetry by including AI-based auto-segmentation tools and support for quantitative SPECT reconstruction with existing SPECT/CT cameras, in addition to integrating automation into every facet of its design. This remains a primary focus for continued development.

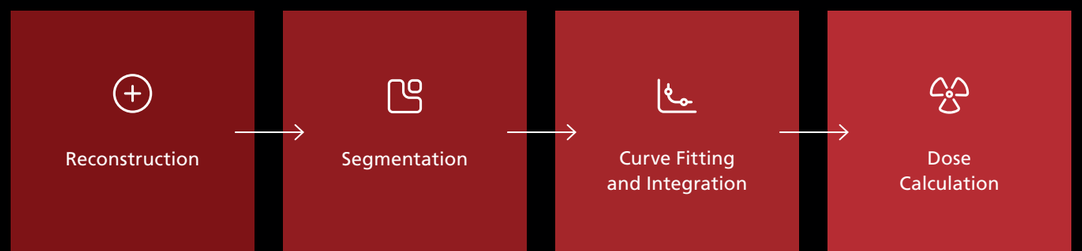
Hospital administrators can take comfort in knowing that resources are being used efficiently. Likewise, patients and physicians alike will gain insight into these therapies and begin to characterize dose-response relationships for future planning.

Explore the Dosimetry Workflow

The history of dosimetry for these therapies is fraught with tedious computations and over-simplifications. Let's examine how MIM SurePlan MRT maximizes existing resources and reduces the manual effort to make accurate dosimetry practical for a clinical Nuclear Medicine department.



PERSONALIZED DOSIMETRY WORKFLOW



MIM SurePlan MRT automates the entire dosimetry process from reconstruction to dose calculation.

IMAGE ACQUISITION AND PROCESSING

SPECT Image Processing

Capture Quantitative SPECT Imaging with Existing Hardware

Reconstruction can be performed on your existing cameras, and there is no need to spend the energy or money to purchase a new camera that specifically supports this functionality. Additionally, having a vendor-neutral platform can help standardize reconstructions across your department.

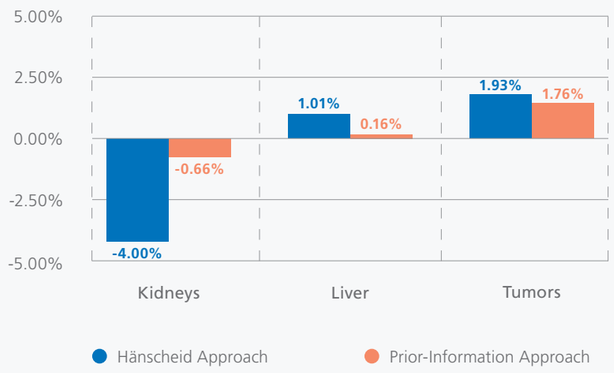
Standardize and Automate Reconstructions

Eliminate the manual SPECT reconstruction process through intelligent programming that automatically performs this task as soon as the images arrive in MIM.

AVERAGE DEVIATION FROM 4 TP RESULTS

Region of Interest	Hänscheid Approach	Prior-Information Approach
Kidney	-4.0 ± 10.7%	-0.7 ± 9.2%
Liver	1.0 ± 7.8%	0.2 ± 6.5%
Tumors	1.9 ± 11.6%	1.8 ± 12.7%

SINGLE-TIMEPOINT COMPARISON TO MULTIPLE-TIMEPOINT DOSIMETRY



Difference between single-timepoint and 4-timepoint dosimetry calculations in percent.

Implement Practical Imaging Protocols

Single-timepoint dosimetry is a cutting-edge dosimetry process that allows estimation of the absorbed dose with only a single SPECT/CT, further reducing the requirements needed to perform dosimetry.

Multiple-Timepoint Dosimetry

Model activity over time with two or more post-therapy image acquisitions. Generate patient-specific absorbed dose calculations on the voxel-level.

