

NEW CURRICULA

Advanced Training in Nuclear Medicine

Curriculum standards



RACP
Specialists. Together

About this document

The new Advanced Training in Nuclear Medicine curriculum consists of curriculum standards and learning, teaching, and assessment (LTA) programs.

This document outlines the curriculum standards for Advanced Training in Nuclear Medicine for trainees and supervisors. The curriculum standards should be used in conjunction with the Advanced Training in Nuclear Medicine [LTA programs](#).

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Program overview

Purpose of Advanced Training

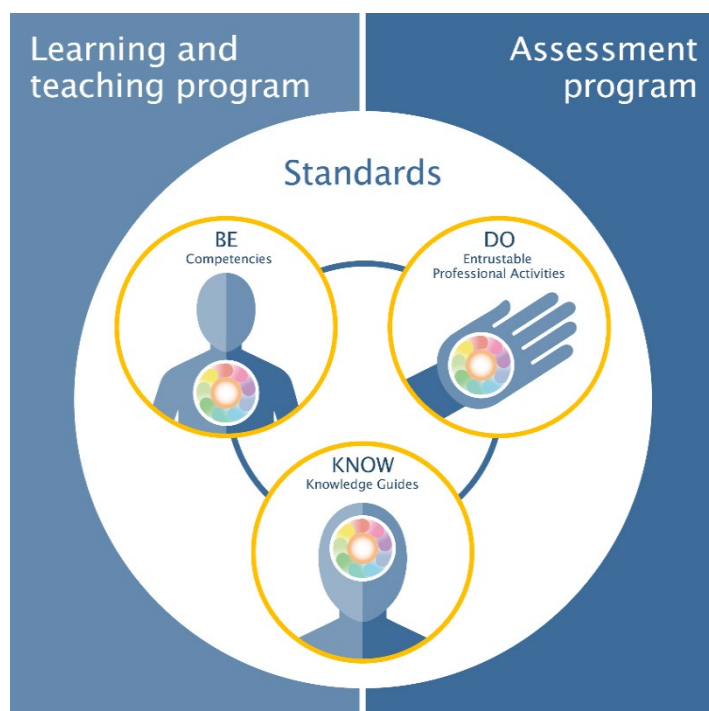
The RACP offers Advanced Training in 33 diverse medical specialties as part of Division, Chapter, or Faculty training programs.

The purpose of Advanced Training is to develop a workforce of physicians who:

- have received breadth and depth of focused specialist training, and experience with a wide variety of health problems and contexts
- are prepared for and committed to independent expert practice, lifelong learning, and continuous improvement
- provide safe, quality health care that meets the needs of the communities of Australia and Aotearoa New Zealand.



RACP curriculum model



The **RACP curriculum model** is made up of curricula standards supported by learning, teaching, and assessment programs.

Learning and teaching programs outline the strategies and methods to learn and teach curricula standards, including required and recommended learning activities.

Assessment programs outline the planned use of assessment methods to provide an overall picture of the trainee's competence over time.

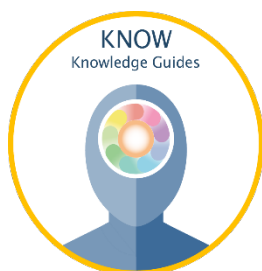
The **curricula standards** outline the educational objectives of the training program and the standard against which trainees' abilities are measured.



Competencies outline the expected professional behaviours, values, and practices of trainees in 10 domains of professional practice.



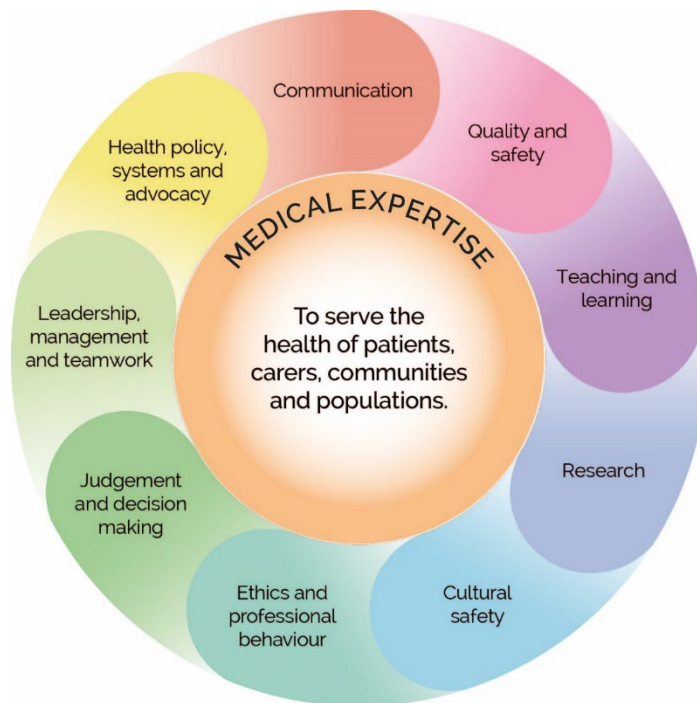
Entrustable Professional Activities (EPAs) outline the essential work tasks trainees need to be able to perform in the workplace.



Knowledge guides outline the expected baseline knowledge of trainees.

Professional Practice Framework

The Professional Practice Framework describes 10 domains of practice for all physicians.



Learning, teaching, and assessment (LTA) structure

The learning, teaching and assessment structure defines the framework for delivery and trainee achievement of the curriculum standards in the Advanced Training program.

Advanced Training is structured in three phases. These phases will establish clear checkpoints for trainee progression and completion.

- | | |
|-----------------------------------|---|
| 1 Specialty foundation | <ul style="list-style-type: none">• Orient trainees and confirm their readiness to progress in the Advanced Training program |
| 2 Specialty consolidation | <ul style="list-style-type: none">• Continue trainees' professional development in the specialty and support progress towards the learning goals |
| 3 Transition to Fellowship | <ul style="list-style-type: none">• Confirm trainees' achievement of the curriculum standards, completion of Advanced Training, and admission to Fellowship• Support trainees' transition to unsupervised practice |



Figure 1: Advanced Training learning, teaching, and assessment structure

- An **entry decision** is made before entry into the program.
- A **progress decision**, based on competence, is made at the end of each phase of training.
- A **completion decision**, based on competence, is made at the end of the training program, resulting in eligibility for admission to Fellowship.



Advanced Training is a **hybrid time- and competency-based training program**. There is a minimum time requirement of full-time equivalent experience, and progression and completion decisions are based on evidence of trainees' competence.

Nuclear Medicine specialty overview

Nuclear medicine specialists have expertise in the study and application of nuclear properties and molecular tracers in prevention, detection, diagnosis, management, and treatment of diseases and disorders.

Nuclear medicine determines the cause of the medical problem based on the function of the organ, tissue, or bone. This is how nuclear medicine differs from anatomically based methods of determining the presence of disease based primarily on structural appearance.

Nuclear medicine specialists address the **health care needs of the community** through:

- **diagnosis, management, and treatment** of serious diseases and disorders.
- **investigation and imaging**, which provides detailed physiological and molecular information to help detect and diagnose the presence and severity of cancers and many other conditions in most organs and tissues in the body (for example the heart, brain, lungs, bones, liver, kidneys, thyroid, and skeleton).
- **non-invasive tools to monitor and predict** responses to therapy, and to help characterise diseases based on their molecular imaging appearances.
- **training to select the most appropriate examination and treatment** for the patient's particular medical problem, thereby avoiding unnecessary cost, inconvenience, and radiation exposure.

Nuclear medicine specialists possess **unique clinical attributes**, such as:

- **broad clinical science knowledge**, including anatomy, chemistry, radiation biology and safety, radiopharmacy, normal physiology and pathophysiology of disease, and nuclear physics.
- **high level skills in the technical processes and routine procedures** undertaken in the specialty, including bone densitometry, PET, planar and SPECT gamma imaging, and radionuclide therapy.
- **clinical judgement skills** that focus on the clinical setting and the pathophysiological processes involved in each case.
- **monitoring quality and adherence** to regulatory standards of radionuclide preparation, administration, and disposal, and advising other clinicians of the clinical assessments, indications, limitations, and risks of diagnostic and therapeutic applications of radioactive materials and molecular ligands.

