Australian Government

Australian Radiation Protection and Nuclear Safety Agency

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ACDS 2021–22

Year in Review

Welcome to the ACDS 2021–22

Year in Review

A publication of the Australian Clinical Dosimetry Service (ACDS)

In what has been another challenging year, the ACDS has continued to deliver and develop its radiotherapy dosimetry audit program, striving to support the highest level of quality and patient safety in radiation therapy across Australia and New Zealand.

Having last year celebrated 10 years of service, the ACDS is now a mature, sustainable and cost-recovered service within the Federal Government's Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). ACDS' audit coverage has grown to include the majority of New Zealand radiation oncology providers, as well as Australian facilities.

ACDS audits continue to support Radiation Oncology Health Program Grants funding, Trans-Tasman Radiation Oncology Group (TROG) clinical trial credentialling and also offer benchmarking data across Australian and New Zealand facilities. The ACDS is ISO/IEC 17025 accredited by the National Association of Testing Authorities (NATA). The service also has a memorandum of understanding with the Imaging and Radiation Oncology Core (IROC), whereby our Level I mail-out audits are comparable for international trial credentialing. Our comprehensive radiotherapy audit services are recognised as meeting the Radiation Oncology Alliance Radiation Oncology Practice Standards criteria for independent dosimetric comparison/auditing. ACDS' comprehensive Australian and New Zealand dataset also allows benchmarking of audit results for subscribers.

ACDS expanded its audit program with the introduction of stereotactic ablative body radiotherapy (SABR) audits in 2021–22. During the year, 28 such audits were conducted, which provided confidence in the SABR technique for separate treatment cases including soft tissue, spine and lung. Audits of stereotactic radiosurgery and kilovoltage X-ray therapy have also successfully matured from field trial to live audits.

ACDS staff attended both national and international conferences and scientific meetings (virtually) during the 2021–22 period. Two publications in international journals share ACDS experience in audit development and analysis of aggregated audit data. More details can be found in the Publications and Presentations section.

The ACDS has also continued to develop audits for emerging radiotherapy techniques, such as online adaptive radiotherapy and motion adaptive radiotherapy. Audits of the adaptive process on MR linear accelerators (linacs) were performed in field trials. Motion adaptive audit development is moving quickly towards the field trial stage.

In a fast-moving environment of technology, change and adoption, the ACDS strives to support the radiotherapy community with an independent and comprehensive dosimetry audit service to ensure the highest level of quality and patient safety in radiotherapy.

Rhonda Brown
Director ACDS

Gillian Hirth
CEO of ARPANSA

Cover photo courtesy of RANZCR and Targeting Cancer

Acknowledgement of Country

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) respectfully acknowledges Australia's Aboriginal and Torres Strait Islander communities and their rich culture and pays respect to their Elders past and present. We acknowledge Aboriginal and Torres Strait Islander peoples as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely.

We recognise and value the ongoing contribution of Aboriginal and Torres Strait Islander peoples and communities to Australian life and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

Contents

ACDS overview

Our vision

A world leading dosimetry auditing service for the highest level of quality and patient safety in radiation therapy.

Our mission

To guide, support and improve patient safety and radiotherapy service delivery by:

- providing a comprehensive suite of audit modalities covering all common clinical practices
- improving national dosimetry capabilities in clinical treatment delivery
- offering our services to Australian and overseas radiotherapy centres on a fee-for-service basis.

The mission of the ACDS is fully aligned with Key Activity 1 of ARPANSA and its initiative to '*Promote the safe and effective use of medical radiation*'.

Our structure

The Director of the ACDS, Rhonda Brown, has held this position since January 2021, after being the Acting Director since July 2020. Rhonda leads a skilled team of medical physicists, radiation therapists and support staff, who work together to deliver on the ACDS strategic objectives, while supporting ARPANSA's Corporate Plan.

The ACDS forms an integral part of the Medical Radiations Services Branch (MRSB) at ARPANSA, along with the Primary Standards Dosimetry Laboratory (PSDL), which maintains the Australian primary standard for absorbed dose. The PSDL calibrate the detectors used in ACDS audits against this primary standard, underpinning the quality of the dosimetry checks.

Research and audit development are aligned with current and emerging clinical practice. The Roger Allison Quality Radiotherapy Centre, opened in March 2019, provides essential access to a modern linear accelerator. The ACDS physicists were instrumental in the acceptance and commissioning of this Elekta VersaHD linac and continue to maintain ongoing quality assurance. This is an essential resource for audit development for modalities, including stereotactic ablative body radiotherapy (SABR), stereotactic radiosurgery (SRS), and most recently the Level III 4D motion adaptive audit utilising our newest phantom; a magnetic resonance imaging compatible CIRS phantom with motion capabilities and simulated lungs, liver, kidney and spine.

Currently, 99% of Australian and 50% of New Zealand radiation oncology providers subscribe to the ACDS. Information gathered during audits across the facilities allows the ACDS to provide consistent data for benchmarking, so that individual facilities can measure their performance against other radiotherapy facilities with similar resources.

Our staff

Rhonda Brown, Andrew Alves, Sabeena Beveridge, Brendan Healy, Andrew Cole, Fayz Kadeer, Kate Francis, Jeremy Supple, Julie Giblett, Daniela D'Antonio, Raymond Sun, Alex Burton, Katherine Collins, Maya El-Moslmani, Kath Metzger.

Staff departed in 2021–22: Maddison Shaw, Cate Davey

Our associates and external auditors

Ivan Williams, Joerg Lehmann, Jessica Lye, Francis Gibbons, Johnny Laban, Stephanie Keehan, Max Hanlon, Maddison Shaw.

The Strategic Plan for the ACDS sets out the strategic objectives over four years and is aligned with ARPANSA's 2-year Corporate Plan, notably ARPANSA's Key Activity 1 and its initiative to '*Promote the safe and effective use of medical radiation*.'

We are confident that the dedicated and highly competent ACDS staff, with the support of ARPANSA's infrastructure and advice from the Clinical Advisory Group, will continue to deliver quality services to the Australian and New Zealand health care system for the benefit of patient safety.

Our strategic objectives

Be recognised as a **global leader** and associated with the **highest standards of quality and safety** in radiotherapy

Be a **comprehensive provider of auditing services** to all Australian and New Zealand radiotherapy centres

Support and collaborate in **high quality research and development** in clinical practice and audit methodologies

Offer **competitive quality audit services** that cover all clinical practices and emerging technologies

Positively **influence the use of radiation in medicine** and have **tangible impact benefitting patient safety**

The Clinical Advisory Group

The Clinical Advisory Group (CAG) comprises members across all jurisdictions and practices who have a broad base of professional clinical experience.