Hybrid SPECT/Planar Dosimetry

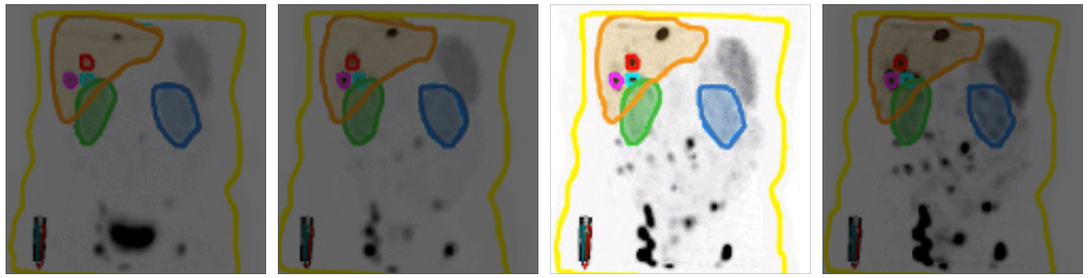
Achieve 3D dosimetry without multiple SPECT/CTs. Voxel-level dosimetry is performed with planar timepoints for activity modeling, leveraging 3D information from a single SPECT/CT.

Prior-Information Approach to Single-Timepoint Dosimetry

Determine activity models with as few as two timepoints in the first cycle of therapy, then use those models with single-timepoint acquisitions in subsequent therapy cycles. Achieve accurate, patient-specific dosimetry with flexible image acquisition times.

Hänscheid Approach to Single-Timepoint Dosimetry

Direct calculation of time-integrated activity using a single-timepoint. The Hänscheid approach is available for post-therapy acquisitions of 177Lu-DOTATATE.



Single-Timepoint SPECT Acquisition

Single-timepoint methods reduce the imaging burden without sacrificing the benefits of patient-specific dosimetry.

NORMAL ORGAN AND TUMOR SEGMENTATION

Normal Organ Segmentation

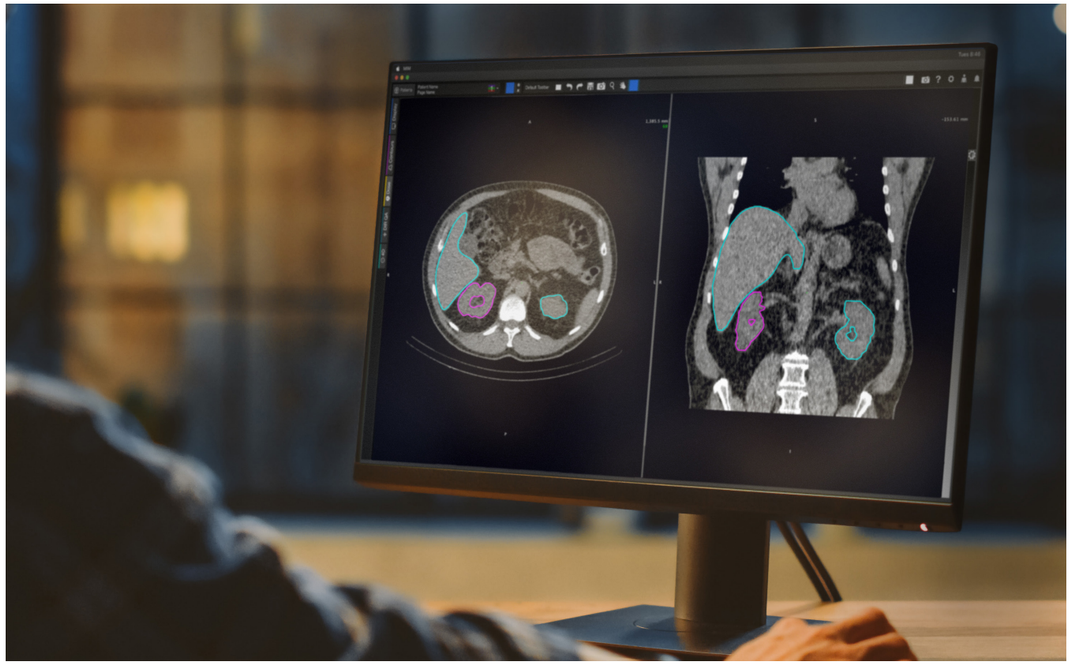
Segment Normal Structures with Artifical Intelligence

Manual segmentation is time-consuming, burdensome, and introduces inter-user variability.

Triggered automatically upon image arrival, Contour ProtégéAI™ for MIM SurePlan MRT uses a neural network for segmenting normal structures on CT images. Results are more accurate than atlas-based approaches so users spend less time editing.

