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DNA-Dependent Protein Kinase Inhibitors as Radiosensitisers of [^{177}Lu]Lu-DOTATATE Treatment for Neuroendocrine Tumours

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BACKGROUND: [^{177}Lu]Lu-DOTATATE is a peptide receptor radionuclide therapy (PRRT) used for somatostatin receptor (SSTR2)-expressing gastroenteropancreatic neuroendocrine tumours (GEP-NETs). Aotearoa New Zealand has recently developed a nationally co-ordinated, publicly funded PRRT service for SSTR2+ve neuroendocrine tumours. Despite impressive increases in progression-free survival outcomes compared to high-dose octreotide in recent trials, there remains a need to improve patient survival, especially in advanced well-differentiated GEP-NETs. Radiation kills cancer cells by generating DNA double-strand breaks (DSBs), and DNA-dependent protein kinase (DNA-PK) plays an essential role in repair of these DSBs. We have developed a novel, selective and potent DNA-PK inhibitor, DDRx-124. There is a clear opportunity for DDRx-124 to sensitise [^{177}Lu]Lu-DOTATATE β-radiation to increase treatment efficacy.

METHODS: DNA-PK inhibitors were evaluated as radiosensitisers of γ- and X-ray radiation against a human tumour-cell line panel using a clonogenic survival endpoint. Lead compounds were evaluated in mice for tolerability, pharmacokinetic profile and radiosensitisation of human tumour xenografts using an *ex vivo* clonogenic survival assay. Sensitisation of H1299-7 cells expressing SSTR2 treated with [^{177}Lu]Lu-DOTATATE was evaluated in a growth inhibition study.

RESULTS: DDRx-124 demonstrated effective radiosensitisation in a panel of human and mouse cancer-cell lines. When administered orally at a range of non-toxic doses, DDRx-124 provided significant additional tumour-cell killing of various tumour xenografts in combination with a single (13 Gy) radiation treatment. DDRx-124 potentiated tumour-cell growth inhibition by [^{177}Lu]Lu-DOTATATE *in vitro*.

CONCLUSION: DDRx-124 is a potent, selective inhibitor of DNA-PK and is an effective radiosensitiser of human tumour-cells *in vitro* and *in vivo* in conjunction with γ- and X-ray radiotherapy. Preliminary results show that DDRx-124 is also a potent sensitiser of [^{177}Lu]Lu-DOTATATE treatment *in vitro*. We continue to develop preclinical data to identify the opportunity to combine DDRx-124 with PRRT in patients with GEP-NETs and to advance the compound to clinical studies.

Synergistic Role of ^{99m}Tc-Sestamibi and ^{99m}Tc-Sulfur Colloid Imaging in Breast Cancer Evaluation

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Background: Breast imaging is complex and still evolving. Preventive programmes are seeking more effective ways of detecting more cancers in the earlier stages. For staging purposes, a multimodality approach using a combination of multiple imaging methods is necessary for proper planning of the patient's subsequent management (1).

Methods: This study evaluates the combined role of scintimammography using technetium-99m methoxyisobutylisonitrile (^{99m}Tc-MIBI) and sentinel lymph node scintigraphy using technetium-99m sulfur colloid (^{99m}Tc-SC) in patients with breast cancer.

Discussion: Scintimammography with ^{99m}Tc-MIBI provides functional imaging based on tumor metabolic activity and mitochondrial uptake, enabling detection of primary breast lesions, particularly in dense breast tissue and inconclusive mammographic findings. Sentinel lymph node (SLN) mapping with ^{99m}Tc-SC allows accurate identification of the first draining lymph node from the primary tumor, facilitating minimally invasive axillary staging and reducing the need for complete axillary lymph node dissection (2). The combined application of these nuclear medicine techniques offers a comprehensive diagnostic approach by simultaneously evaluating the primary tumor and regional lymphatic spread. This integrated strategy improves lesion localisation, enhances staging accuracy and assists in surgical planning. Furthermore, sentinel lymph node scintigraphy significantly decreases postoperative complications such as lymphoedema, pain and shoulder dysfunction associated with extensive nodal dissection (3, 4).

Conclusion: The synergistic use of ^{99m}Tc-MIBI scintimammography and ^{99m}Tc-SC sentinel lymph node imaging demonstrates high sensitivity and specificity in breast cancer evaluation. Combined functional tumour imaging and targeted nodal assessment may contribute to earlier diagnosis, individualised management and improved patient outcomes. Further large-scale prospective studies are recommended to validate the clinical utility and cost effectiveness of this combined imaging approach in routine breast cancer care.

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Estimation of Neck Uptake in Carcinoma Thyroid Patients Using Ionisation Chamber-Based Gun Monitor: Comparison with Gold Standard Thyroid Uptake Probe

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Background: Oral administration of ^{131}I has been used to treat thyroid cancer for many years (1), as a prerequisite for treatment of carcinoma thyroid patients with high-dose iodine therapy (HDIT) after surgery. Successful ablation of residual thyroid tissue has been reported to occur with a single initial ^{131}I administration (1). A nuclear medicine scintigraphy scan is undertaken pre and post administration of HDIT to calculate the percentage thyroid uptake. Neck uptake is performed using a thyroid probe, which is considered as the gold-standard method after 24 hours in pre-therapy patients and after 48 hours in first follow-up post-therapy patients. Alternatively, percentage uptake of iodine by the residual tissue in the neck can be approximately estimated by a gun monitor. Measurement of the neck surface reading can also be used as indirect method in the estimation of percentage neck uptake. However, not much literature is available on this technique. Thus, a prospective study was undertaken in the Department of Nuclear Medicine, GGSMCH, Faridkot, to calculate percentage neck uptake in carcinoma thyroid patients using an ionisation chamber-based gun monitor and comparing it with the percentage uptake calculated using a thyroid probe.

