Australian Government
Australian Radiation Protection and Nuclear Safety Agency

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Australian Clinical Dosimetry Service

Level III Audit – Fact Sheet

Definition

The Level III audit offered by the ACDS investigates the accuracy with which a Radiation Oncology Facility delivers dose to a simulated patient. An anthropomorphic phantom undergoes all steps within the facility, which a patient would experience for treatment with radical intent. Dosimetry measurements are made with an electrometer with ionisation chambers (Farmer-type PTW 30013, IBA CC13) and microDiamond detectors (PTW 60019), as well as Gafchromic™ film (EBT3, Ashland, Wilmington, DE) in a CIRS thorax phantom or IMT SRS cranial phantom. As recommended by TRS-398, the ACDS uses ion chamber calibration factors determined in high-energy beams of similar quality (referred to as "Directly measured"). All detector calibrations are traceable to the Australian Primary Standards Dosimetry Laboratory (PSDL).

Audit Coverage

One Level III Audit is performed at a facility as part the four year ACDS audit program. For organisations with matched beam models, centralised planning and/or common CT Scanners, the Level III audit delivery must still be completed at each physical treatment facility. The Level III audit is also available for a new Radiation Oncology facility, prior to clinical treatment. The Level III SRS audit is not included in the four year program and may be arranged at separate cost upon request.

Audit Scope

The audit comprises multiple modalities and energies, components of which can be performed on a Conventional Linac, Halcyon®, Ethos™, MR-Linac, Tomotherapy®, CyberKnife® or Gamma Knife® system (see Table 1). Measurements are performed on a single representative machine of each machine class type, at each facility. If the facility operates different linac class types (e.g. a Conventional Linac and a Halcyon), the Level III audit will be offered for both systems.

Table 1. Summary of options available for the Level III audit

Modality	Conventional Linac	Halcyon	Ethos	MR-Linac	Tomotherapy	Cyberknife	Gamma Knife
3DCRT#	6X, 10X, 18X, 6FFF, 10FFF	6FFF		7FFF	6FFF	6FFF	
IMRT	6X, 10X, 6FFF, 10FFF	6FFF		7FFF	6FFF		
VMAT	6X, 10X, 6FFF, 10FFF	6FFF		7FFF	6FFF		
SABR Soft Tissue, Spine, Lung	6X, 10X, 6FFF, 10FFF	6FFF		7FFF*	6FFF	6FFF	
Online Adaptive	6X, 10X, 6FFF, 10FFF		6FFF	7FFF*			
Motion adaptive*	6X, 10X, 6FFF, 10FFF		6FFF	7FFF	6FFF	6FFF	
SRS Single Met. MR Multi Met. Complex Multi Met.	6X, 10X, 6FFF, 10FFF	6FFF		7FFF*	6FFF	6FFF	Co-60

A subset of 3DCRT cases are measured as reference beams for the complex treatment modalities and specialist treatment machines.
*In field trial or development.

CPD

For Radiation Therapists participating in the audit, ASMIRT CPD hours are claimable at a rate of 15 hours for treatment planning and 5 for treatment delivery.

Radiation Oncology Medical Physicists participating in the audit may claim 5 ACPSEM CPD points and 1 Optional Reflective point.

Certificates will be issued with the audit report.

Dose reporting

The ACDS acknowledges that treatment planning systems can report dose as dose-to-water or dose-to-tissue (where the TPS is modelling the phantom as a mixture of muscle and soft tissue by default). The audit is performed in a water equivalent phantom. AAPM TG-329 has identified the mass energy absorption coefficient ratio and the stopping power ratio of muscle/water to be approximately 0.99. The D_{tissue}/D_{water} correction and the audit outcome are tailored according to the algorithm that was used by the facility to report dose.

Additionally, ACDS detectors have been calibrated in water. For the measurement points in non-water equivalent materials (lung and bone), the ACDS applies medium-dependent corrections to the measurements, reporting both dose-to-scaled density water (D_w) and dose-to-medium (D_m). Dose has been calculated both ways; using the respective D_w and D_m corrections. The outcome of the audit is tailored according to the algorithm that was used by the facility to report dose.

Film is used as the primary dosimeter for both SABR and SRS outcomes. MicroDiamond measurements provide a real-time dose measurement during audit delivery. The ACDS film dosimetry processing methodology has extensive quality control mechanisms in place and is a fully independent analysis – using in-house developed software (Python, MatLab). The overall uncertainty in the ACDS film dosimetry results is within 2.5%.