Deliver AI on Premise or in the Cloud

Contour ProtégéAI for MIM SurePlan MRT has flexible deployment models that allow for easier adoption across any institution.



Tumor Segmentation

PET Edge®+

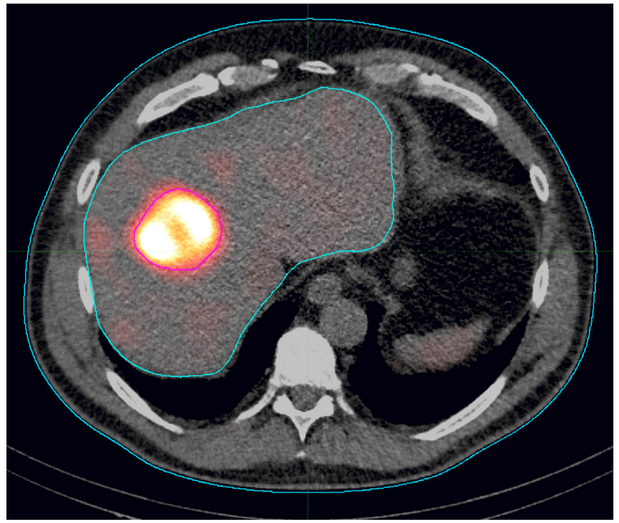
MIM Software's proprietary, gradient-based technique segments lesions with a single click.

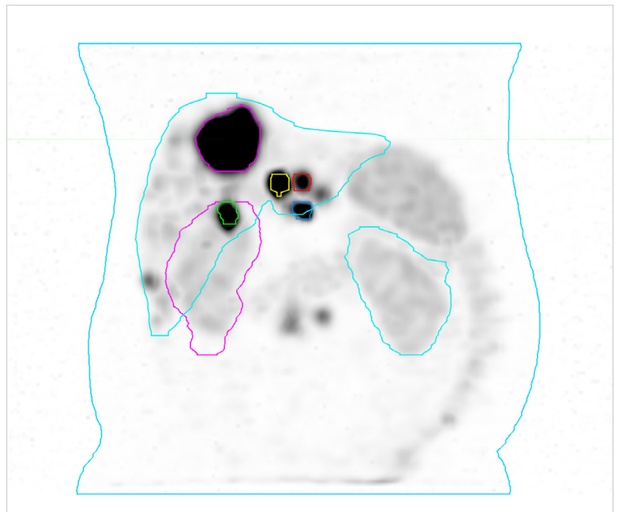
Speed and Consistency

Experience accurate and reproducible tumor segmentation regardless of who is doing the work.

Advanced Therapy Response

Capture additional therapy response metrics beyond tumor volume, such as SUV peak and tumor burden.



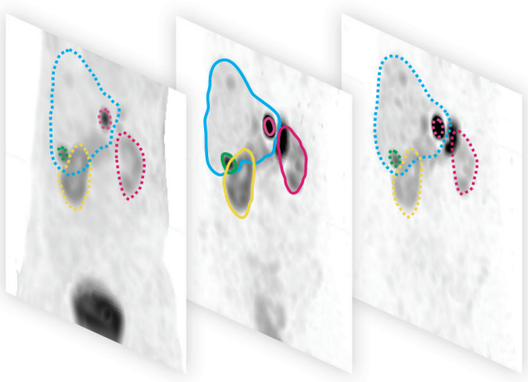


PREPARATION

Image Alignment, Curve-Fitting, and Time-Integration

Automatic SPECT Alignment for Accurate Activity Quantification Across Time

Optimized contour-based SPECT-to-SPECT activity alignment results in ROIs only needing to be defined on one SPECT/CT. MIM SurePlan MRT provides a flexible and robust alignment technique that supports a variety of image qualities.



Activity-based alignment optimized per dosimetry structure.