Materials and Methods: Study population: Carcinoma thyroid patients post-surgery referred to the Nuclear Medicine Department for HDIT and patients treated with HDIT coming for first follow-up were included in the study. A total of 30 patients were included in this study – 22 were female and eight were male (mean age: 45.1 years; range: 21–80 years). The patients were divided into two groups: Group 1 (nine patients) were pre-therapy patients and were administered 1–2 mCi of ^{131}I; Group 2 (21 patients) were post-therapy patients and were administered 2–3 mCi of ^{131}I. Uptake of ^{131}I in the neck was calculated at 24 hrs in Group 1 and 48 hrs in Group 2 using an uptake probe (make: Capintec; model: Captus 3000) equipped with a Lucite neck phantom, and an ionisation-based gun monitor (make: Ram Ion; model: BAK-1940).

Method for uptake probe calculation: A thyroid uptake probe with a flat-field collimator, the associated electronics and single-channel analyser was used to take neck counts. A ^{131}I sodium iodide

dose was used for calculation of the radioactive iodine uptake. A pre-administered ^{131}I dose was placed in the Lucite neck phantom and counts were taken by the detector placed at a standardised distance of 25 cm in both pre- and post-therapy patients. These counts were taken for 60 seconds. After administration of the dose to patients, uptake was calculated at respective times. During calculation of uptake, the patient's thigh was also counted for background correction. To calculate the percentage uptake, counts were obtained from neck and thigh, as per the given formula:

$$\text{Percentage neck uptake} = \frac{\text{neck count (cpm)} - \text{patient background count (cpm)}}{\text{Administered count (cpm)} - \text{background count}} \times 100$$

Method for ionisation chamber-based gun monitor: Survey meters are used to monitor the radiation exposure level in many nuclear medicine departments, nuclear power plants, laboratory radiology and other industrial settings. The RAM ION is a battery-operated, auto-ranging, portable ionisation chamber survey meter designed for stability and measurement of dose rates and integrated doses of gamma, x-ray and beta radiation. The meter covers a measuring range of 1 uSv/hr to 500 uSv/hr (0.1 mR/h to 50 R/h) in the dose-rate mode, and 0.01 uSv to 10 Sv (1uR to 999R) in the integrated-dose mode.

$$\text{Percentage neck uptake} = 0.2 \times \text{exposure rate (uSv/hr)} / \text{activity administered (mCi)}$$

Results: Pearson correlation coefficient (r) was calculated between neck uptake done by thyroid probe and ionisation chamber-based gun monitor in both Group 1 and Group 2 patients. The r values were 0.86 and 0.76 for Group 1 and Group 2 patients respectively. Thus, there is a strong positive correlation between the thyroid uptake probe and the gun monitor for the estimation of percentage neck uptake in thyroid carcinoma patients.

Conclusion: An ionisation chamber-based gun monitor can be used for percentage neck uptake estimation in the event of a non-functioning thyroid probe.

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Optimising Shielding and Workflow to Minimise Radiation Exposure in PET/CT Staff

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Background: Increasing use of ^{18}F-FDG PET/CT has raised occupational radiation exposure among nuclear medicine professionals, particularly during radiotracer dispensing and injection. This study evaluated the effectiveness of shielding modifications and optimised workflow in reducing occupational radiation exposure in a PET/CT facility.

Methods: In this prospective observational study, 141 ambulatory adult patients (67 men, 74 women) undergoing whole-body ^{18}F-FDG PET/CT were included. Radiation exposure during dispensing and injection was measured using a Geiger–Muller survey meter positioned 5 cm from the operator's right hand. Exposure rates were compared during dispensing with and without a tungsten syringe shield, and during injection performed near the patient versus through a shielded injection window. Personal dosimeters were additionally used for occupational monitoring.

Results: Administered activity ranged from 7.2–11.3 mCi (mean, 9.09 mCi). During dispensing, the mean radiation exposure rate without syringe shielding was 442.7 µSv/h (range, 248–602 µSv/h), which decreased to 65.9 µSv/h (range, 41.6–93.3 µSv/h) with tungsten syringe shielding, representing an approximately 67% reduction. During radiotracer administration, the mean exposure rate near the patient was 289.12 µSv/h, whereas administration through the shielded injection window reduced exposure to 22.7 µSv/h (range, 4.8–40.6 µSv/h), corresponding to an approximately 62.1% reduction.

Conclusion: Tungsten syringe shielding, shielded injection-window workflow and optimised patient handling significantly reduced occupational radiation exposure during ^{18}F-FDG PET/CT procedures. Integration of engineering controls with ALARA-based radiation safety practices can effectively minimise occupational radiation dose in nuclear medicine professionals.

Innovative Shielding Techniques: A Review Study to Enhance Safety for Radiation Workers in Diagnostic and Therapeutic Environments

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Background: Lead has traditionally been used as a form of radiation protection due to its high atomic number, high effectiveness in attenuating radiation and a high known density. However, it has since been noted that there are several setbacks in using it as a primary form of shielding, such as heavy weight, musculoskeletal strain, and also rigidity and poor flexibility.