Nuclear medicine specialists have **distinctive professional skills**, including:

- **research skills** to support ongoing evidence-based practice in the specialty, with well-developed educational skills to support a teaching role in areas related to the specialty, especially with medical students, junior staff, nursing and allied health professionals, and members of the public.

- **high level communication skills**, especially in the explanation and reporting of procedures and studies employed in the specialty, and in the discussion of scientifically complex molecular treatments. Graduates of the program will be able to use these skills with referring doctors, other health professionals, and with patients and their families or carers.
- **quality assurance skills** to enable the implementation and ongoing evaluation of nuclear medicine practice to a high technical and professional standard.
- **organisational skills** to support independent practice in nuclear medicine, as well as contributions to and leadership of hospital teams.
- **working as an integral member of multidisciplinary teams.** Nuclear medicine physicians and specialists work collaboratively with other health professionals to make balanced and objective clinical decisions, and ensure each patient receives the best available treatment and management.

Nuclear Medicine learning goals

The curriculum standards are summarised as 19 learning goals. The learning goals articulate what trainees need to be, do and know, and are assessed throughout training.

BE Competencies	1. Professional behaviours
DO EPAs	2. Leadership in the nuclear medicine department 3. Supervision and teaching 4. Quality improvement 5. Clinical assessment and management, including prescribing radioisotopes 6. Longitudinal care of patients, including those receiving Theranostics and transitions in care 7. Communication 8. Investigations and procedures
KNOW Knowledge guides	9. Scientific basis of nuclear medicine, including radiation safety 10. Cardiovascular nuclear medicine 11. Endocrine nuclear medicine 12. Gastrointestinal nuclear medicine 13. Genitourinary nuclear medicine 14. Musculoskeletal nuclear medicine 15. Neurological nuclear medicine 16. Oncological nuclear medicine 17. Pulmonary nuclear medicine 18. Inflammation and infection 19. Radionuclide therapies / Theranostics

Curriculum standards

Competencies

Competencies outline the expected professional behaviours, values and practices that trainees need to achieve by the end of training.

Competencies are grouped by the 10 domains of the professional practice framework.

Competencies will be common across training programs.

Learning goal 1: Professional behaviours



Medical expertise

Professional standard: Physicians apply knowledge and skills informed by best available current evidence in the delivery of high-quality, safe practice to facilitate agreed health outcomes for individual patients and populations.

Knowledge: Apply knowledge of the scientific basis of health and disease to the diagnosis and management of patients.

Synthesis: Gather relevant data via age- and context- appropriate means to develop reasonable differential diagnoses, recognising and considering interactions and impacts of comorbidities.

Diagnosis and management: Develop diagnostic and management plans that integrate an understanding of individual patient circumstances, including psychosocial factors and specific vulnerabilities, epidemiology, and population health factors in partnership with patients, families, whānau and/or carers¹, and in collaboration with the health care team.

² References to patients in the remainder of this document may include their families, whānau and/or carers.



Communication

Professional standard: Physicians collate information, and share this information clearly, accurately, respectfully, responsibly, empathetically, and in a manner that is understandable.

Physicians share information responsibly with patients, families, carers, colleagues, community groups, the public, and other stakeholders to facilitate optimal health outcomes.

Effective communication: Use a range of effective and appropriate verbal, nonverbal, written and other communication techniques, including active listening.

Communication with patients, families, and carers: Use collaborative, effective, and empathetic communication with patients, families, and carers.

Communication with professionals and professional bodies: Use collaborative, respectful, and empathetic clinical communication with colleagues, other health professionals, professional bodies, and agencies.

Written communication: Document and share information about patients to optimise patient care and safety.

Privacy and confidentiality: Maintain appropriate privacy and confidentiality and share information responsibly.



Quality and safety

Professional standard: Physicians practice in a safe, high-quality manner within the limits of their expertise.

Physicians regularly review and evaluate their own practice alongside peers and best practice standards and conduct continuous improvement activities.

Patient safety: Demonstrate a safety focus and continuous improvement approach to own practice and health systems.

Harm prevention and management: Identify and report risks, adverse events, and errors to improve healthcare systems.

Quality improvement: Participate in quality improvement activities to improve quality of care and safety of the work environment.

Patient engagement: Enable patients to contribute to the safety of their care.



Teaching and learning

Professional standard: Physicians demonstrate a lifelong commitment to excellence in practice through continuous learning and evaluating evidence.

Physicians foster the learning of others in their profession through a commitment to mentoring, supervising, and teaching².

Lifelong learning: Undertake effective self-education and continuing professional development.

Self-evaluation: Evaluate and reflect on gaps in own knowledge and skills to inform self-directed learning.

Supervision: Provide supervision for junior colleagues and/or team members.

Teaching: Apply appropriate educational techniques to facilitate the learning of colleagues and other health professionals.

Patient education: Apply appropriate educational techniques to promote understanding of health and disease amongst patients and populations.



Research

Professional standard: Physicians support creation, dissemination and translation of knowledge and practices applicable to health.³ They do this by engaging with and critically appraising research, and applying it in policy and practice to improve the health outcomes of patients and populations.

Evidence-based practice: Critically analyse relevant literature and refer to evidence-based clinical guidelines and apply these in daily practice.

Research: Apply research methodology to add to the body of medical knowledge and improve practice and health outcomes.

² Adapted from Richardson D, Oswald A, Chan M-K, Lang ES, Harvey BJ. Scholar. In: Frank JR, Snell L, Sherbino J, editors. The Draft CanMEDS 2015 Physician Competency Framework – Series IV. Ottawa: The Royal College of Physicians and Surgeons of Canada; 2015 March.

Cultural safety



Professional standard: Physicians engage in iterative and critical self-reflection of their own cultural identity, power, biases, prejudices, and practising behaviours. Together with the requirement of understanding the cultural rights of the community they serve; this brings awareness and accountability for the impact of the physician's own culture on decision making and health care delivery. It also allows for an adaptive practice where power is shared between patients, family, whānau, and/or community and the physician, to improve health outcomes.

Physicians recognise the patient and population's rights for culturally safe care, including being an ally for patient, family, whānau, and/or community autonomy and agency over their decision making. This shift in the physician's perspective fosters collaborative and engaged therapeutic relationships, allows for strength-based (or mana-enhanced) decisions, and sharing of power with the recipient of the care, optimising health care outcomes.

Physicians critically analyse their environment to understand how colonialism, systemic racism, social determinants of health, and other sources of inequity have and continue to underpin the healthcare context. Consequently, physicians then can recognise their interfacing with, and contribution to, the environment in which they work to advocate for safe, more equitable and decolonised services, and create an inclusive and safe workplace for all colleagues and team members of all cultural backgrounds³

Critical reflection. Engage in iterative and critical self-reflection and demonstrate cultural safety in the context of their own cultural identity, power, biases, prejudices and practising behaviours.

Allyship. Recognise the patient and population's rights to culturally safe care, including being an ally for patient, family, whānau and/or community autonomy and agency over their decision-making.

Inclusive communication. Apply culturally-safe communication, acknowledging the sharing of power, and cultural and human rights to enable patients, families and whānau to engage in appropriate patient care decisions.

Culturally safe environment. Contribute to a culturally safe learning and practice environment for patients and team members. Respect patients may feel unsafe in the healthcare environment.

³ The RACP has adopted the Medical Council of New Zealand's definition of cultural safety (below): Cultural safety can be defined as:

- the need for doctors to examine themselves and the potential impact of their own culture on clinical interactions and healthcare service delivery
- the commitment by individual doctors to acknowledge and address any of their own biases, attitudes, assumptions, stereotypes, prejudices, structures, and characteristics that may affect the quality of care provided
- the awareness that cultural safety encompasses a critical consciousness where health professionals and health care organisations engage in ongoing self-reflection and self-awareness, and hold themselves accountable for providing culturally safe care, as defined by the patient and their communities.

Curtis et al. "Why cultural safety rather than cultural competency is required to achieve health equity". International Journal for Equity in Health (2019) 18:174



Ethics and professional behaviour

Professional standard: Professional standard. Physicians' practice is founded upon ethics, and physicians always treat patients, their families, communities, and populations in a caring and respectful manner. Physicians demonstrate their commitment and accountability to the health and well-being of individual patients, communities, populations, and society through ethical practice.