The CAG members are appointed by the CEO of ARPANSA and nominated by their professional bodies* to advise the ACDS on development of audit methodologies and immediate clinical interpretation of specific audit outcomes. In addition to this, they review phantom design, measurement techniques and provide advice on relevant treatment techniques for audits, and on what skills, experience, and training is required for ACDS auditing staff.

The CAG meets quarterly and out of session, if necessary, to discuss audit results that could potentially pose a risk to the safety of patients receiving radiation therapy. They report yearly to the Australian Health Protection Principal Committee structure.

The CAG has been an invaluable source of experience and support since the establishment of the ACDS. It provides high quality and independent governance to the ACDS, ensuring that audit development and strategic direction align with industry needs.

Clinical Advisory Group members

- Lucinda Morris – Chair: RANZCR
- Joerg Lehmann – TROG
- Adam Briggs – ACPSEM
- Louise Nardone – RANZCR
- Andrew Cousins – ACPSEM – New Zealand
- Katrina Woodford – ASMIRT
- Rebecca Thyne – NZIMRT
- Tomas Kron – independent technical expert

* Professional bodies consist of the Royal Australian and New Zealand College of Radiologists (RANZCR), Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM), Trans-Tasman Radiation Oncology Group (TROG), Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) and the New Zealand Institute of Medical Radiation Technology (NZIMRT).

www.trog.com.au

Supporting sound research in radiation therapy is one of the key functions of the ACDS. Our strong relationship and collaboration with the Trans-Tasman Radiation Oncology Group (TROG) has enabled the development of audits that support credentialling for clinical trials. The ACDS is an observer member of the **Global Quality Assurance of Radiation Therapy Clinical Trials Harmonization Group** (GHG), whose goal is to promote harmonisation of radiotherapy quality assurance between trial groups globally. ACDS audits may be used towards clinical trial accreditation for TROG trials, demonstrating that they meet the quality assurance requirements necessary for robust research. It is important to note that audits still in field trial are accepted by TROG as supporting evidence that trial participants meet the trial credentialling criteria.

Level II/III

3DCRT/IMRT/VMAT	SABR	SRS
AGITG AG0407GR/TROG 08.08 TOPGEAR	TROG 17.03 LARK	TROG 16.02 LOCAL HER-O
EORTC 1308/TROG 15.02 ROAM	PMC 17/013/TROG 17.05 AZTEC	TROG 17.02 OUTRUN
ANZ 1601/BIG 16-02 EXPERT	TROG 18.01 NINJA	
TROG 18.06 FIG	CTC 0245/AGITG AG0118PS/ TROG 18.04 MASTERPLAN	
ANZUP 1801 DASL-HiCaP	TROG 19.06 DECREASE	
TROG 20.01 CHEST-RT	VCCC/TROG 20.03 AVATAR	
MASC 2101 i-MAT	TROG 21.07 SOCRATES	
ANZGOG1910/2020/CTC0299 ADELE	AGITG TROG 21D RESOLUTE	
	TROG 15.03 FASTRACK II	

Horizon scanning – particle therapy

The ACDS is preparing to conduct Level Ib and III dosimetry audits at the SAHMRI Proton Centre in Adelaide when it opens ~2024. As a part of the scoping work, the ACDS is participating in GHG Harmonisation of Proton vs Photon QA, to ensure that developed procedures are in line with international best practice. Also, ACDS is considering supervising a PhD student in proton therapy audit dosimetry in conjunction with the University of Adelaide to commence in 2024.

ACDS accreditation requirements

The ACDS is an ISO/IEC 17025 accredited testing service which provides dosimetry audits to meet:

- Radiation Oncology Alliance Radiation Oncology Practice Standards (a peak group comprising the four key specialties in radiation oncology and representing their respective organisations RANZCR, ASMIRT, ACPSEM and Cancer Nurses Society of Australia)
- Radiation Oncology Health Program Grants (ROHPG) (Australia) funding conditions
- jurisdictional radiation licensing requirements.

The ACDS forms part of the ARPANSA corporate ISO/IEC 17025 National Association of Testing Authorities (NATA) accreditation. This is a competency-based standard which requires the ACDS, and the six other ARPANSA laboratories, to undertake a rigorous internal and external auditing program focused on employee competence.

NATA
WORLD RECOGNISED ACCREDITATION
NATA Accredited Laboratory 14442

The NATA is the external certification body which performs a surveillance audit and re-assessment audit every 18 months thereafter. These re-assessment audits require the use of an external technical expert in ACDS' field of radiotherapy dosimetry. As ACDS is the peak body in Australia, we use equivalent experts from around the world to perform technical assessments of ACDS staff.

Further information regarding NATA accreditation, the ACDS and the ARPANSA management system can be obtained by contacting our quality manager at qualitymanager@arpansa.gov.au.

ACDS audit services are recognised as meeting the Radiation Oncology Alliance, Radiation Oncology Practice Standards (ROPS) criteria for independent dosimetric comparison/audit.

International collaboration

Global Harmonization Group

The ACDS is an observer member of the Global Quality Assurance of Radiation Therapy Clinical Trials Harmonization Group (GHG). The group consists of clinical trial quality assurance offices and auditing bodies around the world and aims to harmonise and improve clinical trial quality assurance in radiation therapy worldwide.

International Atomic Energy Agency (IAEA) Dosimetry Audit Network

As a member of IAEA's international Dosimetry Audit Network (DAN), the ACDS continues to play a constructive role in projects such as film dosimetry intercomparisons and the provision of expert lecture support.