Methods: A systematic review study was conducted and data was taken from several databases, such as Google Scholar, PubMed, Scopus and Web of Science. Data was taken based on several predefined inclusion and exclusion criteria.

Results: Recent research has highlighted the advanced composites, the use of more than one metal with a high atomic number and density, which will then be highly effective in attenuating radiation; nano-materials and polymeric materials as ionising radiation shields; and lead-free materials for radiation shielding. Furthermore, researchers have also covered RIS panels, which guarantee privacy and environmental isolation.

Conclusion: The work highlighted the various materials that can be used for radiation shielding. These materials not only offer good shielding properties, but are also compatible with others, flexible, and can easily be incorporated with others through the use of advanced technology. Most importantly of all, they are less or non-toxic, hence ensuring safety to users over time.

Beyond the Image: The Leadership Challenges of New Technology Implementation

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Background: The utilisation of new technology in medical imaging offers significant opportunities for improved clinical outcomes and operational efficiency. Realising these depends on leadership decisions around implementation, as well as the functionality of the technology. The role of clinical leaders in supporting staff through technological transitions remains an underexplored area in the medical imaging literature.

Methods: The qualitative component of a sequential exploratory mixed-methods study informs this presentation. Semi-structured interviews were conducted with medical imaging technologists who had experienced the transition from film-screen to computed radiography and/or flat-panel digital radiography systems in Aotearoa New Zealand. Interpretive description was used as the methodology because of its suitability for investigating complex clinical-practice issues.

Results: Participants identified a range of leadership-related challenges that influenced their experience of the transition. Its significance was underestimated, which influenced decisions around implementation timelines, training provision and staff support. Training was predominantly task-driven, creating a theory–practice gap with consequences for clinical decision-making and patient-centred care. Budget constraints, shift work and reliance on cascade training were identified as factors that limited effective knowledge transfer. The absence of structured change-management emerged as a significant factor, with participants further reflecting that better training and ongoing support would have been beneficial.

Conclusion: These findings offer important insights for leaders when introducing new technology in medical imaging and nuclear medicine settings. Interpreted through a change-management lens, they highlight that the quality of implementation is as important as the technology itself. For healthcare leaders in Aotearoa, navigating workforce pressures, budget constraints and ongoing system reform, these insights provide a practical and evidence-based foundation to support future implementation of new technology.

Combining Imaging Biomarkers with Therapy Response in Theranostic Protocols

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Background: Theranostics has changed the landscape of personalised oncology with targeted molecular pairs such as ^{68}Ga-PSMA-11/^{177}Lu-PSMA-617 and ^{68}Ga-DOTATATE/^{177}Lu-DOTATATE. Standardised integration of quantitative imaging biomarkers for monitoring therapy response has shown clinical efficacy in landmark trials, but remains inconsistent across centres. Recent evidence underscores the relevance of PET-derived metrics for outcome prediction and treatment optimisation cycles in theranostic protocols.

Method: A review of literature published from 2020 to 2025 was carried out using PubMed and Google Scholar. We included studies of quantitative PET imaging biomarkers such as SUVmax, tumour to-background ratio, total lesion activity, metabolic tumour volume and lesion heterogeneity indices in patients undergoing ^{177}Lu-PSMA or ^{177}Lu-DOTATATE therapy. Therapy response was assessed by PERCIST 1.0 criteria and correlated with progression-free survival and overall survival outcomes.

Results: Baseline SUVmax and TBR were found to be significant predictors of complete metabolic response in several studies. Absorbed-dose metrics showed important associations with clinical benefit in Lu-177 PSMA studies. Lesion heterogeneity on PSMA PET prior to therapy was an independent predictor of poor response to Lu-177 therapy (1). Radiomics-based biomarkers further improved response prediction beyond conventional SUV metrics (2).

Conclusion: Recent evidence strongly supports the integration of quantitative PET imaging biomarkers into theranostic protocols for improved assessment of therapy response. Standardisation across institutions of SUVmax, TBR, TLA and radiomics parameters could improve patient selection and cycle optimisation, towards genuinely individualised theranostic medicine.

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Excel-Based Computations for Safety Assessment Report, a Recent Requirement in eLORA

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Background: According to a circular in the Atomic Energy Radiation Board's Electronic Licensing of Radiation Applications (e-LORA), released in May 2025, all nuclear medicine institutions need to submit the Safety Assessment Report (SAR) and Radiation Protection Plan (RPP) at the time of obtaining a licence or renewal of licence to operate the equipment.

Aim: To develop a user-friendly, Microsoft Excel-based computational tool that automates the dose assessment in normal working conditions. This dose assessment is required to ensure that the total dose likely to be received by staff from all the routine nuclear medicine procedures is below the permissible limit of 400 µSv per week.

Materials and Methods: Dose rates have been measured wherever possible by using a survey meter with valid calibration. In situations where dose rates are not available, theoretical values were computed with following parameters: gamma ray constant in mSv/hr/MBq, half-value thickness in mm, activity in MBq and distance in metres. The maximum dose receivable is calculated in the Excel sheet by multiplying gamma ray constant, activity, attenuation correction factor and the distance correction factor. This calculation has been done for all procedures and radionuclides in the normal working conditions, such as preparation of radiopharmaceuticals, dispensing, dose administration, patient positioning, imaging and therapy. The total weekly dose received is computed. Adding the dose received in the last column of the Excel sheet gives the maximum dose receivable in one week.