Physicians demonstrate high standards of personal behaviour.

Beliefs and attitudes: Reflect critically on personal beliefs and attitudes, including how these may impact on patient care.

Honesty and openness: Act honestly, including reporting accurately, and acknowledging their own errors.

Patient welfare: Prioritise patients' welfare and community benefit above self-interest.

Accountability: Be personally and socially accountable.

Personal limits: Practise within their own limits and according to ethical principles and professional guidelines.

Self-care: Implement strategies to maintain personal health and wellbeing.

Respect for peers: Recognise and respect the personal and professional integrity, roles, and contribution of peers.

Interaction with professionals: Interact equitably, collaboratively, and respectfully with other health professionals.

Respect and sensitivity: Respect patients, maintain appropriate relationships, and behave equitably.

Privacy and confidentiality: Protect and uphold patients' rights to privacy and confidentiality.

Compassion and empathy: Demonstrate a caring attitude towards patients and endeavour to understand patients' values and beliefs.

Health needs: Understand and address patients', families', carers', and colleagues' physical and emotional health needs.

Medical and health ethics and law: Practise according to current community and professional ethical standards and legal requirements.



Judgement and decision making

Professional standard: Physicians collect and interpret information, and evaluate and synthesise evidence, to make the best possible decisions in their practice.

Physicians negotiate, implement, and review their decisions and recommendations with patients, their families and carers, and other health professionals.

Diagnostic reasoning: Apply sound diagnostic reasoning to clinical problems to make logical and safe clinical decisions.

Resource allocation: Apply judicious and cost-effective use of health resources to their practice.

Task delegation: Apply good judgement and decision making to the delegation of tasks.

Limits of practice: Recognise their own scope of practice and consult others when required.

Shared decision-making: Contribute effectively to team-based decision-making processes.



Leadership, management, and teamwork

Professional standard: Physicians recognise, respect, and aim to develop the skills of others, and engage collaboratively to achieve optimal outcomes for patients and populations.

Physicians contribute to and make decisions about policy, protocols, and resource allocation at personal, professional, organisational, and societal levels.

Physicians work effectively in diverse multidisciplinary teams and promote a safe, productive, and respectful work environment that is free from discrimination, bullying, and harassment.

Managing others: Lead teams, including setting directions, resolving conflicts, and managing individuals.

Wellbeing: Consider and work to ensure the health and safety of colleagues and other health professionals.

Leadership: Act as a role model and leader in professional practice.

Teamwork: Negotiate responsibilities within the healthcare team and function as an effective team member.



Health policy, systems, and advocacy

Professional standard: Physicians apply their knowledge of the nature and attributes of local, national, and global health systems to their own practices. They identify, evaluate, and influence health determinants through local, national, and international policy.

Physicians deliver and advocate for the best health outcomes for all patients and populations.

Health needs: Respond to the health needs of the local community and the broader health needs of the people of Australia and Aotearoa New Zealand.

Prevention and promotion: Incorporate disease prevention, health promotion, and health surveillance into interactions with individual patients and their social support networks.

Equity and access: Work with patients and social support networks to address determinants of health that affect them and their access to needed health services or resources.

Stakeholder engagement: Involve communities and patient groups in decisions that affect them to identify priority problems and solutions.

Advocacy: Advocate for prevention, promotion, equity, and access to support patient and population health needs within and outside the clinical environment.

Resource allocation: Understand the factors influencing resource allocation, promote efficiencies, and advocate to reduce inequities.

Sustainability: Manage the use of health care resources responsibly in everyday practice.

Entrustable Professional Activities

Entrustable Professional Activities (EPAs) outline the essential work tasks trainees need to be able to perform in the workplace.



#	Theme	Title
2	Leadership in the nuclear medicine department	Lead a team of health and clerical professionals in the nuclear medicine context, encompassing inpatients, outpatients and multidisciplinary
3	Supervision and teaching	Supervise and teach professional colleagues
4	Quality improvement	Identify and address failures in health care delivery
5	Clinical assessment and management, including prescribing radioisotopes	Clinically assess and manage the ongoing care of patients, including prescribing radioisotopes
6	Longitudinal care of patients, including those receiving Theranostics and transitions in care	Manage and coordinate the longitudinal care and transitions in care of nuclear medicine patients, including those receiving Theranostics
7	Communication	Communication to optimise the care of nuclear medicine patients
8	Investigations and procedures	Plan, prepare for, perform, and provide aftercare for important investigations and practical procedures in nuclear medicine

Learning goal 2: Leadership in the nuclear medicine department

Theme	Leadership in the nuclear medicine department	
Title	Lead a team of health and clerical professionals in the nuclear medicine context, encompassing inpatients, outpatients and multidisciplinary teams	
Description	This activity requires the ability to: - describe all aspects of nuclear medicine, including molecular imaging and therapy - lead a team with kindness and integrity, with the patient as the central focus - prioritise workload - manage multiple concurrent tasks, including inpatient and outpatient services - articulate individual responsibilities, expertise, and accountability of team members - understand the range of team member’s skills, expertise, and roles - acquire and apply leadership techniques in daily practice, including problem-solving skills - encourage and adopt insights from team members - act as a role model	
Behaviours		
<u>Professional practice framework domain</u>	Ready to perform without supervision	Requires some supervision
	Expected behaviours of a trainee who can routinely perform this activity without needing supervision The trainee will:	Possible behaviours of a trainee who needs some supervision to perform this activity The trainee may:
Medical expertise	- assess, advise on, and authorise appropriate nuclear medicine diagnostic and therapeutic interventions for patients - use evidence-based care to meet the needs of patients or populations - assess and effectively manage clinical risk in various scenarios, including radiation safety - direct optimisation of diagnostic nuclear medicine image quality in terms of patient preparation, image acquisition, post processing, and display - demonstrate clinical competence and skills to effectively support team members - convey information to clinicians in a manner that enhances patient management	- demonstrate adequate knowledge of health care issues by interpreting complex information - contribute to the coordination of quality health care for populations or patients as a member of a multidisciplinary team
Communication	provide adequate information to referrers and patients to optimise appropriate test requesting and informed patient consent	communicate effectively with colleagues

Quality and safety	• demonstrate rapport with people at all levels by tailoring messages to different stakeholders • provide timely, accurate, and clinically pertinent reports on all nuclear medicine diagnostic studies and therapeutic interventions • ensure timely escalation of clinically significant or unexpected findings with urgent management implications for the patient • engage in quality improvement activities • facilitate ongoing review of current practices to remain up to date in an ever-changing environment • identify opportunities to improve care by participating in surveillance and monitoring of adverse events and 'near misses' • place safety and quality of care first in all decision making • identify activities within systems to reduce errors, improve patient, population, and staff safety, and implement cost-effective change	• communicate effectively with patients, families or carers, and/or the public • respect the roles of team members • participate in audits and other activities that affect the quality and safety of patients' care • participate in multidisciplinary collaboration to provide effective health services and operational change • use information resources and electronic medical record technology where available
Teaching and learning	• regularly self-evaluate personal professional practice, and implement changes based on the results • actively seek feedback from supervisors and colleagues on own performance • identify personal gaps in knowledge and skills, and engage in self-directed learning • maintain current knowledge of new technologies, health care priorities, and changes of patients' expectations • teach competently by imparting professional knowledge • manage and monitor learners' progress, providing regular assessments and feedback	• accept feedback constructively, and change behaviour in response • recognise the limits of personal expertise, and involve other health professionals as needed • demonstrate basic skills in facilitating colleagues' learning plan and deliver learning activities