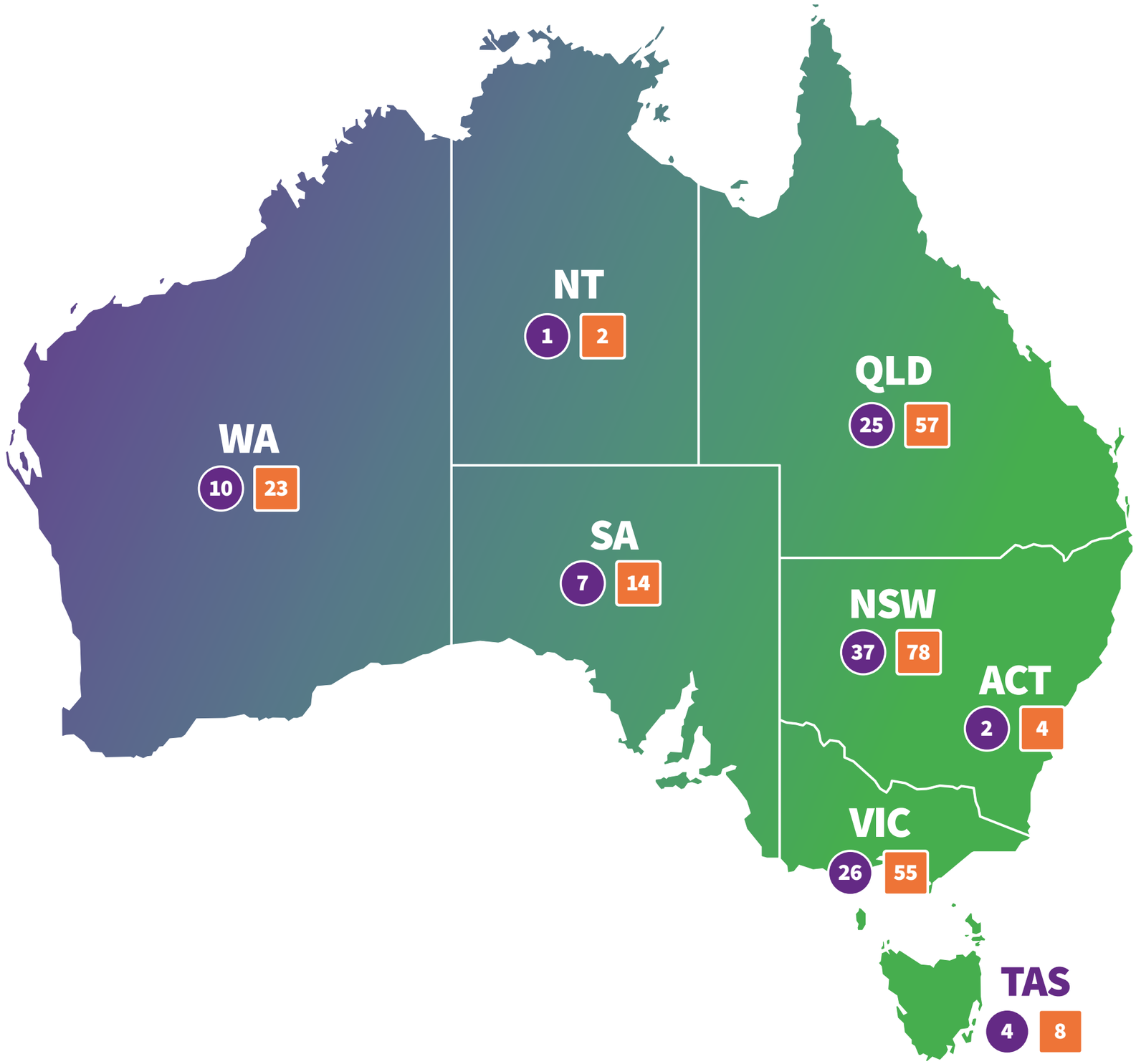
Imaging and Radiation Oncology Core (IROC)

The ACDS and IROC Houston QA Center have a memorandum of mutual recognition agreement of dosimetric audit equivalence for the ACDS Level I optically stimulated luminescence dosimeters (OSLD) audits. This agreement recognises the technical equivalence and frequency of both organisations' OSLD mail-out audits. In practice, this means that a facility may provide ACDS Level I OSLD results where there is a requirement for an IROC OSLD audit, such as in a clinical trial. This agreement is maintained by regular intercomparisons of the mail-out audit by the ACDS and IROC.

ACDS continues to seek feedback and advice from its Stakeholder Engagement Group (SEG). A successful meeting of SEG was held for a full day in March 2022, bringing together meeting representatives from state and territory radiation regulators, the Commonwealth Department of Health and Aged Care, peak professional bodies, TROG, as well as private and public radiotherapy facilities.

The SEG meeting provided the opportunity for ACDS to present its audit structure and schedule, receive feedback from SEG and horizon-scan future auditing capabilities.

National and international audit coverage



KEY	TOTAL
# FACILITIES	117
# LINEAR ACCELERATORS*	255

* Note that ACDS has also audited two Gamma Knife units and 18 kV X-ray therapy units under field trial.

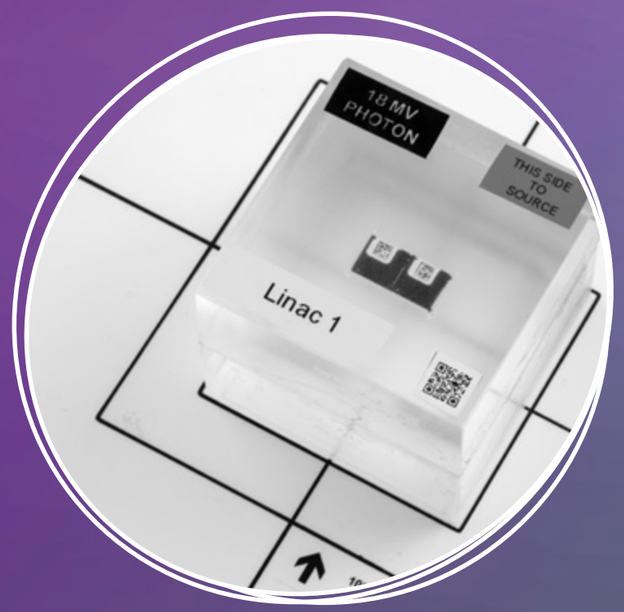
Approximately **70,000 patients across Australia** alone receive radiotherapy each year. All benefit from the services of the ACDS.

112 Australian radiotherapy facilities subscribe to the ACDS, covering **241 linacs**

5 New Zealand radiotherapy facilities subscribe to the ACDS, covering **14 linacs**

110 on-site audits
including 12 field trials,
7 follow-up audits

135 linacs covered by 65 facility mail out audits



2 peer-reviewed publications,
11 presentations at conferences

Financial year 2021–22 marked a transition from COVID-related lockdowns and border closures to vaccinations and ongoing PPE requirements. Again, the ACDS met the challenge to perform on-site audits during 2021–22. During border closures in the early part of the financial year, state regulators continued to agree that they would support ACDS applications to enter their state or territory to conduct audits. The ACDS engaged with the hospitals and obtained agreement to enter and perform these essential audits. Where access was restricted, the ACDS also continued to offer mail-out OSLD audits and deployed audit staff to Queensland and Western Australia in the period September to December 2021.

During onsite audits, the ACDS continued to comply with all hospital requirements for safety of staff and patients including physical distancing, antigen testing, PPE and vaccination status. The ACDS acknowledges the support of radiotherapy facilities in accommodating onsite audits during this unprecedented period.

Stereotactic Radiosurgery (SRS) audits

The ACDS has completed field trials of SRS audits and from 1 July 2022 SRS audits are live and can be requested by facilities outside of the regular schedule. Overall, 22 field trial audits were conducted, with five field trials completed in financial year 2021–22. The SRS audit involves three cases planned on an anthropomorphic head phantom with dosimetry provided by radiochromic film and microdiamond detectors. Aggregate results from field trials allowed the determination of action level and out of tolerance limits with the approval of the CAG. Refer to the ACDS current audit program 2022 for more details.