Results: The maximum dose calculated from the Excel sheet for all the routine procedures in our hospital was 260.68389 µSv per week, which is far below the acceptable limit.

Conclusion: The computation of dose assessment is made easier by using an Excel sheet, which can be used directly in the preparation of the SAR and RPP that needs to be uploaded in eLORA while applying for a licence or renewal of licence to operate.

Triphosgene-Free Solid-Phase Synthesis of Urea-Containing PSMA-Targeting Radiotheranostic Peptides: A Comparative Study

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Background: Prostate-specific membrane antigen (PSMA) is a validated target for prostate cancer (PC). Most clinically relevant radiotheranostics for PC rely on a lysine-urea-glutamate (KuE) motif for high-affinity binding to PSMA. Syntheses of these peptide-based ligands often rely on hypertoxic triphosgene to construct the asymmetric urea pharmacophore, limiting safety and scalability. Furthermore, a hybrid method of solution- and solid-phase peptide synthesis is commonly used to separately construct urea and linker components of such radioligands, requiring late-stage conjugation and several chromatographic purifications.

Methods: Fmoc-SPPS was used to optimise the synthesis of the KuE pharmacophore on resin, adjusting several variables; most importantly, carbonylation reagents alternative to triphosgene. Three carbonylation reagents, 4-nitrophenyl chloroformate (NPC), N,N′-disuccinimidyl carbonate (DSC) and 1,1′-carbonyldiimidazole (CDI), were compared for urea construction. Optimised methods were validated by synthesising the FDA-approved PSMA-617, PSMA-I&T, and four additional PSMA-targeting analogues on resin.

Results: Of the reagents examined, CDI emerged as a particularly effective and benign choice, enabling near-quantitative urea formation with excellent reproducibility under mild, SPPS-compatible conditions. Under optimised conditions, using TentaGel® resin equipped with HMPB-linker, PSMA-617 was synthesised in >80% crude purity, PSMA-I&T in >75% crude purity, and four additional analogues all in >80% crude purity. PSMA-617 was then radiolabelled with ^{68}Ga in >99% radiochemical purity, thus confirming its chemical integrity.

Conclusion: In this systematic comparative study, CDI prevailed as the optimal carbonylation reagent for construction of the KuE motif, replacing triphosgene. We have demonstrated that Fmoc-SPPS is practical for the full synthesis of PSMA-targeting ligands in a rapid, efficient manner. Furthermore, we found that TentaGel® resin equipped with HMPB linker is higher yielding than the commonly employed 2-chlorotrityl chloride resin.

Structural, Workforce and Health System Barriers to Equitable Cancer Care for Māori and Pasifika Patients in Aotearoa New Zealand: A Research Proposal – The Role of Healthcare Students in Addressing Health Inequities and Contributing to Meaningful Change

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Context and Background: Evidence from media reports and academic research highlights persistent systemic inequities affecting Māori and Pasifika access to cancer care in Aotearoa New Zealand (1, 2, 3). These populations experience delayed diagnoses, reduced access to services and poorer health outcomes (4). Structural barriers include financial constraints, inequitable access to screening, and culturally unsafe care. Experiences of ineffective communication contribute to mistrust, delayed help-seeking and reduced engagement with treatment. Addressing these inequities requires workforce development, culturally safe practice and health system reform grounded in te Tiriti o Waitangi. The Nursing Council of New Zealand emphasises cultural safety, health equity and partnership with Māori as foundational principles for nursing education and practice (5).

Rationale: Māori and Pasifika patients may be reluctant to engage with healthcare services due to experiences of racism, poor communication and feeling dismissed (2, 3). These experiences foster mistrust, delay help-seeking, reduce engagement and lower adherence to follow-up care, reflecting systemic inequities rather than individual deficits (2, 3). Despite growing literature on cancer inequities, there is limited research exploring how nursing students can contribute to addressing these challenges in future practice.

Conclusion: This research proposes a qualitative interpretive description study exploring the role of nursing students in identifying strategies to reduce inequities and improve culturally safe cancer care for Māori and Pasifika communities. The study aims to generate insights into how future nurses can contribute to health equity and meaningful system change.

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Navigating the Hurdles of ^{68}Ga Radiopharmacy

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Background: ^{68}Ga has emerged as a cornerstone of modern PET imaging, offering the allure of 'in-house' isotope production and versatile labelling. However, for the PET technologist, this clinical breakthrough introduces a complex set of operational headaches. Due to the high cost and scarcity of ^{68}Ge/^{68}Ga generators, the journey from isotope to injectable dose is fraught with logistical and physical obstacles.

Methods: The practical realities of managing ^{68}Ga in a clinical setting have been evaluated. The impact of its brief 68-minute half-life and the rigorous chemical processing was analysed specifically in the use of dilute HCl eluents, pH buffering, and specialised filtration to strip away metallic impurities. When both [^{18}F]FDG and ^{68}Ga cases are appointed for dose administration, misadministration has been prevented by vigilant patient segregation and optimum time-management. Performance of rapid quality control (QC) for new ^{68}Ga radiopharmaceuticals, or whenever in doubt, has to be made. Proper training by dummy runs and supervision of the radioactive procedures by the senior technical staff on the new technical hands have been implemented to reduce the radiation burden and maintain a high quality of work.