Research	• facilitate research and teaching activities in the department / practice • ensure that any protocol for human research is approved by a human research ethics committee, in accordance with the national statement on ethical conduct in human research	• understand that patient participation in research is voluntary and based on an appropriate understanding about the purpose, methods, demands, risks, and potential benefits of the research
Cultural safety	• demonstrate culturally competent relationships with professional colleagues and patients • demonstrate respect for diversity and difference • provide a physically, culturally, and psychologically safe service • take steps to minimise unconscious bias, including the impact of gender, disability, religion, cultural beliefs, sexuality, and socioeconomic background on decision making • model inclusive workplace practices	• demonstrate awareness of cultural diversity and unconscious bias • work effectively and respectfully with people from different cultural backgrounds
Ethics and professional behaviour	• promote a team culture of shared accountability for decisions and outcomes • encourage open discussions of ethical and clinical concerns • respect differences of multidisciplinary team members • understand the ethics of resource allocation by aligning optimal patients and organisational care • effectively consult with stakeholders, achieving a balance of alternative views • acknowledge personal conflicts of interest and unconscious bias • act collaboratively to resolve behavioural incidents and conflicts such as harassment and bullying	• support ethical principles in clinical decision making • maintain standards of medical practice by recognising the health interests of patients or populations as primary responsibilities • respect the roles and expertise of other health professionals • promote team values of honesty, discipline, and commitment to continuous improvement • demonstrate understanding of the negative impact of workplace conflict
Judgement and decision making	• evaluate health services and clarify expectations to support systematic, transparent decision making • make decisions when faced with multiple and conflicting perspectives	• monitor services and provide appropriate advice • review new health care interventions and resources • interpret appropriate data and evidence for decision making

Leadership, management, and teamwork	• ensure medical input to organisational decision making • adopt a systematic approach to analysing information from a variety of specialties to make decisions that benefit health care delivery • lead compliance with nuclear medicine statutory and financial regulations • consult, collaborate, and communicate with other health professionals, maintaining a patient-centred approach to deliver optimal multidisciplinary patient care • combine team members' skills and expertise in delivering patient care and/or population advice • develop and lead effective multidisciplinary teams by developing and implementing strategies to motivate others • build effective relationships with multidisciplinary team members to achieve optimal outcomes • ensure all members of the team are aware of their individual professional responsibilities and accountable for their individual practices	• understand the range of personal and other team members' skills, expertise, and roles • acknowledge and respect the contribution of all health professionals involved in patient care • participate effectively and appropriately in multidisciplinary teams • seek out and respect the perspectives of multidisciplinary team members when making decisions
Health policy, systems, and advocacy	• engage in appropriate consultation with stakeholders on the delivery of health care • advocate for the resources and support for health care teams to achieve organisational priorities • influence the development of organisational policies and procedures to optimise health outcomes • identify the determinants of health of the population, and mitigate barriers to access to care • remove self-interest from solutions to health advocacy issues • advocate for inclusive workplace practices for the benefit of patients and colleagues	• communicate with stakeholders within the organisation about health care delivery • understand methods used to allocate resources to provide high-quality care • promote the development and use of organisational policies and procedures • respond to an individual patient's health needs by advocating with the patient within and beyond the clinical environment

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- advocate for nuclear medicine in the hospital / community setting, and promote the speciality as one that is useful in addressing many clinical needs
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Learning goal 3: Supervision and teaching

Theme	Supervision and teaching		Nuc-Med-EPA-02
Title	Supervise and teach professional colleagues		
Description	This activity requires the ability to: • provide work-based teaching in a variety of settings • teach professional skills • create a safe, inclusive, and supportive learning environment • plan, deliver, and provide work-based assessments • encourage learners to be self-directed and identify learning experiences • supervise learners in day-to-day work, and provide feedback • support and promote a culture of continuous improvement in the workplace • support learners to prepare for assessments		
Behaviours			
<u>Professional practice framework domain</u>	Ready to perform without supervision	Requires some supervision	
	Expected behaviours of a trainee who can routinely perform this activity without needing supervision	Possible behaviours of a trainee who needs some supervision to perform this activity	
	The trainee will:	The trainee may:	
Medical expertise	• combine high-quality care and teaching • explain the rationale underpinning a structured approach to decision making • consider the patient-centric view during consultations • encourage the learner to consider the rationale and appropriateness of investigations, management options, and radiation safety	• teach basic knowledge and skills to learners	
Communication	• establish rapport and demonstrate respect for junior colleagues, medical students, and other health and administrative professionals • communicate effectively when teaching, assessing, and appraising learners • encourage learners to tailor communication as appropriate for patients of differing demographic backgrounds • actively encourage a collaborative and safe learning environment with learners and other health professionals • support learners to deliver clear, concise, and relevant information in both verbal and written communication	• observe learners to reduce risks and improve health outcomes by improving communication skills	

	• listen and convey information clearly and considerately	
Quality and safety	• support learners to deliver quality care while maintaining their own wellbeing • apply lessons learned about patient safety by identifying and discussing risks with learners • assess learners' competence, and provide timely feedback to minimise risks to care • maintain the safety of patients and organisations involved with education, and appropriately identify and action concerns	• observe learners in clinical practice to reduce risks and improve health outcomes • encourage a culture of 'speaking up' among learners
Teaching and learning	• demonstrate knowledge of the principles, processes, and skills of supervision • provide direct guidance to learners in day-to-day work • work with learners to identify professional development and learning opportunities, based on their individual learning needs • offer feedback and act as a role model • participate in teaching and supervision of professional development activities • encourage self-directed learning and assessment • develop a consistent and fair approach to assessing learners • tailor feedback and assessments to learners' goals • seek feedback and reflect on own personal teaching experiences, developing goals and strategies to improve • establish and maintain effective mentoring through open dialogue • support learners to identify and attend formal and informal learning opportunities • recognise the limits of personal expertise, and involve others appropriately	• demonstrate basic skills in the supervision of learners • tailor learning, assessment, and feedback to individual learners or groups of learners • match teaching and learning objectives clearly to outcomes • encourage learners to be self-directed
Research	• clarify the goals and requirements of trainees' and colleagues' research projects, and provide feedback on the strengths and challenges of the proposed research • monitor the progress of learners' research projects regularly, and review research projects prior to submission	• guide learners with respect to the choice of research projects • ensure that planned research projects are feasible and of suitable standards

	• support learners to find forums to present research projects • encourage and guide learners to seek out relevant research to support practice	
Cultural safety	• exemplify a culturally sensitive and inclusive teaching method • encourage learners to seek out opportunities to develop and improve their own cultural competence • encourage learners to consider culturally appropriate care of Aboriginal and Torres Strait Islander and Māori peoples • consider cultural, ethical, and religious values and beliefs in teaching and learning	• operate effectively and with respect when working with and teaching individuals from diverse cultural backgrounds
Ethics and professional behaviour	• apply principles of ethical practice to teaching scenarios • act as a role model to promote professional responsibility and ethics among learners • respond appropriately to learners seeking professional guidance	• demonstrate professional values, including commitment to high-quality clinical standards, compassion, empathy, and respect • provide learners with feedback to improve their experiences
Judgement and decision making	• prioritise workloads and manage learners with different levels of professional knowledge or experience • link theory and practice when explaining professional decisions • promote joint problem solving • support a learning environment that allows for independent decision making • use sound and evidence-based judgement during assessments and when giving feedback to learners, and escalate concerns about learners appropriately	• provide general advice and support to learners • use health data logically and effectively to investigate difficult diagnostic problems
Leadership, management, and teamwork	• maintain personal effective performance and continuing professional development • contribute to the professional development of learners • maintain professional, clinical, research, and/or administrative responsibilities while teaching • help shape organisational culture to prioritise quality and work safety through openness, honesty, shared learning, and continued improvements • create an inclusive environment in which learners feel part of the team	• demonstrate the principles and practice of professionalism and leadership in health care • participate in mentor programs, career advice, and general counselling

Health policy, systems, and advocacy	• advocate for suitable resources to provide quality supervision and maintain training standards • explain the value of health data in the care of patients or populations • support innovation in teaching and training	• integrate public health principles into teaching and practice supervision when applicable • promote knowledge of the Australian and Aotearoa New Zealand healthcare systems among learners, including financial, geographical, and cultural barriers to optimal health care
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Learning goal 4: Quality improvement