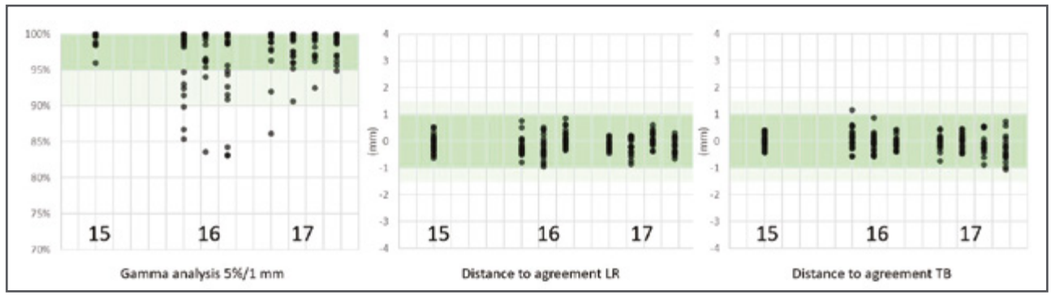


FIGURE 1

Kilovoltage X-ray therapy audits

The ACDS has completed field trials of kilovoltage X-ray therapy Level Ib audits from 1 July 2022 these audits are live and can be requested by facilities outside of the regular schedule. Overall, 18 field trial audits were conducted. The audit involves in-air measurements with calibrated ionization chambers following the American Association of Physicists in Medicine (AAPM) TG61 protocol. An action level of 3.5% and an out of tolerance level of 5% has been set for this audit (refer to the ACDS current audit program 2022). Field trials of Level I OSLD audits for kilovoltage units is ongoing. The ACDS is also conducing research in the measurement of stem corrections ($P_{stem,air}$ in AAPM TG1 terminology) for the commonly used ionization chambers PTW model 23342 and model 23344. The aim in applying stem corrections is to reduce uncertainty in dosimetry measurements for treatment applicators smaller than the reference applicator.

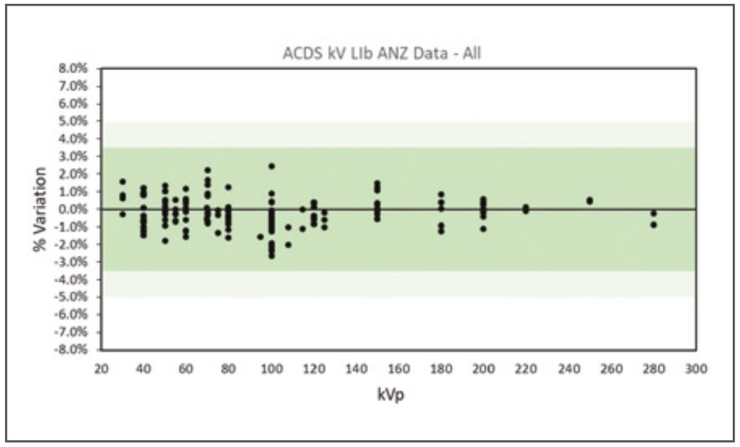


FIGURE 2

Motion management audit development

The ACDS has continued its development of an end-to-end dosimetry audit for respiratory motion management throughout the last year. The results of the national survey conducted in the previous year were instrumental in determining the required scope of the audit, as well as informing key design decisions in the development of the first phantom prototype. A full analysis of the survey results has recently been published in The European Society for Radiotherapy and Oncology (ESTRO) journal *phiRO* (https://doi.org/10.1016/j.phro.2022.09.003). The results were also presented at the EPSM conference in November 2021 and used in the ACPSEM NSW/ACT Branch Workshop on Motion Management in External Beam Radiation Therapy. This was a Continuing Professional Development-endorsed event run over the course of two afternoons, attended by over 250 medical physicists around the country.

The proposed audit structure, including the phantom design and radiation detector arrangement were finalised and presented as a poster at the ESTRO Congress in Copenhagen, May 2022. The phantom can simulate respiratory motion for both lung and liver treatment sites, and enables workflows specific to motion management to be included in the audit. This includes respiratory-correlated simulation imaging (4DCT) and image guidance under moving conditions, which simulate the challenges faced in the clinic when treating these sites of disease. The phantom is currently under construction and is expected to undergo testing in the first quarter of 2023.

The ACDS is currently designing a number of experiments to ensure the accuracy, robustness, and relevance of the prospective dosimetry audit. A method of 4D dose accumulation is being developed in partnership with the Peter MacCallum Cancer Centre, which will allow the dose for a moving target in a phantom to be simulated for different respiratory motion characteristics. Using this tool will enable the prediction of audit outcomes, and inform the eventual tolerance and action levels. In parallel to this work, the detectability of changes in respiratory characteristics under audit conditions will be investigated through an image guidance study. In this experiment, a motion phantom will be taken to facilities, which will attempt to perform cone-beam CT (CBCT)-based image guidance under a variety of breathing patterns. This work will investigate the degree of inter-observer variability arising from the challenge of performing IGRT using images that are blurred by respiratory motion. It will also enable the ACDS to establish the types of motion characteristics that can be used in the final audit. Finally, as the dosimetry phantom nears completion, measurement correction factors will be modelled using Monte Carlo simulation in EGSnrc. This will enable doses measured with detectors calibrated in terms of dose-to-water to be accurately compared to dose-to-medium calculations.