Results: The findings highlight a significant 'efficiency tax' on radio pharmacy operations. The necessity of removing metallic contaminants by filtration often results in lower-than-ideal yields. Furthermore, the high-energy positron emission of ^{68}Ga increases the radiation burden on staff, requiring meticulous handling.

Conclusion: While ^{68}Ga is a precious diagnostic tool, its successful application demands more than just equipment – it requires a strategic overhaul of lab protocols. By optimising filtration steps and strictly segregating ^{68}Ga from ^{18}F workflows, facilities can mitigate exposure and maximise isotope utility. Overcoming these challenges is essential so that this powerful tracer remains accessible for patient care without compromising staff safety or diagnostic precision.

Prospective Role of ^{68}Ga- and ^{177}Lu-cyclic Pentapeptides Theranostic Molecules in Patients with Adrenocortical Carcinomas

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Background: Precision medicine plays a crucial role in patient management. Theranostics is one such precision-medicine approach combining diagnostics and targeted therapy into one, used to treat deadly diseases such as cancers. The specific use of these radiopharmaceuticals has been highlighted in our study.

Methods: In-house synthesis of radiolabelled ^{68}Ga- and ^{177}Lu-cyclic pentapeptides. Quality-control checks of ^{68}Ga- and ^{177}Lu-cyclic pentapeptides such as radionuclide purity, radiochemical purity, sterility and pyrogenicity were carried out. Diagnostic efficacy of ^{68}Ga-cyclic pentapeptide was studied in patients with adrenocortical carcinoma showing CXCR4 receptor over-expression. The therapeutic use of ^{177}Lu-cyclic pentapeptide was explored initially in the set of same patients.

Results: Radionuclide and radiochemical purity of the in-house synthesised radiopharmaceuticals was found to be more than 99%. The radiopharmaceutical preparations were sterile and pyrogen-free. High diagnostic efficacy of ^{68}Ga-cyclic pentapeptide molecule (CXCR4 receptor antagonist) was noted in the patients with adrenocortical carcinoma. Based on the preliminary outcomes of the study, the use of ^{177}Lu-cyclic pentapeptide as a therapeutic option is feasible.

Conclusion: Radiolabelled ^{68}Ga- and ^{177}Lu-cyclic pentapeptides have shown a potential role as theranostic molecules in patients with adrenocortical carcinomas.

Not That Kind of Pet: A Picture Book to Explain PET Scans to Children

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Background: When children and their parents or caregivers are told that a positron emission tomography (PET) scan is required, the term is often misunderstood – commonly associated with animals rather than nuclear medicine. Additionally, introducing the concept of radiation can provoke anxiety. Despite the need for child-friendly explanations, there is currently a lack of dedicated picture-book resources to support pediatric patients undergoing PET scans.

Methods: A picture book was developed to educate pediatric patients aged 3–12 years about PET scans in an age-appropriate and engaging manner. The book was written by two nuclear medicine technologists and illustrated by a childhood cancer survivor who is also a parent, contributing valuable insight grounded in lived patient experience. It is designed to guide children through the PET scan procedure using simple language and visual storytelling to provide an educational distraction tool to aid technologists and caregivers. The book forms part of a broader series, Raju's nuclear medicine books, and follows a similar theme to Raju's nuclear medicine colouring book.

Results: Preliminary feedback from healthcare professionals indicates that the book will be a valuable resource to improve children's understanding of the procedure and help reduce anxiety prior to imaging. The book is still in the final drafting stage, with plans to launch on Amazon.

Conclusion: This picture book represents a novel educational tool that may enhance pediatric patient preparation for PET scans. By improving understanding and reducing anxiety, it has the potential to support a more positive imaging experience for both children and their caregivers.

Radium-223 Dichloride in Targeted Alpha Therapy: Mechanisms, Clinical Efficacy and Future Directions in Prostate Cancer Management

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Context/Background: Targeted alpha therapy (TAT) offers high linear energy transfer for potent cancer-cell cytotoxicity while sparing surrounding healthy tissue, overcoming key limitations of beta-emitting radionuclides. ^{223}Ra-dichloride is a bone-targeting alpha emitter approved for metastatic castration-resistant prostate cancer, yet questions remain regarding its efficacy in skeletal metastases and optimisation of combination regimens. This review evaluates radium-223's therapeutic potential and identifies research priorities for expanded TAT applications.

Methods: We conducted a systematic review of preclinical and clinical studies published between 2010 and 2025 from PubMed, Scopus and clinicaltrials.gov, focusing on ^{223}Ra dosimetry, biodistribution and outcomes from Phase III trials. Data synthesis included meta-analysis of survival endpoints and toxicity profiles, alongside microdosimetry findings.

Results: Radium-223 significantly prolongs overall survival in mCRPC patients with symptomatic bone metastases (hazard ratio 0.70, $p<0.001$), with low-grade 3–4 hematologic toxicity (anemia in 16%) due to its short tissue range (50–100 µm). Homologous uptake via calcium-mimetic properties enables TAT-like targeting without chelators, though extraskeletal efficacy remains limited (response rates <20% in visceral disease).

Conclusions: ^{223}Ra-dichloride exemplifies TAT's clinical success in bone-dominant cancers. Future trials should prioritise conjugation strategies and dosimetry personalisation to broaden its utility beyond skeletal metastases, ultimately improving outcomes in advanced prostate cancer.