Theme	Quality improvement	
Title	Identify and address failures in health care delivery	
Description	This activity requires the ability to: • identify, mitigate, and report actual and potential ('near miss') errors • conduct system improvement activities • adhere to best practice guidelines • audit clinical guidelines and outcomes • contribute to the development of policies and protocols designed to protect patients and enhance health care • monitor one's own practice and develop individual improvement plans	
Behaviours		
<u>Professional practice framework domain</u>	Ready to perform without supervision	Requires some supervision
	Expected behaviours of a trainee who can routinely perform this activity without needing supervision The trainee will:	Possible behaviours of a trainee who needs some supervision to perform this activity The trainee may:
Medical expertise	• regularly review patients and outcomes • evaluate practice to ensure it aligns with available evidence and guidelines • evaluate population, environmental, and lifestyle health risks, and advocate for healthy lifestyle choices • use standardised protocols to adhere to best practice and prevent the occurrence of wrong site / wrong patient procedures using mandatory informed consent • evaluate practice regularly to ensure it aligns with available evidence and guidelines	• contribute to processes on identified opportunities for improvement • recognise the importance of prevention and early detection in clinical practice • use local guidelines to assist patient care decision making
Communication	• use and support patients' access to high-quality, easy-to-understand information about health care • assist patients in participating in the decision-making process regarding their health care, according to their preferences and availability of care • help patients comprehend the organisation's open disclosure policy • discuss with patients any safety and quality concerns they have relating to their care • implement the organisation's open disclosure policy	• explain how health literacy may affect the way patients or populations gain access to, understand, and use health information

Quality and safety	- demonstrate best practice, including infection control, radiation safety, adverse event reporting, and effective clinical handover - facilitate organisational quality and safety activities, including peer review, morbidity and mortality meetings and clinical incident reviews, and apply decisions to practice - use clinical audits and registries of patients' experiences and outcomes, and learn from incidents and complaints, to improve patients' experiences and outcomes and mitigate against potential adverse outcomes	demonstrate an understanding of a system approach to improving the quality and safety of health care
Teaching and learning	- participate in professional training in quality and safety to ensure a contemporary approach to safety system strategies - supervise and manage junior colleagues' performance in the delivery of safe, high-quality care - ensure continuing professional development as per RACP or RANZCR training requirements	
Research	ensure protocols for human research are approved by a human research ethics committee, in accordance with the national statement on ethical conduct in human research	recognise patient participation in research is voluntary and based on an appropriate understanding about the purpose, methods, demands, risks, and potential benefits of the research
Cultural safety	actively participate in professional development opportunities that focus on the influence of cultural bias on health outcomes	communicate effectively with patients with cultural awareness
Ethics and professional behaviour	- align improvement goals with the priorities of the organisation - consistently demonstrate integrity and a patient-centred approach in all work activities - comply with professional regulatory requirements and codes of conduct	recognise the importance of regulatory requirements and codes of conduct
Judgement and decision making	- use decision-making support tools, such as guidelines, protocols, pathways, and reminders, including ALARA principles - analyse and evaluate current care processes to improve health care	access information and advice from other health care practitioners to identify, evaluate, and improve patients' care management

Leadership, management and teamwork	• support multidisciplinary team activities to lower patient risk of harm and promote multidisciplinary programs of education • contribute to developing an organisational culture that enables and prioritises patients' safety and quality	• demonstrate attitudes of respect and cooperation among members of different professional teams • partner with clinicians and managers to ensure that patients receive appropriate care and information on their care
Health policy, systems, and advocacy	• support the development, implementation, evaluation, and monitoring of governance processes	• maintain a dialogue with service managers about issues that affect patient care • contribute to relevant organisational policies and procedures • help to shape an organisational culture that prioritises safety and quality through openness, honesty, learning, and quality improvement

Learning goal 5: Clinical assessment and management, including prescribing radioisotopes

Theme	Clinical assessment and management, including prescribing	
Title	Clinically assess and manage the ongoing care of patients, including prescribing radioisotopes	
Description	This activity requires the ability to: • identify and access sources of relevant information about patients • obtain patient histories, including medication histories • gather and interpret prior investigations, including the results of relevant laboratory and imaging investigations • perform and interpret physical examinations • assess the patient's suitability to proceed with diagnostic or therapeutic nuclear medicine interventions • generate patient-centric management plans • establish goals of care in collaboration with referring clinicians and/or multidisciplinary teams, patients, and their families to ensure that only appropriate diagnostic and therapeutic procedures are performed • discuss management plans with referring clinicians, patients, families, and/or carers • communicate information with other health professionals	
Behaviours		
<u>Professional practice framework domain</u>	Ready to perform without supervision	Requires some supervision
	Expected behaviours of a trainee who can routinely perform this activity without needing supervision The trainee will:	Possible behaviours of a trainee who needs some supervision to perform this activity The trainee may:
Medical expertise	• identify high-risk patients who may require additional supportive or acute care during nuclear medicine studies and Theranostic procedures • elicit accurate, organised, and problem-focused medical histories (including collateral histories), considering relevant risk factors where appropriate • perform targeted physical examinations to establish the nature and extent of problems • ensure adequate patient preparation • synthesise and interpret findings from patients' histories and examinations to devise the most likely provisional diagnoses • assess the severity of problems, including the likelihood of complications, and identifying patients who	• take patient-centred histories, considering psychosocial factors • perform accurate physical examinations • recognise and correctly interpret abnormal findings during examinations and evaluation of laboratory / other imaging results • follow guidelines to ensure adequate patient preparation • synthesise pertinent information to direct the clinical encounter and diagnostic categories • demonstrate the ability to identify patients who may require supportive / acute care • develop appropriate management plans

	may require supportive / acute care and clinical outcomes • develop proficiency in identifying patients attending the nuclear medicine department who may need urgent care • consider the radiation protection factors which may impact the management of patients in acute care settings • identify and evaluate information relevant to the provisional and differential diagnosis • develop management plans based on relevant information, integrate guidelines, and consider the balance of benefit and harm by taking patients' personal circumstances into account • consider age, chronic disease status, lifestyle factors, allergies, potential drug interactions, and patient preference prior to implementing new management plans • follow ALARA principles when prescribing radioisotopes • demonstrate an awareness of potential side effects and practical prescription points when prescribing radioisotopes or other medications required for patients undergoing nuclear medicine studies or therapies • recognise and manage anaphylaxis	• understand the risk factors associated with intravenous iodine contrast hypersensitivity and anaphylaxis
Communication	• communicate openly, listen, and take patients', families', or carers' concerns seriously, giving them adequate opportunity to ask questions • provide information to patients, family members, or carers to enable them to make fully informed decisions from various diagnostic, therapeutic, and management options • communicate clearly, effectively, respectfully, and	• anticipate, read, and respond to verbal and nonverbal cues • demonstrate active listening skills • communicate patients' situations to colleagues, including senior clinicians

	promptly with other health professionals involved in patients' care • discuss and evaluate the risks and benefits of treatment options, making decisions in partnership with patients	
Quality and safety	• demonstrate professional safety skills, including infection control, adverse event reporting, and effective clinical handover • observe existing departmental procedures and policies for management of patients in the acute care setting, from medical and radiation perspectives • follow existing departmental procedures and policies for management of patients in the acute care setting, from medical and radiation safety perspectives • recognise and effectively manage aggressive and violent patient behaviours • obtain informed consent before undertaking any investigations or providing treatment, except in emergencies • ensure patients are informed of the material risks associated with any part of proposed management plans • evaluate the contraindications, indications, safety aspects, and potential advantages of prescribing radioisotopes especially in relation to Theranostics • perform hand hygiene, and take infection control precautions at appropriate moments • apply principles of radiation safety during all aspects of patient care • maintain up-to-date certification and licence requirements	• know where to access existing departmental policies for management of patients in the acute care setting, from medical and radiation safety perspectives • take precaution against assaults from confused or agitated patients, and ensure appropriate care of patients • document history and physical examination findings, and synthesise with clarity and completeness
Teaching and learning	• set defined objectives for clinical teaching encounters, and solicit feedback on mutually agreed goals	• set goals and objectives for self-learning • develop an understanding of the importance of self-reflection, and develop