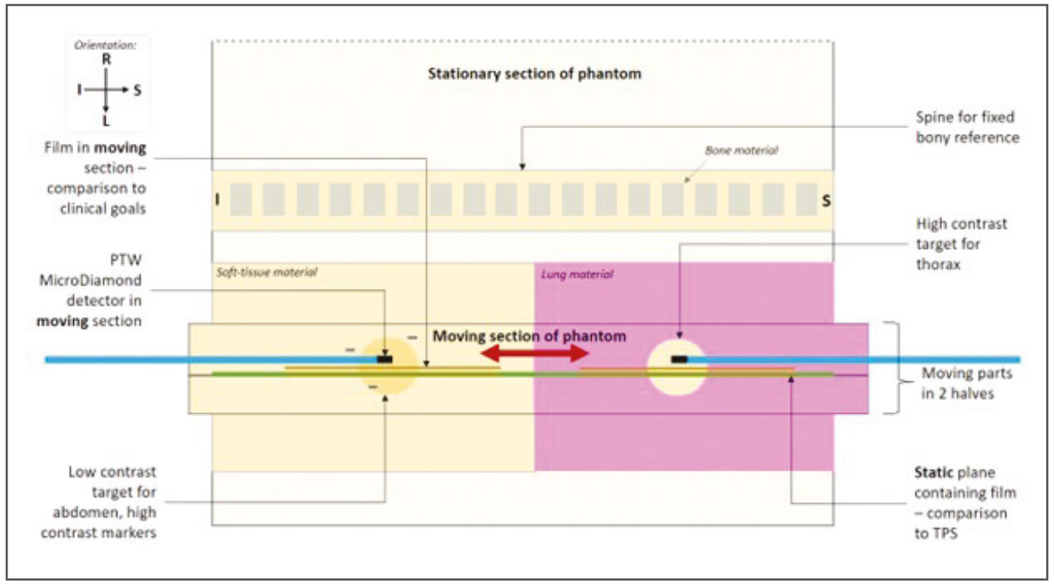
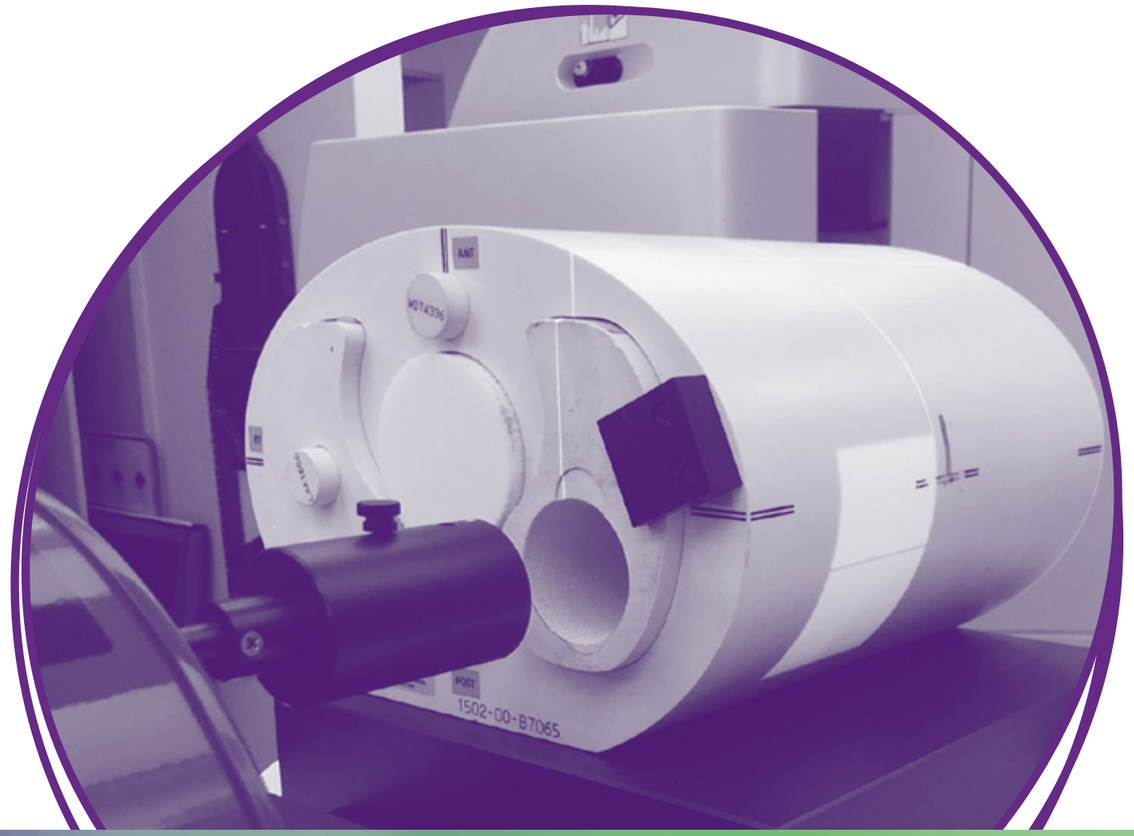


FIGURE 3



Online adaptive audit development

The ACDS has performed a total of eight LIII audits on MR-Linacs and Varian Ethos treatment machines, both of which have adaptive workflows. The ACDS has been working with radiotherapy centres to develop an audit protocol that can test the limits of these speciality machines. There are two adaptive cases that are based on the ideal (no shift, no change of shape) Case 7 protocol that has the challenging C-Shape target volume: Case 18 and Case 20.

Case 18 tests how well the system adapts to a positional shift only. During field trials, the ACDS were applying a 1 cm shift in the Superior and Left/Right directions – trying to push the limits of the systems to test feasibility and functionality. Although these systems could handle such a large shift in patient position, clinical protocols would not allow treatment until the patient was physically shifted closer to the desired position prior to treatment. As a result, the audit protocol has reduced these shifts to 0.5 cm to better test the clinical workflows.

Case 20 tests positional shifts as well as changes in target shape. The original C-shape structure is required to be redrawn to match the Case 7 structure provided in the ACDS fusion dataset. The treatment needs to be adapted with full multi-leaf collimator (MLC) and dose optimisation, and the plan protocol variations are checked prior to the treatment. Reports now include comparison tables between the original plan and the adapted plan protocols.

The ACDS has been building the National Data Set to include the adaptive cases and is now including comparative graphs in the reports. This allows clinics with specialised treatment machines to compare their results against a national standard and have confidence in their adaptive workflows and specialised patient treatments. So far, the ADCS has shown that clinics using MR-linacs and Ethos treatment machines have similar results (within tolerance) to standard linac treatments and are within similar tolerance levels when compared against each other.

Development with the adaptive audit is ongoing, with future work to include motion management options and planning on the ACDS Live On Line Adaption (LOLA) phantom, which is MR-compatible.