A Review of Cross-Talk Artifact Reduction Strategies in Simultaneous Dual-Tracer Nuclear Medicine Imaging

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Background: Using two radioactive tracers in either PET or SPECT allows mapping multiple biopathways, tumour metabolism and hypoxic conditions in tissues all in one session. Factors such as cross-talk artefacts reduce efficiency of this dual-tracer cocktail use, whereby high-energy down-scatter photons leak into the lower energy window, causing blurring in the images produced, hence the quality of images is degraded.

Objective: In this research we aim to systematically evaluate, categorise and compare the efficiency that current software and hardware offer when it comes to methods for removing cross-talk artefacts while using dual tracers for imaging.

Methods: We will employ the use of databases such as PubMed, Google Scholar and ScienceDirect to go through peer-reviewed studies from the past five years. We will also be looking at different isotope combinations, the types of corrections that were used, and also include quantitative measures of image quality.

Expected Results: Reconstruction using deep learning and machine learning is expected to perform better than traditional methods such as collimator-based imaging and energy window. This is based on how clear the images produced are and how well they reduce artefacts. We expect that the methods above are capable of improving the quality of the images without needing expensive hardware changes such as replacing collimators or adjusting the settings of the energy.

Conclusion: By taking already available data and organising it, this review will be able to outline the current technologies, identify the gaps available in the current methods of computing, and offer practical ways to choose the best dual-tracer imaging protocols based on evidence.

Periodic Quality Audits in Nuclear Medicine: Ensuring Safety, Compliance and Excellence

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Background and Aims: The actual level of performance of nuclear medicine services can only be accurately determined if internal and external audits are conducted to cover the management, operating and safety procedures, facilities, equipment and human resources, and their effects on clinical practice. This study is set up to encourage regular periodic audits in the clinical environment.

Materials and Methods: The authors used a questionnaire to gather data. The survey consisted of checklists of various quality indicators, categorised into three main sets. 1. Patient Satisfaction Index was calculated via feedback forms on their diagnostic and therapeutic procedure experiences. 2. Employee safety and satisfaction were gauged by different parameters: (a) the extent to which the employees adhere to hand hygiene rules, (b) compliance with radiation safety procedures, (c) degree of their adherence to safe injection practices, (d) percentage of employees who are familiar with their duties and benefits, and (e) the number of staff who have had their vaccinations before potential exposure. 3. Finally, quality of work services was determined with these measures: (a) duration of a patient's waiting time from arrival until the initiation of the test, (b) accuracy of reports in reflecting diagnosis, (c) the frequency of the repeated procedures, (d) incidence of errors in reporting, and (e) total downtime of equipment.

Observations: The nuclear medicine department's Patient Satisfaction Index was 94% – an excellent score, per periodic audits carried out. The department is continuing with proper hand hygiene measures and compliance with radiation safety procedures. There have only been four needle-stick injuries in the last five years. The recognition level of employee rights and welfare programmes is moderate. Hepatitis B vaccination has been administered to all staff. The average waiting time is less than one hour. 93% of reports corresponded to clinical diagnoses. The re-dose percentage is 3.85%. The main reason for re-dosing is the extravasation of radioactivity. Errors in reporting constitute 2%, due to misprints. Equipment downtime was monitored, and immediate steps were taken.

Conclusion: A culture of continuous auditing through peer review will not only improve the contribution of nuclear medicine to patient care, but also will help the department demonstrate its efficiency, quality, safety and reliability in clinical services delivery.

Targeted Alpha Therapy with Actinium-225 in Hematologic and Solid Malignancies: A Systematic Review of Phase I/II Clinical Trials

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Background: Actinium-225 (^{225}Ac) is an alpha-emitting radionuclide that decays through a series of four high-energy alpha emissions, providing robust tumour-cell destruction with a limited tissue-penetration range. This systematic review assesses the efficacy and safety of ^{225}Ac-labelled targeted therapeutics in five clinical trials involving acute myeloid leukemia (AML), metastatic castration-resistant prostate cancer (mCRPC) and metastatic breast cancer.

Methods: Five studies were chosen and analysed, including two Phase I trials of ^{225}Ac-lintuzumab in AML (1, 2), one Phase I trial of ^{225}Ac-J591 in mCRPC (3), one lesion-level imaging substudy of ^{225}Ac-J591 (4), and one Phase 2 imaging trial using treatment of ^{225}Ac-Dotatate in ER+ breast cancer (5). Risk of bias was evaluated using appropriate tools (MINORS criteria and narrative assessment). Certainty of evidence was evaluated using GRADE.

Results: In AML studies, ^{225}Ac-lintuzumab decreased blasts but needed CLAG-M chemotherapy for significant remission and measurable residual disease (MRD) negativity rates. In mCRPC, ^{225}Ac-J591 produced prostate-specific antigen (PSA) responses and a median overall survival of 10.7 months. Treatment also showed a favourable response towards osseous, nodal and visceral lesions, with a significant decline ($p<0.05$) in the absolute SUVpeak value at each site with initial positive results in 30 breast cancer patients. Myelosuppression (neutropenia, sepsis deaths) was the dose-limiting toxicity. ^{225}Ac-Dotatate therapy showed early potential in breast cancer. Overall, ^{225}Ac safety profile is manageable, with a mixed picture of both haematological and non-haematological side effects, and limited nephrotoxicity and hepatotoxicity.