Audit Outcomes

Outcomes are attained for each modality the facility chooses to include in the audit. Measurement results that are reported but not scored include out of field points, repeated measurements and deliveries restricted from clinical use. Outcome thresholds for all available audits are outlined in Table 2.

For 3DCRT, IMRT, and VMAT, audit results are determined for each case using the dose variation between the facility stated dose (planned dose) and the ACDS measured dose. SABR and SRS results are determined using the measured 2D dose map from the film in comparison to the facility DICOM planning files provided. Local dose variation measurements are measured with a microDiamond detector for both SABR and SRS.

Table 2. Scoring criteria for Level III audits

Modality	Metric	Criteria	Pass (Optimal Level)	Pass (Action Level)	Out of Tolerance
3DCRT	Local dose variation	100% points	≤ 3.3%*	> 3.3% and ≤ 5%	> 5%
IMRT and VMAT	Local dose variation	94% points*			
SABR	Gamma Criteria	5%/2 mm	≥ 95%	< 95% and ≥ 90%	< 90%
	Soft Tissue 1D profile DTA	Mean DTA @ 70% isodose (L-R) and (A-P)			> 3.0 mm
	Spine 1D profile DTA	Mean DTA @ 70% isodose (L-R). DTA @ PTV-Spinal Cord PRV interface @ 70%			> 2.0 mm

Modality	Metric	Criteria	Pass (Optimal Level)	Pass (Action Level)	Out of Tolerance
	Lung 1D profile DTA	Mean DTA @ 70% isodose (S-I)			> 3.0 mm
	Local dose variation	100% points (microDiamond)			> 8%
SRS	Gamma Criteria	5%/1mm	≥ 95%	< 95% and ≥ 90%	< 90%
	1D DTA	Mean DTA @ 90% Isodose (L-R) (A-P) and (S-I)	≥ 1 mm	> 1 mm and ≤ 1.5 mm	> 1.5 mm
	Local dose variation	100% of points (microDiamond)			> 8%

*An Out of Tolerance outcome will be given for IMRT or VMAT if a single point returns > 8% local dose variation.

Adaptive

The Online Adaptive modality is currently in field trial for MR-Linacs, and thus the results will be reported but not scored against the overall audit outcome. The Motion Adaptive modality is currently entering field trial.

Outcome Reporting

An individual report is created for each facility and is specific to the beam model(s) audited. A formal report will be sent to the Facility within approximately 30-45 days of the audit. This timeline will extend if additional information or follow up of non-optimal audit results are required.

Out of Tolerance results are promptly communicated to the Chief Physicist and reviewed by the Clinical Advisory Group. Data collected is held confidentially by the ACDS and its oversight groups. Publicly reported outcomes are randomised and de-identified.

The Australia and New Zealand (ANZ) Dataset is comprised of an extensive number of data points and information collected while developing, executing, and analysing ACDS audits. This comparative data is available for benchmarking the Facility's audit results against measured audit data for all cases in the Level III and Level III SRS audits, and will be included in the formal report.

General Audit Procedures

- The phantom undergoes all steps within the facility, which a patient would experience for treatment with radical intent.
- A CT scan of the phantom is completed at the facility ~6 weeks prior to the audit. For SRS, an MR scan is also required.
- For SRS, patient immobilisation including a thermoplastic mask is required.
- Planning is completed according to 'ARPANSA-WI-3001 RT Planning and Treatment Instructions' or 'ARPANSA-WI-3122 SRS Audit Instructions'. Planning data should be returned to the ACDS 2 weeks prior to the audit.
- At minimum, the Facility should book staff and equipment for 8 hours of treatment planning time and 5 to 7 hours of treatment delivery time. Additional beam models and modalities will increase planning and delivery time required. For MRI-Linacs, allow 1-1.5 hours per case.
- The Linac must be acceptable for clinical treatment on the day of the audit.
- At minimum, the Facility must ensure that a Radiation Therapist is available for the duration of the audit to deliver the planned treatment and provide supplemental information if required. Provision of additional Radiation Therapist treatment staff is desirable, according to the Facility treatment protocols. A Physics representative should be available for SABR and SRS reference field deliveries in Service Mode, and to provide supplemental information if required.
- Audit measurements are typically completed in R&V Clinical QA mode to allow multiple deliveries. Specialist treatments may require scheduling in Clinical Treatment mode.

- The facility must confirm the plans are deliverable and pass all facility pre-treatment QA measures for clinical IMRT/VMAT/SABR/SRS plans, including patient specific QA.
- For pre-treatment verification, volumetric imaging is recommended due to the lack of anatomical structures within the phantom.