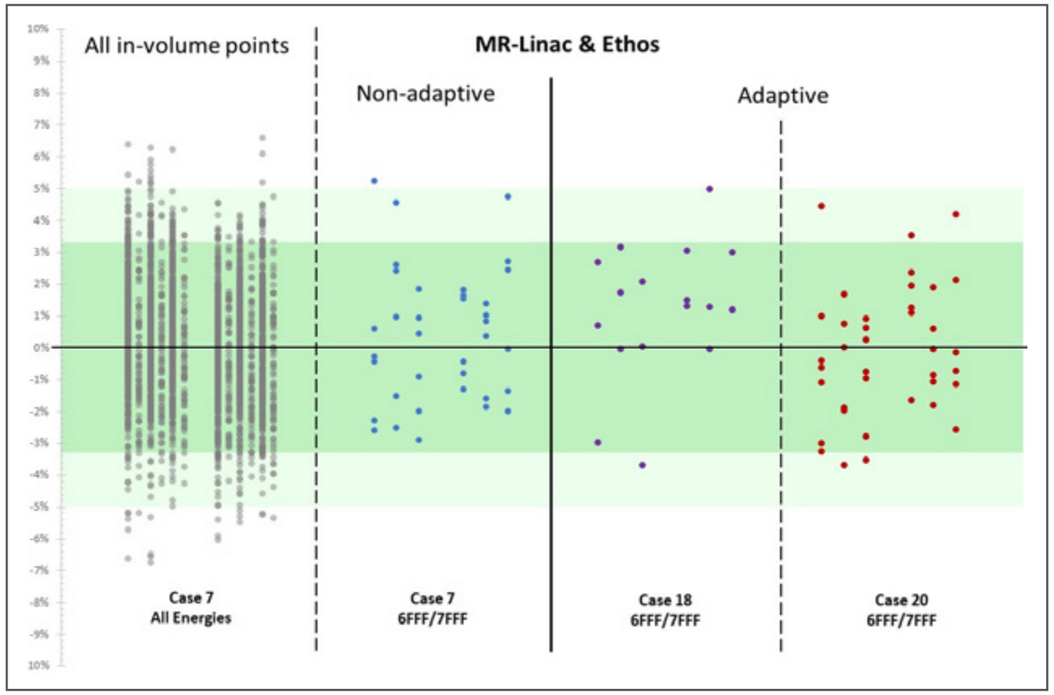


FIGURE 4

Information management and data processing

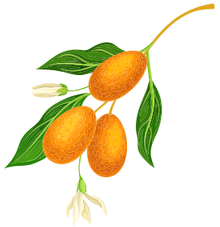
The ACDS is working with the University of Melbourne's Faculty of Engineering and Information Technology as an industry partner to develop a suite of bespoke software applications that will streamline our processes. Our team has engaged with several teams of graduate level students to create and develop specialised software solutions designed to improve database integrity, workflows, and efficiency. Our software specialist, Raymond Sun, has been working to integrate these systems into ARPANSA's digital system and make them accessible to staff.

Astrs: ACDS Self-service TRS-398 portal

Currently in development as an Endeavour Project with the University of Melbourne, ASTRS will simplify the calculations with TRS-398 methodology. Future deployment on a web-based app is currently being researched so that subscribers can use this tool to enter their clinical dosimetry data and check their calculations.

Clover: Calibrations and Lists Of Variables for Evaluation and Reporting

Currently in development with the University of Melbourne industry partner program, Clover is a software application designed to keep track of ACDS equipment inventory, calibrations and certificates, and equipment correction factors. Quality assurance procedures are built-in, with notifications and trend analysis performed in real-time.



Cumquat: Consistency and Uniformity of Measurement QUality Assurance Tracking

The ACDS performs in-depth quality checks of the film scanner equipment and the scanning process to ensure accurate and consistent results in the film dosimetry programme. Cumquat analyses a standard set of filters and tracks changes in the quality and operation of the equipment used in the film dosimetry programme.

Daisy: Data Analysis and Integrated Scientific sYstem

A purpose-built database that allows the ACDS to store and classify data and audit results as part of the National Data Set. The data can be easily examined, analysed and compared, as well as used in client benchmarking and research shared with the global community. Daisy is designed to hold both the LII and LIII audit National Data Sets.

Daffodil: Dynamic Analysis For Film Optical Density ILlustrations

Daffodil performs film calibration and processing to produce a 2D dose map for analysis in Marigold. Daffodil has been designed to track and assess quality metrics throughout the film dosimetry process to ensure consistent and accurate results.

Marigold: Matlab Analysis and RegIstration, Gamma, Or Linear Dta

Performs a film alignment and compares the delivered dose (film processed in Daffodil) with the planned dose (DICOM). Dose difference maps, gamma analysis, and DTA metrics are produced for each audit film.

Mmoss: Motion Management Overview Survey Summary

The ACDS performed an in-depth survey that characterised motion management in radiotherapy across Australia and New Zealand (2021). The results of this survey can be viewed at arpansa.gov.au/mmoss.

Orchid (2&3): Online Radiotherapy CHecker for Integrating Dicoms

Extracts the dose information contained in the planning DICOMs – eliminating the need for pdf planning reports to be generated. By extracting from the DICOM files, more accurate and consistent information is used for audit assessments.

Poplar: Program to Organise PLanar Array Reports

A LII audit application based in MatLab that quickly analyses and compares the 2D array data to the planned DICOM dose. Results and graphs are automatically generated for each case and data is stored as part of the ACDS National Data Set.

TifTuf: Tif Tightening Uncertainties on Film

Part of the ACDS film dosimetry process, TifTuf creates an average image from a set of scanned film images. By using an average image, scanner noise can be reduced which will improve the uncertainty in overall film dosimetry.

Violet: Verification In Orthovoltage and Low Energy Therapy

A software application designed specifically for the ACDS kV auditing program where quality metrics and results are calculated in real-time. Calibrations, correction factors, and calculations based on AAPM TG-61 protocols have been built-into the application.

Sharing key findings and making recommendations for facilities provides valuable insight into ways of strengthening the quality assurance practices involved in radiotherapy planning and delivery. This in turn has a positive tangible impact on patient safety.

Image guidance

In-room image guidance is an important component of Level III audits. Limitations or failures in image guidance have led to Out of Tolerance results for gamma analyses of radiochromic film covering the intended target. The importance of robust clinically-relevant image guided radiation therapy (IGRT) procedures during audit is emphasised.

Examples of IGRT issues that occurred during audits include:

- Gamma pass rates for SABR cases of 62.4%, 76.9%, 76.1% (soft tissue), 86.5% (lung). There were no IGRT images available to review during investigation of the Out of Tolerance outcomes for SABR Soft Tissue and Lung. The facility confirmed that image guidance was not performed for SABR cases.
- Gamma pass rates for a SABR case of 79.4%, 80.3% (lung). The facility reviewed the IGRT image matching for the SABR Lung cases from the original audit and it indicated that a rotation was present in the transverse plane, resulting in a vertical displacement in the film location (see FIGURE 5).
- The CBCT image match was reviewed on the day of audit which showed that the match was made to the incorrect vertebra.
- Gamma pass rate for SABR case of 86.7% (lung). Post-audit follow-up with the facility revealed that this offset was attributable to an IGRT misalignment on the day of the audit. The coronal plane demonstrated that the superior edge of the treated LungITV was ~2 mm superior to the position of the LungITV in the phantom, corresponding to the offset observed on the film. The misalignment visible on the pre-treatment CBCT was not detected by facility representatives on the day of the audit (See FIGURE 6).