	- regularly reflect upon and self-evaluate professional development - obtain informed consent before involving patients in teaching activities - use clinical activities as teaching moments when appropriate	strategies for the development thereof - learn to process and implement feedback from supervisors to ensure positive learning outcomes - deliver teaching considering learners' level of training
Research	- search for, find, compile, analyse, interpret, and evaluate information relevant to the research subject - adhere to ethical research practice, including informed consent, for all diagnostic and therapeutic procedures	- demonstrate an understanding of the limitations of the evidence and the challenges of applying research in daily practice - demonstrate a good understanding of ethical research practice, including informed consent - refer to guidelines and medical literature to assist in clinical assessments when required
Cultural safety	- demonstrate effective and culturally competent communication and care for Aboriginal and Torres Strait Islander and Māori peoples, and members of other cultural groups - acknowledge patients' beliefs and values, and how these might impact on health - use a professional interpreter, a health advocate, or a family or community member to assist in communication with patients - use plain language patient education resources, and demonstrate cultural awareness - consider and reflect on the role of unconscious bias, diversity, equity, and inclusion plays in health service provision	- display respect for patients' cultures, and attentiveness to social determinants of health - appropriately access interpretive or culturally focused services - display an understanding of at least the most prevalent cultures in society, and an appreciation of their sensitivities
Ethics and professional behaviour	- demonstrate professional values, including compassion, empathy, respect for diversity, integrity, honesty, and partnership to all patients - hold information about patients in confidence, unless the release of information is	- demonstrate professional conduct, honesty, and integrity - consider patients' decision-making capacity - identify patients' preferences regarding management and the role of families in decision making

	- required by law or public interest - assess patients' capacity for decision making, and involve a proxy decision maker appropriately - demonstrate understanding of the ethical implications of industry-funded research	- appropriately prioritise patient wellbeing and care in relation to personal and professional needs - consider the efficacy of prescribed Theranostics in treating illnesses, including the relative merits of alternate treatment options
Judgement and decision making	- apply informed clinical judgement to identify patients' issues - make logical, rational decisions, and act to achieve positive patients' outcomes - use a comprehensive approach to health, considering comorbidities, uncertainty, and risk - use the best available evidence for the most effective therapies and interventions to ensure quality care - evaluate new management options in relation to their possible efficacy and safety profile for individual patients, including the economic impact on the patient and their family	- demonstrate clinical reasoning by gathering focused information relevant to patients' care - recognise personal limitations, and seek help in an appropriate way when required - consider the following factors for all proposed management options: » alternate treatments » contraindications » cost to patients, families, and the community » funding and regulatory considerations » interactions » risk-benefit analysis, including long-term consequences of radiation exposure / dose
Leadership, management, and teamwork	- work effectively as a member of multidisciplinary teams to achieve patients' best health outcomes - advocate for patients if conflict occurs between interprofessional teams - demonstrate an awareness of colleagues in difficulty, and work within the appropriate structural systems to support them while maintaining patient safety	- understand the importance of and show the ability to work effectively within a team - share relevant information with members of the health care team - show compassion and support colleagues in difficulty - develop skills for managing conflict / diversity within interprofessional teams
Health policy, systems, and advocacy	- participate in health promotion, disease prevention and control, screening, and reporting notifiable diseases - aim to achieve the optimal cost-effective patient care to allow maximum benefit from the available resources - recognise the difference between publicly funded and	- identify and navigate components of the healthcare system relevant to patients' care - identify and access relevant community resources to support patient care

non-funded management options	• prescribe radioisotopes in accordance with the organisational policy
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Learning goal 6: Longitudinal care and transitions in care of nuclear medicine patients, including those receiving Theranostics

Theme	Longitudinal care of patients	
Title	Manage and coordinate the longitudinal care and transitions in care of nuclear medicine patients, including those receiving Theranostics	
Description	This activity requires the ability to: - develop management plans and goals in consultation with patients, families, and carers, and other multidisciplinary team members - manage complex and advanced chronic conditions, complications, disabilities, and comorbidities in the context of nuclear medicine investigations and therapy - collaborate with other health care providers, including transition of patient care - ensure continuity of care, and clearly communicate to other team members each person's role in the care of the patient - facilitate patients', families' or carers' self-management and self-monitoring - engage with the broader health policy context	
Behaviours		
<u>Professional practice framework domain</u>	Ready to perform without supervision	Requires some supervision
	Expected behaviours of a trainee who can routinely perform this activity without needing supervision The trainee will: - document the results of nuclear medicine procedures in a timely manner after the administration of a radioisotope for diagnosis or therapy, including information on radiation safety precautions where applicable - convey the concepts of relative and absolute risk, as they apply to radiation exposure, in discussion of investigations and treatment with colleagues and patients - monitor treatment outcomes, effectiveness, and adverse events - facilitate an optimal transition of care for patients, including from paediatric to adult care - recognise goals of patient care and resuscitation status - appropriately apply Theranostic procedures to improve quality of life in the palliative care setting, in collaboration with the patient and other carers	Possible behaviours of a trainee who needs some supervision to perform this activity The trainee may: - assess patients' knowledge, beliefs, concerns, and daily behaviours in relation to the performance of nuclear medicine tests / therapies - accurately and sufficiently contribute to medical record entries on histories, examinations, and management plans as a member of multidisciplinary teams - demonstrate an understanding of the principles of care for patients at the end of their lives
Medical expertise		
Communication	encourage patients' self-management through education to take greater	work in partnership with patients, and motivate them to comply with agreed care plans

	- responsibility for their care, and support problem solving - communicate with multidisciplinary team members, and involve patients in that dialogue where appropriate - communicate with patients, families, or carers about transition of care, and engage and support these parties in decision making - collaborate effectively with those managing end of life care	ensure consistent messages are given to patients, families, or carers about treatment options, their likelihood of success, risks, and prognosis
Quality and safety	- use innovative models of care, including telehealth and digitally integrated support services, as appropriate - review medication use, and ensure patients understand safe medication administration to assist in the prevention of errors	- participate in continuous quality improvement processes and clinical audits on chronic disease management - identify activities that may improve patients' quality of life
Teaching and learning	educate patients to recognise and monitor their symptoms, and undertake strategies to assist their recovery	demonstrate an awareness of how patients can self-monitor and undertake strategies to assist their recovery
Research	- prepare reviews of literature to present at journal club meetings - search for and critically appraise evidence to resolve clinical areas of uncertainty	- search literature using Problem / Intervention / Comparison / Outcome (PICO) format - recognise appropriate use of review articles
Cultural safety		- provide culturally safe chronic disease management - demonstrate an awareness of patient support and advocacy groups patients may relate to
Ethics and professional behaviour	- share information about patients' health care, consistent with privacy laws and professional guidelines about confidentiality - use consent processes for the release and exchange of health information - assess patients' decision-making capacity, and appropriately identify and use alternative decision makers	- share information between relevant service providers - acknowledge and respect the contribution of health professionals involved in patients' care
Judgement and decision making	- implement stepped care pathways in the management of chronic diseases and disabilities - recognise appropriate stages of end-of-life care and limitation of treatment	recognise personal limitations, and seek help in an appropriate way when required

	recognise patients' needs in terms of both internal resources and external support on long-term health care journeys	
Leadership, management, and teamwork	- use a multidisciplinary approach across services to manage patients with chronic diseases and disabilities - develop collaborative relationships with patients, families, or carers, and a range of health professionals - coordinate whole-person care through involvement in all stages of the patients' care journey - effectively manage challenges of dealing with death and grief	participate in multidisciplinary team care for patients with chronic diseases and disabilities, including organisational and community care on a continuing basis, appropriate to patients' context
Health policy, systems, and advocacy	- participate in government initiatives for cancer and chronic disease management to reduce hospital admissions and improve patients' quality of life - contribute to processes for managing risks and identifying strategies for the improvement of transitions of care - engage in organisational processes to improve transitions of care	demonstrate awareness of government initiatives and services available for patients with chronic diseases and disabilities, and knowledge of how to access them, such as palliative care