Conclusion: Targeted alpha therapy with ^{225}Ac shows promising antileukemic and antitumor activity in high-risk, treatment-resistant populations, especially when combined with chemotherapy in AML and as a single agent in mCRPC. Further work on preliminary evidence in SSTR2-expressing breast cancer is indicated. Myelosuppression remains dose-limiting, but non-hematologic safety profiles are acceptable. Future efforts should focus on optimising fractionated dosing, combination strategies, and extending to other solid tumours.

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Teaching Pharmacology to Nursing Students Caring for Cancer Patients – Effective Strategies

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Background: Preparing nursing students to care for patients with cancer requires a strong emphasis on medication safety, applied pharmacology and the management of immunocompromised individuals. Oncology nursing practice requires knowledge of cancer treatments, symptom management and the safe administration of high-risk medications. Nursing care of people with cancer involves pain management, management of treatment-related side effects, infection prevention and patient education (1). Undergraduate nursing students at Unitec represent a culturally and academically diverse cohort, including Māori, Pacific, international, school-leaver and mature learners. This diversity requires inclusive and practice-focused teaching approaches that support a range of learning needs while promoting safe clinical practice.

Methods: A variety of teaching strategies are used to facilitate learning in oncology pharmacology. The curriculum focuses on analgesics for cancer-related pain, antimicrobials for infection prevention and treatment, and antiemetics for chemotherapy- and radiotherapy-induced nausea and vomiting. Simulation, case-based learning, role play, videos and quizzes are used to integrate theoretical knowledge with clinical practice and strengthen clinical reasoning skills. A new pharmacology resource booklet was developed for students.

Results: Students develop knowledge and skills in medication safety, pharmacokinetics, adverse effects, drug interactions and the safe handling of cytotoxic medications. Particular emphasis is placed on recognising treatment-induced neutropenia, interpreting laboratory findings and implementing timely interventions to prevent complications. Active learning strategies increase engagement and support readiness for evidence-based oncology nursing practice.

Conclusion: Simulation and case-based learning provide effective approaches for teaching oncology pharmacology. These strategies support the development of clinical reasoning, medication-management skills and confidence in caring for patients with cancer. Future work will evaluate the effectiveness of a pharmacology resource booklet designed to support student learning during clinical placements.

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The Role of Radiogenomics in Precision Radiopharmaceutical Therapy

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Background: The integration of genomics into radiobiology is gradually transforming the practice of nuclear medicine, especially in the context of targeted radioligand therapies such as Lutetium-177 PSMA (Lu-177 PSMA). This publication aims to report current scientific evidence on the nexus of radiogenomics, radiopharmacogenomics, and Lu-177 PSMA therapy. It also aims to highlight the potential, if any, of genomic biomarkers to personalise treatment for metastatic castration-resistant prostate cancer (mCRPC).

Methods: The general body of scientific research and case-study reports involving genomic markers, pharmacokinetics and Lu-177 PSMA, published in the last 20 years, was reviewed.

Results: There is solid evidence that genetic peculiarities, in fact, impact the effectiveness of Lu-177 PSMA radioligand therapy. Deletions, amplifications and mutations of certain genes have been reported to show correlation with resistance to Lu-177 PSMA therapy. It was also found that genetic profiling tools such as circulating tumour DNA (ctDNA) and copy number variation (CNV) have emerged for use in profiling candidates for Lu-177 PSMA therapy based on the likelihood of effective treatment, as tailored care continues to deepen in the fast-evolving field of theranostics. A third finding from the reviewed studies is that linking certain imaging phenotypes with underlying genetic profiles has enabled voxel-level prediction of radiosensitivity. Combining this with radiopharmaceutical kinetics has given rise to radiopharmacogenomics – yet another framework for precision radiopharmaceutical therapy. The studies reviewed also highlight several challenges to the adoption of this approach. Some of them include the limitations of current biomarker validation, the availability of genomics expertise, and integrating highly technical data into routine clinical workflows.

Conclusion: The body of evidence reviewed reveals that the convergence of genomics and radiobiology, despite current challenges, has the potential to transform the practice of Lu-177 PSMA therapy from a one size-fits-all approach to one of a truly personalised treatment modality.

Approaching Five Decades in Nuclear Medicine: From Gamma Cameras to Theranostics

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Background: Since commencing my career as a nuclear medicine technologist (NMT) in 1975, I have witnessed and participated in the remarkable evolution of nuclear medicine, from the era of rectilinear scanners to the modern landscape of molecular imaging and theranostics. This journey spans nearly five decades of technological innovation, clinical advancement and expanding patient care capabilities.

Methods: This presentation provides a personal and professional perspective on the progression of nuclear medicine practice over five decades. It traces the transition from analogue imaging systems and manual workflows of the 1970s and early 1980s to the introduction of digital technologies, hybrid SPECT/CT imaging, and PET/CT systems. The narrative highlights key milestones in the development of nuclear medicine services in Aotearoa New Zealand, including involvement in the establishment of the country's first PET/CT service and, more recently, the development of the first regional Molecular Imaging and Therapy Centre in Hawke's Bay.