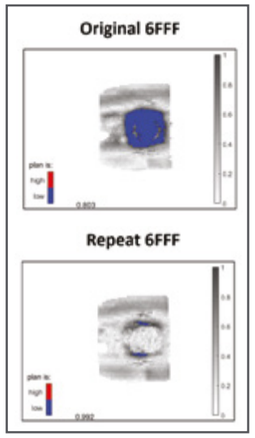


FIGURE 5

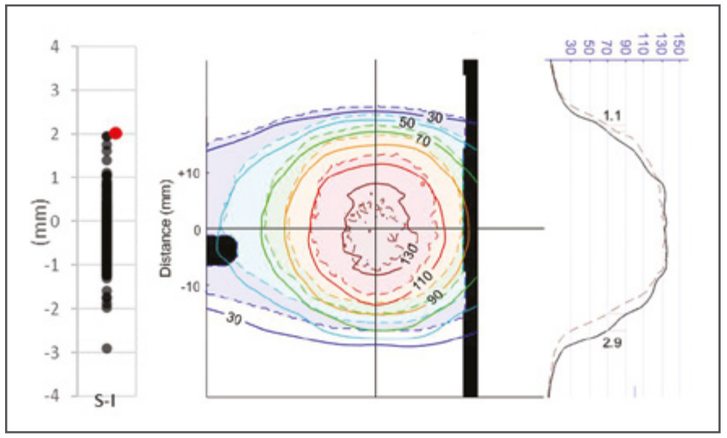


FIGURE 6

Plan settings

Audits are useful in testing the ability of the treatment planning system to match the treatment delivery. A review of audit outcomes leads to the conclusion that plan parameters (particularly in inverse planning) play a role in audit outcome.

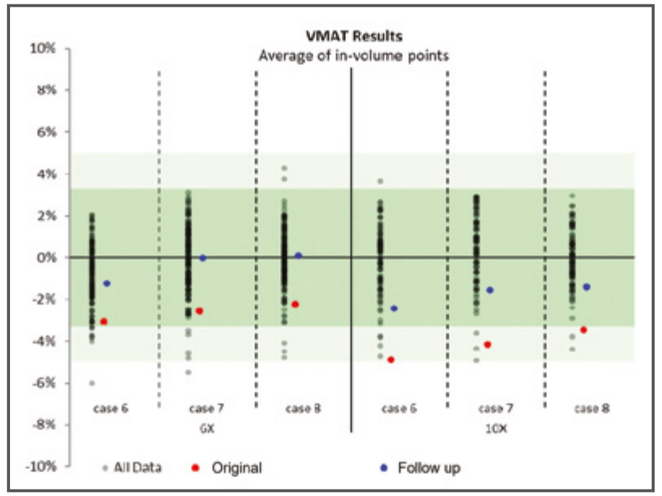


FIGURE 7

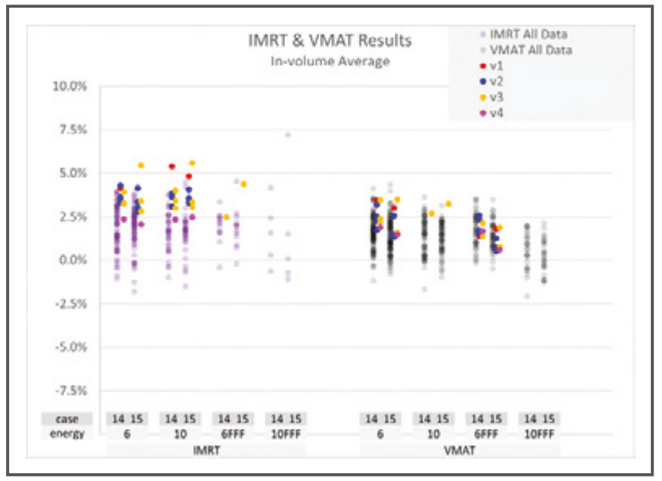


FIGURE 8

In these examples the facility treatment approval processes were not able to prevent plans from being treated on the audit. Parameters such as the aperture shape controller, control point interval, level of modulation, and grid resolution need to be applied for audits as per clinical guidelines and thorough plan quality assurance applied:

- Aperture shape controller parameter in inverse planning. Different settings of this parameter led to considerably different audit outcomes in a Level III audit of volumetric modulated arc therapy (VMAT) cases (see FIGURE 7).
- Four versions of treatment plans led to different audit outcomes for IMRT delivery to a C-shape target in Level II audits (see FIGURE 8).

Beam modelling

It is well known that modelling of MLC characteristics is important for modulated techniques. In one example, at the early stage of clinical commissioning, a noticeable variation in audit outcome for the Level II audit C shape was observed with different MLC parameters applied in the beam model. Issues can also arise with multiple linear accelerators sharing the same beam model with one set of MLC parameters.

Analysis of the results of more than 200 Level II audits enables the identification of trends in treatment planning system capability. In this case, it has been observed for the Acuros XB algorithm that there is a systematic overestimation of dose towards the corners (diagonals) of open 10 x 10 cm^2 fields. The same trend is not observed for open 20 x 20 cm^2 fields. The ACDS is investigating this issue and is conducting an Australia and New Zealand (ANZ)-wide experimental program to corroborate these findings.

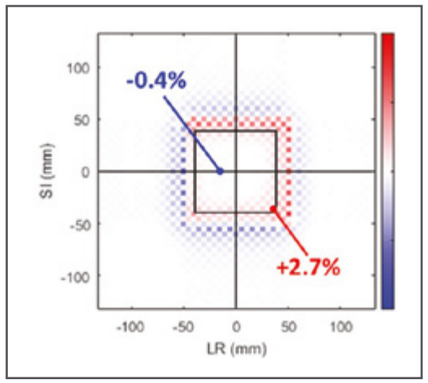


FIGURE 9

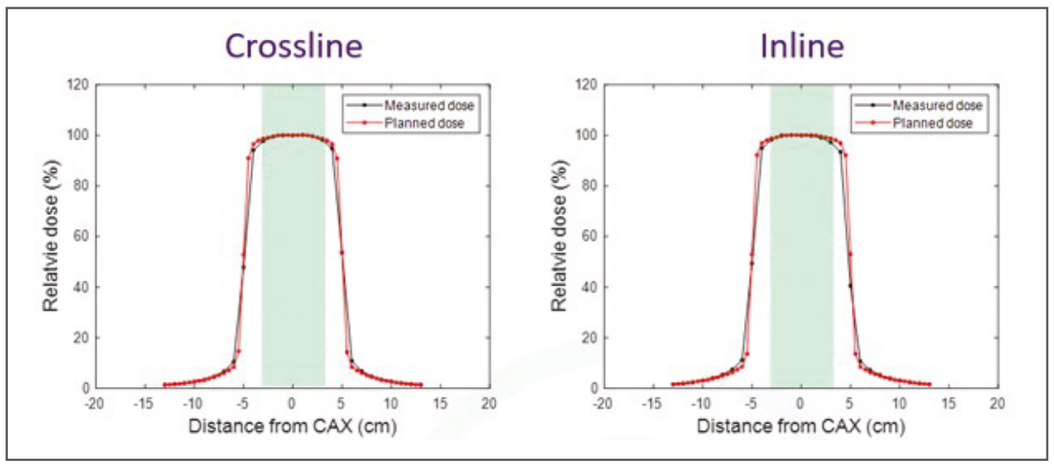


FIGURE 10

Air gaps present in CT scans of ACDS phantoms

Instances have occurred of unintentional air gaps being present during CT scanning of ACDS phantoms. These air gaps can affect film dosimetry if treatment planning is performed with air gaps in the CT dataset. During audit, the film is placed at the location of the air gap and treatment delivery can occur with no air gap present. ACDS has found in one example a 3.5% difference in film dosimetry due to this issue.