Learning goal 7: Communication

Theme	Communication with patients and health care workers involved in multidisciplinary care of nuclear medicine patients	
Title	Communication to optimise the care of nuclear medicine patients	
Description	This activity requires the ability to: • identify appropriate contexts to include family, carers, and/or other team members when communicating with patients • adopt a patient-centred perspective, including adjusting for language skills, cognition, and disabilities • select and use appropriate technologies and communication strategies • negotiate a mutually agreed management plan • verify patients', family members' or carers' understanding of information conveyed • develop and implement clear plans and processes agreed upon in the context of multidisciplinary patient care, including explicit lines of responsibility and reporting • ensure conversations and resultant plans are appropriately documented	
Behaviours		
<u>Professional practice framework domain</u>	Ready to perform without supervision	Requires some supervision
	Expected behaviours of a trainee who can routinely perform this activity without needing supervision The trainee will:	Possible behaviours of a trainee who needs some supervision to perform this activity The trainee may:
Medical expertise	• anticipate and be prepared to address any misconceptions patients might have regarding their conditions and/or risk factors • guide patients through the informed consent process prior to nuclear medicine investigations and/or treatments • seek to understand the concerns and goals of patients, and plan management in partnership with them	• apply knowledge of the scientific basis of health and disease to the management of patients • demonstrate an understanding of the clinical problems being discussed • formulate management plans in partnership with patients
Communication	• select and employ appropriate communication strategies and modalities, such as email, face-to-face, or phone calls • obtain patients' perspectives, worries, and preferences to foster rapport • provide information to patients in plain language, avoiding the use of jargon, acronyms, and other complex medical terms • encourage questions, and answer them thoroughly • ask patients to share their thoughts or to explain their management	• collaborate with patient liaison officers as required • adapt communication style in response to patients' cognitive, physical, cultural, socioeconomic, and situational factors

	plan in their own words, to verify understanding - document and share written and electronic information about the patient encounter to optimise clinical decision making, patient safety, confidentiality and privacy - author clear and comprehensive reports on imaging studies conveying relevant findings, clinical opinion, level of certainty and any additional recommendations as appropriate - communicate with patients thoughtfully and sensitively, seeking clarification when unsure of the best course of action - convey the concept of relative and absolute risk, as it applies to radiation exposure, in discussion of investigations and treatment - discuss significant unexpected findings urgently with the referring clinician, and document accordingly with the date / time and person communicated to in a way they can understand before asking for their consent	
Quality and safety	- consider patients' capacity for decision making and consent - recognise and take precautions where patients may be vulnerable, such as issues of self-harm, non-accidental injury, or elder abuse - respect patient confidentiality - respond appropriately to complaints from patients, family, and carers, and participate in processes to manage these	- inform patients of the material risks associated with proposed management plans - treat information about patients as confidential
Teaching and learning	- discuss the aetiology of diseases in a relevant and understandable way - explain the purpose, nature, and practicalities of nuclear medicine interventions which could be conducted to assess or treat the disease - obtain informed consent or other valid authority before involving patients in teaching	respond appropriately to information sourced by patients, and to patients' knowledge regarding their conditions
Research	- obtain informed consent or other valid authority before involving patients in research - provide information to patients that is based on guidelines issued by the National Health and Medical Research Council and/or Health Research Council of NZ	- refer to evidence-based clinical guidelines - demonstrate an understanding of the limitations of the evidence and the challenges of applying research in daily practice

	provide information to patients in an understandable manner before asking for consent to participate in research	
Cultural safety	- effectively communicate with members of all cultural groups, including Aboriginal and Torres Strait Islander and Māori peoples, by meeting patients' specific language, cultural, and communication needs - when necessary, use qualified language interpreters or cultural interpreters to help to meet patients' communication needs - provide plain language and culturally appropriate written materials to patients when possible - use gender inclusive language in verbal and written interactions with patients and colleagues	allow enough time for communication across cultural barriers
Ethics and professional behaviour	- behave equitably towards all, irrespective of gender, age, culture, socioeconomic status, sexual preference, beliefs, contribution to society, illness related behaviours, or the illness itself - avoid sexual, intimate, and/or financial relationships with patients - demonstrate a caring attitude towards patients - encourage and support patients to be well informed about their health, and to use this information wisely when they are making decisions - encourage and support patients and, when relevant, their families or carers, in caring for themselves and managing their health - demonstrate respectful professional relationships with patients - prioritise honesty, patient welfare, and community benefit above self-interest - develop a high standard of personal conduct, consistent with professional and community expectations - support patients' right to seek second opinions - respect the preferences of patients - respect patients, including protecting their rights to privacy and confidentiality - openly disclose harmful patient safety incidents to patients and	- communicate appropriately, consistent with the context, and respect patients' needs and preferences - maximise patient autonomy, and support their decision making

	their families accurately and appropriately • use social media ethically and according to legal obligations to protect patients' confidentiality and privacy	
Leadership, management, and teamwork	• communicate effectively with health care team members involved in patients' care, and with patients and families or carers • discuss medical assessments, treatment plans, and investigations with patients and primary care teams, and work collaboratively with them • discuss patients' care needs with health care team members to align them with appropriate resources • facilitate an environment where all team members feel they can contribute, and their opinions are valued • communicate accurately and succinctly, and motivate others on the health care team • engage with multidisciplinary teams to ensure a collaborative approach to patient management	• address queries from team members • summarise, clarify, and communicate responsibilities of health care team members • keep health care team members focused on patient outcomes
Health policy, systems, and advocacy	• collaborate with interdepartmental and external services, such as community health centres and consumer organisations, to help patients navigate the healthcare system • effectively provide appropriate radiation safety advice relevant to the procedure or scan being performed	• communicate with and involve other health professionals as appropriate

Learning goal 8: Investigations and procedures in nuclear medicine

Theme	Investigations and procedures in nuclear medicine	
Title	Plan, prepare for, perform, and provide aftercare for important investigations and practical procedures in nuclear medicine	
Description	This activity requires the ability to: • evaluate the anticipated value of the procedure or investigation • select appropriate procedures or investigations in partnership with other health professionals, patients, and their family or carers • communicate potential risks and benefits prior to obtaining informed consent • perform procedures and investigations where appropriate, using relevant infection control requirements • manage unexpected events and complications during and after investigations, procedures, and/or therapies • provide appropriate aftercare for patients • communicate aftercare protocols and instructions to patients and medical and nursing staff • interpret the results of nuclear medicine imaging studies, and produce clear, comprehensive written reports • interpret the results and outcomes of prior procedures and investigations, communicating the outcome of procedures and associated investigations with referrers and other clinicians involved in the patient's care • perform this activity across multiple relevant settings	
Behaviours		
<u>Professional practice framework domain</u>	Ready to perform without supervision Expected behaviours of a trainee who can routinely perform this activity without needing supervision	Requires some supervision Possible behaviours of a trainee who needs some supervision to perform this activity
	The trainee will:	The trainee may:
Medical expertise	• assess patients and identify indications for procedures or investigations • consider risks and complications of procedures or investigations • check for allergies, adverse reactions, and contraindications, documenting these in patients' records, and alerting team members accordingly • review the appropriateness of the requested procedures or investigations by assessing patient-specific factors, risks, benefits, and considering alternatives • ensure patients have complied with pre-procedure preparation • confidently and consistently perform and interpret a range of common nuclear medicine procedures and investigations • use correlative investigations, such as diagnostic radiology,	• interpret results of specialists or uncommon diagnostic procedures or investigations • check for allergies, adverse reactions, and contraindications, documenting these in patients' records, and alert team members accordingly • perform a range of common procedures and investigations in a skillful and safe manner, adapting to unanticipated findings or changing circumstances • understand the significance of abnormal test results, and act on them • organise and document post procedure or investigation reviews of patients • recognise the role that artificial intelligence plays in the medical imaging and broader health care context

	endoscopy, and pathology, to complement nuclear medicine practice • confirm the correct position / site / side / level on the patient for the planned procedure • advise on optimal preparation, such as pain relief or sedation, and positioning of patients for procedures and during the acquisition of medical images • recognise and effectively manage complications arising during or after procedures or investigations • use appropriate processing software, including artificial intelligence applications, to ensure that investigation results and reports are accurate and clear	
Communication	• explain procedures and investigations clearly to patients, family members, or carers, including reasons for procedures or investigations, possible risks, benefits, burdens, costs, side effects, radiation precautions, and potential alternatives, including the option to have no investigations or procedures • tailor language according to patients' age and capacity to understand • facilitate communication within procedural teams to ensure all members are familiar with each other's roles • communicate effectively with team members, patients, family, and carers prior to, during, and after procedures or investigations • discuss postprocedural care with patients, family, or carers • complete relevant patients' documentation, and conduct appropriate clinical handovers • accurately document procedures and investigations in the clinical notes, including informed consent, procedures or investigations requested and performed, reasons for procedures or investigations, medicines given, aseptic technique, and aftercare • author clear and comprehensive reports in a timely fashion following completion of procedures, investigations, and therapies which communicate diagnoses and manage recommendations (where appropriate)	• explain the process of procedures or investigations to patients to help patients, family, or carers choose procedures or investigations in collaboration with treating clinicians • complete relevant patients' documentation, and conduct appropriate clinical handovers