Automatic Curve-Fitting and Time-Integration Computed at the Voxel-Level

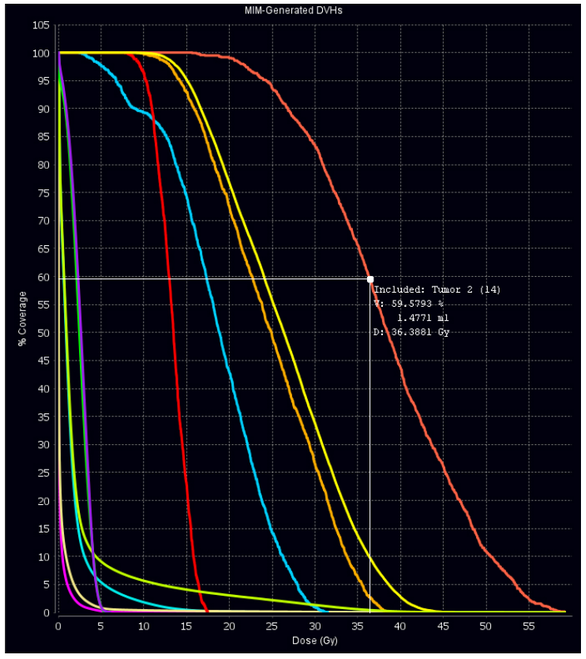
Time-activity curve-fitting, on the voxel or ROI-level, optimized with a variety of exponential models. Optionally compute and fit dose-rate maps instead of activity maps.

Single-timepoint modeling with the **Prior-Information approach** uses kinetics from the first therapy cycle to model activity and integrate over time. **The Hänscheid approach** allows for direct calculation of time-integrated activity from a single acquisition.

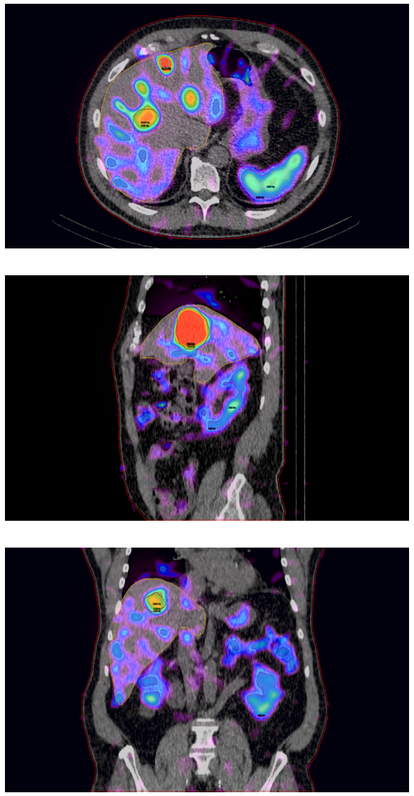
Dose Calculation

Fast, Patient-Specific Dose Calculation on the Voxel-Level

Voxel S-Value (VSV) kernels developed with Monte Carlo simulation are included in MIM SurePlan MRT for clinically used isotopes. Dose-volume histograms and dose maps are available as well.



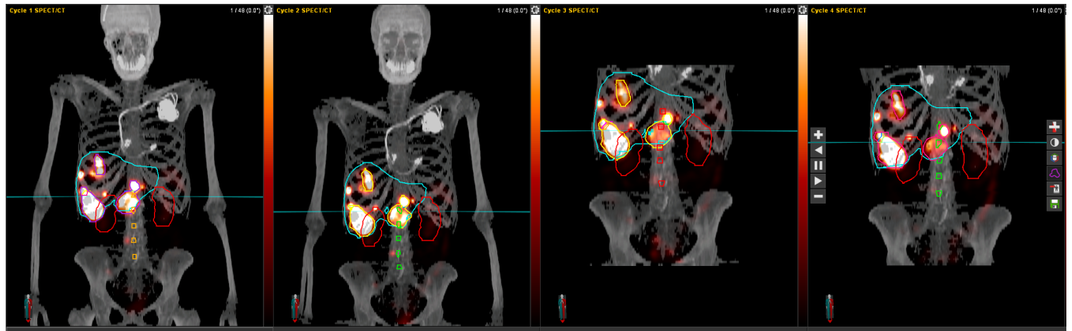
Name		Volume	Max Dose	Min Dose	Mean Dose	SD
Kidney_L		238.1671	6.0497	0.0586	2.5958	1.1883
Kidney_R		233.5663	5.6213	0.0366	2.4629	1.2235
Liver		1980.8583	59.9974	0.0348	2.4796	5.5321
Tumor 1		69.5145	46.3251	8.4426	26.3990	7.3282
Tumor 2		2.4792	59.9974	15.6384	38.6669	8.7904
Tumor 3		2.211	17.5431	7.8261	13.3896	1.8742
Tumor 4		2.3265	31.7464	2.4886	18.4782	6.1036
Tumor 5		2.9132	39.0687	9.1844	24.8206	6.6718
WB		31412.5263	59.9974	0.0018	0.3966	1.6377
Rest of Body		28958.0887	30.4079	0.0018	0.2180	0.5966
Healthy Liver		1903.2599	40.6786	0.0348	1.5110	2.3110