It is suggested that facilities fill in the air gap with appropriate density overrides in the treatment planning system. Alternatively, facilities should be aware to look for unintended air gaps in datasets immediately after CT scanning and prior to treatment planning.

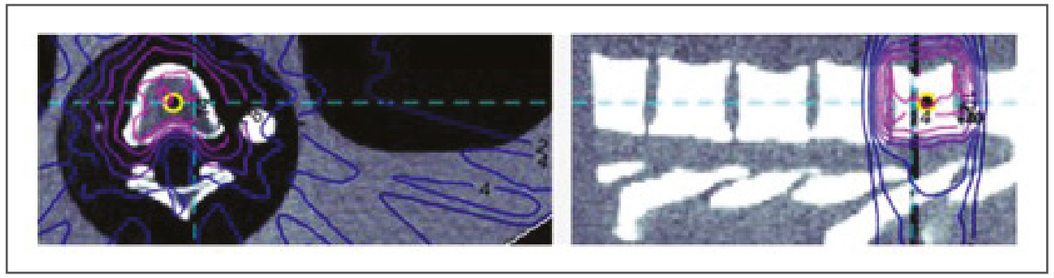


FIGURE 11

Audit outcomes and the role of CAG

Deidentified OT results are referred to the Clinical Advisory Group (CAG) as the dose difference may impact patient outcomes. The CAG will:

- evaluate for clinical impact
- advise on follow up
- advise on recommendations.

The CAG reviewed 44 Out of Tolerance (OT) audit cases from 20 facilities in FY 2021/22.

Of these, 4 cases were reassigned due to audit artefacts and 12 facilities were offered repeat audits as follow up.

Level II 33 audits	No. OT cases	Level III 37 audits, 4 SRS	No. OT cases
3DCRT	3	SABR Lung	3
3DCRT FFF	2	SABR Soft Tissue	2
IMRT	16	SABR Spine	3
IMRT FFF	2	SRS MR Multi Met.	2
VMAT	9	VMAT	1
VMAT FFF	1		

Publications

Shaw M, Lye J, Alves A, Keehan S, Lehmann J, Hanlon M, Kenny J, Baines J, Porumb C, Geso M, Brown R (2021). Characterisation of a synthetic diamond detector for end-to-end dosimetry in stereotactic body radiotherapy and radiosurgery, *Physics in Imaging and Radiation Oncology, 20:40-45*

doi: 10.1016/j.phro.2021.10.002

Hughes J, Lye JE, Kadeer F, Alves A, Shaw M, Supple J, Keehan S, Gibbons F, Lehmann J, Kron T (2021). Calculation algorithms and penumbra: Underestimation of dose in organs at risk in dosimetry audits, *Medical Physics*, 48:6184-6197

doi: 10.1002/mp.15123

Presentations

TROG Technical Research Workshop
30 June 2022 Gold Coast
Brown R. *Forward motion: ACDS audits for adaptive and 4D technologies*

ASMIRT 2022
19–22 May 2022 Cairns

Metzger, K. *The role of the radiation therapist in Level III audits and why it's so important*

Francis, K. *Australian Clinical Dosimetry Service involvement in implementing emerging technologies safely in the clinic*

ESTRO 2022
6–10 May Copenhagen
Poster presentation
Burton A, Beveridge S, Hardcastle N, Lye J, Sanagou M, Franich R. *Designing a national end-to-end audit for respiratory motion management*

EPSM 2021
7–10 November Brisbane (and virtual)

Oral presentations

Williams, I. *The Australian Clinical Dosimetry Service: A decade of improving safety and quality*

Alves A, Shaw M. *Applying spatially dependent density corrections to film data*

Burton A, Beveridge S, Hardcastle N, Lye J, Franich R. *The current state of motion management in Australia and New Zealand – results of the ACDS respiratory motion management survey*

Kadeer F, Alves A, Davey C. *Detection of increased dosimetric uncertainty in OSLD readouts using inhouse quality control metrics*

Lye J, McDermott L, Shaw M, Harris B, Vaithianathan H, Alinaghi R, Shelton N, Rykers K. *Beyond the passing rate, using gamma statistics for improved analysis*

Poster presentation

Alves A, Shaw M, Kenny J, Lye J, Brown R. *Spatial accuracy of SRS cranial treatment in Australian radiotherapy: Results of the ACDS field trial audit*

RANZCR Annual Scientific Meeting
16–19 September 2021 Melbourne
Williams, I. *Demonstrating the clinical impact of auditing update from the Australian Clinical Dosimetry Service*

IAEA Meeting of Dosimetry Audit Network (DAN)
9–13 August 2021 Vienna (and virtual)
Brown, R. *ACDS: Organisational structure and audit program overview*

ACDS audits continue to be endorsed as a CPD activity by ASMIRT. CPD credits are claimable for both planning and treatment radiation therapists for both Level II and Level III audits.

ACDS audits are endorsed by the ACPSEM as a CPD activity. This falls under category 3 'Measuring outcomes' activity B 'Clinical Audits'. Audit participation certificates have been issued to medical physicists for audits performed since 1 January 2022.

Stakeholder feedback is essential to the cycle of ACDS audit development and review. It ensures that audits continue to meet the needs of radiation therapy departments and contribute to the safety of treatment planning and delivery. The ACDS continues to actively seek feedback on both their products and service delivery.

Our post-audit feedback surveys have been redeveloped so that information is collected relative to specific professional clinical groups. This allows us to tailor our changes in practice and ensure that we provide a service reflecting the needs of our consumers. Surveys have been constructed to be as time sensitive as possible.

All feedback is seen as an Opportunity for Improvement (OFI) and all OFIs are discussed quarterly at ARPANSA quality meetings or sooner when necessary. As well as informal feedback and post-audit surveys, the formal review process, developed in consultation with the CAG, is accessible via the ARPANSA website.

If a formal review is required, the facility representative is encouraged to discuss any issues or concerns with the director of the ACDS or the Chief Medical Radiation Scientist in the first instance, with the aim of a resolution via email: acds@arpansa.gov.au or phone: +61 3 9433 2220.

Alternatively, or in addition to this, there is the opportunity to either:

- request a further audit review
- dispute a review response by CAG
- provide feedback or a complaint.

Visit the feedback and review webform on our website at arpansa.gov.au/acds-feedback.

Australian Clinical Dosimetry Service

Australian Radiation Protection and Nuclear Safety Agency

619 Lower Plenty Road, Yallambie VIC 3085 AUSTRALIA
+61 3 9433 2211
acds@arpansa.gov.au
arpansa.gov.au/acds