Results: The evolution of imaging technology and radiopharmaceutical applications has transformed the scope and impact of nuclear medicine. Throughout this period of rapid advancement, a consistent focus on patient-centred care has remained central to clinical practice. These developments have enabled the delivery of increasingly accurate diagnostic imaging and innovative therapeutic options, ultimately improving patient outcomes and access to specialised services across Aotearoa.

Conclusion: The progression of nuclear medicine over the past five decades reflects a unique combination of technological innovation, clinical excellence and patient-focused care. This journey demonstrates the significant contribution of nuclear medicine technologists to the development and advancement of molecular imaging and theranostics services, while highlighting the importance of adapting to an ever-evolving healthcare environment.

The Importance of Patient Communication in PET/CT

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Context/Background: A conversation between a medical imaging lecturer and a nursing lecturer (myself) at a professional development session at Unitec was about how some oncology patients who had attended for PET had given feedback that they had been spoken to in a negative way by staff. I have many years of experience in the oncology/haematology/SACT space and have offered to create education tailored to the needs of the PET/CT facility, including administrators and imaging technicians. Feedback from the team was gathered on how they greeted, farewelled and engaged in 'small talk' with patients. An education package was designed and delivered to help staff feel more confident in their interactions with patients. In a collaborative effort between Allevia Radiology and Unitec, a research project is underway to obtain formal patient responses and evaluate the effectiveness of the education package, and, if required, plan further education and training.

Methods: The project is currently in the final stages of work on the pre-ethics application.

Results: These will be available when the patient data is available.

Conclusion: The hope is that conclusions will enable an ongoing responsiveness to the needs of patients and staff.

Terbium-161: A Transformative Shift Toward Precision Targeted Radionuclide Therapy

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Context/Background: Traditional theranostic pairings, specifically Lu and Ga, suffer from substantial dosimetric uncertainties ranging between 30% and 50%. This study explores Terbium-161 (^{161}Tb) as a solution to these limitations, focusing on its ability to provide consistent pharmacokinetics and highly accurate patient-specific dosimetry. The goal is to assess this special radionuclide's therapeutic and diagnostic capabilities in relation to current standards.

Methods: Preclinical comparative data and a 2025 first-in-human study of 32 patients treated with [^{161}Tb]Tb-PSMA-617 for metastatic castration-resistant prostate cancer were investigated as part of the review. The review also reviewed the status of 13 ongoing Phase II and Phase III clinical trials investigating Tb across various oncological targets, including PSMA, HER2 and somatostatin receptors.

Results: ^{161}Tb decay releases approximately 12 electrons per disintegration, with a high yield of internal electrons that increase tumor cell lethality by 3–7 times compared to Lu at equivalent absorbed doses. Clinical findings revealed an 88% PSA50 response rate, significantly higher than the 66% observed with Lu, while reducing dosimetric uncertainty to less than 5% without increasing high-grade toxicity.

Conclusion: Based on its superior therapeutic index and diagnostic consistency, ^{161}Tb is expected to take the lead in targeted radionuclide treatment by the early 2030s. The crucial next step for its extensive clinical integration is to address large-scale production and international logistics.

A Resource-Efficient End-to-End Multimodal AI Framework for Automated PET-CT Report Generation and TNM Staging in Breast Cancer

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Background: Positron emission tomography-computed tomography (PET-CT) is integral to breast cancer staging. However, manual volumetric interpretation is time consuming and subject to inter-observer variability. While artificial intelligence has shown promise in tasks such as lesion detection and SUV quantification, existing approaches are fragmented and do not generate complete, TNM-aligned structured reports. End-to-end vision-language models further face limitations in reliably producing quantitative clinical values. Consequently, there remains a need for an integrated AI framework that can translate PET-CT data into accurate and clinically usable structured reports.

Methods: We developed a multimodal report generator (MMRG) trained on 85 breast cancer patients (440 clusters; 59/15/11 train/validation/test). The pipeline integrates three Swin3D-S backbones for tri-planar feature extraction, a LesionEncoderMLP (1,600→512 dim), a TransformerEncoder fusion module (two layers, eight heads), six task-specific heads (5-class organ, binary lesion and descriptor classifiers, 3-class spatial laterality, size regression, and a dedicated SUVmax backbone-magnitude head), and a fine-tuned GPT-2 for narrative generation with FAISS RAG (k = 3, cosine similarity). Numeric fields are injected deterministically to reduce hallucinations.

Results: On the held-out internal test set (n = 11 patients, 62 clusters), the proposed MMRG achieved lesion detection ROC-AUC = 0.829 (95% CI: 0.72-0.91). Quantitative estimation yielded SUVmax MAE = 6.71 (Pearson r = 0.46) and lesion size MAE = 0.65 cm. The threshold portability analysis confirmed that F1 = 0.0 at calibrated thresholds reflects a distributional shift artefact rather than loss of discriminative capability, with Youden-optimised F1 estimated at approximately 0.72-0.78 for both classification heads. Organ hallucination rate on the internal test set was 35.4% at τ = 0.5. The framework generated structured PET-CT reports with automated lesion description and TNM staging, demonstrating the feasibility of end-to-end multimodal AI-assisted PET-CT interpretation within a single computational pipeline.

Conclusion: The proposed MMRG framework demonstrates the feasibility of end-to-end multimodal AI-assisted PET-CT interpretation, combining lesion detection, quantitative measurement, TNM staging, and automated structured report generation within a single computational pipeline. Future work will focus on improving specificity and quantitative regression performance, and validating the framework across larger multi-centre cohorts.