Dose Map and DVH

Voxel-level dose map is generated automatically as a 3D series for VOI review. The dose-volume histogram includes dose coverage stats for each VOI.

Dosimetry Results Review



2016-06-24 Acquisition			
Cumulative Absorbed Dose (1 Cycle)			
ROI	Mean Dose (Gy)	Activity (GBq*s)	Volume (ml)
Bone Marrow	0.2	29.4	3.4
Kidney_L	2.4	10698.1	104.2
Kidney_R	2.3	10205.2	102.7
Liver	6.4	483306.8	1746.1
Tumor 1	50.6	195216.5	87.2
Tumor 2	28.2	67393.8	54.5
Tumor 3	32.8	24259.1	16.2

2016-08-19 Acquisition			
Cumulative (+New) Absorbed Dose (2 Cycles)			
ROI	Mean Dose (Gy)	Activity (GBq*s)	Volume (ml)
Bone Marrow	0.5 (+0.3)	38.6	3.3
Kidney_L	4.6 (+2.2)	10397.4	109.6
Kidney_R	4.8 (+2.5)	11015.7	102
Liver	12.1 (+5.7)	410684	1652.2
Tumor 1	92.6 (+42.1)	170564.8	92.1
Tumor 2	49.9 (+21.7)	41133	42.5
Tumor 3	61.7 (+28.8)	22772.5	17.5

2016-10-21 Acquisition			
Cumulative (+New) Absorbed Dose (3 Cycles)			
ROI	Mean Dose (Gy)	Activity (GBq*s)	Volume (ml)
Bone Marrow	0.7 (+0.2)	27.2	3.3
Kidney_L	6.9 (+2.3)	9720.2	99
Kidney_R	7 (+2.2)	9540.9	100.4
Liver	16.5 (+4.4)	344153.2	1793
Tumor 1	131.3 (+38.7)	140514.2	81.9
Tumor 2	65.8 (+15.9)	28958.5	40.6
Tumor 3	87.5 (+25.8)	21130.9	18.1

2017-01-13 Acquisition			
Cumulative (+New) Absorbed Dose (4 Cycles)			
ROI	Mean Dose (Gy)	Activity (GBq*s)	Volume (ml)
Bone Marrow	1 (+0.3)	37.9	3.4
Kidney_L	9.3 (+2.4)	11456.8	110.6
Kidney_R	9.7 (+2.7)	11999.1	104.6
Liver	22.4 (+5.9)	438260.2	1718.2
Tumor 1	178.5 (+47.2)	193375.4	92.3
Tumor 2	83.8 (+18)	26836.9	33
Tumor 3	123.5 (+36)	25997	15.8

Dose accumulation statistics provide a therapy summary of absorbed dose and volume changes.

Dosimetry Reports Allow for Effective Communication with Patients and Referring Physicians

The structured report features an automatically generated DVH and relevant screen captures. MIM's structured reports are customizable.

Track Dose Across Therapy Cycles and Quickly Review Tumor Progression

Dose accumulation runs in the background through MIM Assistant®. Cumulative doses and volume changes across cycles can be reviewed. It can also combine with information from pre- and post-therapy diagnostic imaging.

"MIM Software is devoted to providing superior customer service.

For MIM SurePlan MRT, that means around the clock support for questions and technical issues and customized setup and training. We design our dosimetry tools to streamline the clinical process and also allow for research-focused analysis.

We offer guidance for those new to dosimetry and access to clinical scientists for in-depth questions and technical understanding. Our goal is to provide both the tools and the support you need to improve patient care."

Aaron S. Nelson, MD

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08 Jun 2023

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