Quality and safety	• identify adverse outcomes that may result from proposed investigations and procedures, focusing on patients' individual situations • obtain informed consent or other valid authority before undertaking any procedures or investigations • set up all necessary equipment, and consistently use universal precautions and aseptic technique • confirm patients' identification and verify the procedure or investigation, and, where appropriate, the correct site / side / level for the procedure or investigation • ensure that information on patients' consent forms match procedures or investigations to be performed • identify, document, and appropriately notify of any adverse event, radiation maladministration, or equipment malfunction • engage with department quality assurance meetings, such as case review or mortality and morbidity meetings	• provide information in a manner so patients, family, or carers are fully informed when consenting to any procedures or investigations • provide information as to appropriate dose adjustment of radioisotopes for children in line with current recommendations • seek help with interpretation of test results for less common tests or indications or unexpected results
Teaching and learning	• refer to and/or be familiar with relevant published guidelines prior to undertaking procedures or investigations • organise or participate in in-service training on new technology • provide specific and constructive feedback and comments to junior colleagues • initiate and conduct skills training for junior staff	• participate in continued professional development to maintain currency with investigation guidelines • help junior colleagues develop new skills • actively seek feedback on personal technique until competent
Research	• provide patients with relevant information if a proposed investigation or procedure is part of a research program • obtain written informed consent from patients if the investigation or procedure is part of a research program	• refer to evidence-based clinical guidelines • consult current research on investigations and procedures
Cultural safety	• respect religious, cultural, and family values and differences • consider individual patients' cultural perceptions of health and illness, and adapt practice accordingly • seek informed consent for procedures, investigations, and therapies in a culturally and psychologically safe manner	• respect religious, cultural, linguistic, and family values and differences

Ethics and professional behaviour	• confidently perform common procedures or investigations • engage referring and other relevant clinicians when making important clinical decisions • show respect for knowledge and expertise of colleagues • maximise patient autonomy in decision making • respect patients' decisions to refuse investigations or procedures, even if their decisions may not be appropriate or evidence based • follow procedural guidelines and protocols to ensure safe practice • demonstrate an awareness of stochastic and deterministic risks associated with radiation from investigations, procedures, and therapies, and be prepared to discuss this openly and with a strong evidence-based background	• perform new procedures or investigations with adequate guidance and supervision • follow procedural guidelines and protocols to ensure safe practice • demonstrate awareness of stochastic and deterministic risks associated with radiation from investigations, procedures, and therapies
Judgement and decision making	• outline the role and optimal timing for diagnostic procedures and investigations • evaluate the costs, benefits, and potential risks of each investigation or procedure in clinical situations • adapt procedures or investigations in response to assessments of risks to individual patients • make clinical judgements and decisions based on available evidence • prioritise which patients receive procedures or investigations first (if there is a waiting list)	• assist in prioritising which patients receive procedures or investigations first (if there is a waiting list) • recognise personal limitations, and seek help from supervisors in an appropriate way when required • use tools and guidelines to support decision making • engage with clinical radiology colleagues to assist with cross-sectional anatomical imaging evaluation where there is diagnostic uncertainty
Leadership, management, and teamwork	• explain critical steps, anticipated events, and equipment requirements to teams on planned procedures or investigations • provide staff with clear aftercare instructions, and explain how to recognise possible complications • identify relevant management options with colleagues according to their level of training and experience to reduce error, prevent complications, and support efficient teamwork • coordinate efforts, encourage others, and accept responsibility for work performed by staff under supervision	• demonstrate an understanding of what parts of an investigation are provided by different health professionals, including the complementary nature of nuclear medicine and clinical radiology • ensure all relevant team members are aware that a procedure is occurring • discuss patients' management plans for recovery with colleagues

	• ensure team members are confident and competent in their assigned roles	
Health policy, systems, and advocacy	• discuss serious incidents at appropriate clinical review meetings • initiate local improvement strategies in response to serious incidents • use resources efficiently when performing procedures	• perform procedures and investigations in accordance with the organisational guidelines and policies

Knowledge guides

Knowledge guides (KGs) provide detailed guidance to trainees on the important topics and concepts trainees need to understand to become experts in their chosen specialty.

Trainees are not expected to be experts in all areas or have experience related to all items in these guides.



#	Title
9	Scientific basis of nuclear medicine, including radiation safety
10	Cardiovascular nuclear medicine
11	Endocrine nuclear medicine
12	Gastrointestinal nuclear medicine
13	Genitourinary nuclear medicine
14	Musculoskeletal nuclear medicine
15	Neurological nuclear medicine
16	Oncological nuclear medicine
17	Pulmonary nuclear medicine
18	Inflammation and infection
19	Radionuclide therapies / Theranostics

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES

Trainees will have in-depth knowledge of the topics listed under each clinical sciences heading.

For the statistical and epidemiological concepts listed, trainees should be able to describe the underlying rationale, the indications for using one test or method over another, and the calculations required to generate descriptive statistics.

- Anatomy and anatomical variants as relevant to nuclear medicine
- Artificial intelligence (AI) and other automated computational systems in image reconstruction and interpretation
- Bayesian analysis principles applied to diagnostic tests
- Cross-sectional anatomy, including normal / abnormal patterns of CT contrast enhancement and common disease patterns
- CT imaging, including the utility of iodinated contrast media
- Imaging modalities essential to hybrid imaging in nuclear medicine, as well as imaging co-registration fusion technology
- Measures of test diagnostic performance and cost-effectiveness
- Medical management of adverse reactions to radioisotope, radiopharmaceutical, and irrelevant contrast agents
- Medical management of radiation injuries, and radiation contamination management
- Nuclear physics:
 - » atomic structure
 - » emission spectra
 - » half-lives
 - » nuclear properties
 - » radioactive decay principles and radiation properties
 - » radioactivity
 - » radioisotope production
 - » radionuclide types
- Physics and imaging techniques:
 - » camera quality assurance
 - » image acquisition and optimisation
- Physiologic and pathologic tracer uptake patterns in imaging and therapy, as well as radiopharmaceutical kinetics and dosimetry
- Physiology, pathology, and pathophysiology
- Radiation biology:
 - » benefits, hazards, and risk optimization
 - » biological implications of ionising radiation from unsealed sources
 - » tissue interactions
- Radiation detection and imaging:
 - » cameras
 - » collimators
 - » detectors
 - » image reconstruction
- Radiation protection and safety:
 - » dose limits
 - » exposure control
 - » handling radioactive materials
 - » protecting pregnant and breastfeeding individuals
- Radionuclide instrumentation:
 - » calibrators
 - » contamination monitors
 - » quality assurance systems

	• Radiopharmaceutical properties and preparation: » aseptic technique » kits, and quality control methods » radiochemistry
	PCH • Embryology of organ system development • Normal growth and development of specific organ systems • Normal growth and developmental physiology of children • Pathophysiology of common paediatric illnesses • Physiology of organ system development • Radiation biology and potential impact on the child
INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. Trainees will be able to interpret the reported results of each investigation or procedure. Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.	• Clinical indications and nuclear medicine study findings • Clinical report and letter preparation with: » accurate terminology matched to the referrer's expected level of knowledge » appropriate formats » follow contemporary guidelines when applicable » succinct and pertinent interpretation • Ethics and medicolegal insight of emerging technology and appropriate safety measures • Imaging, scanning, and radionuclide therapy techniques, including emerging molecular technologies • Nuclear medicine computer applications, including artificial intelligence • Study interpretation, using detailed knowledge of anatomy and physiology, and use of artificial intelligence / deep learning tools as appropriate
	PCH • Determine suitable studies and techniques for paediatric patients
IMPORTANT SPECIFIC ISSUES Trainees will identify important specialty-specific issues and the impact of these on diagnosis, management and outcomes.	• AI technologies in image reconstruction and interpretation • International guidelines for performing nuclear medicine diagnostic studies and therapies • Nuclear physics and radiochemistry relevant to nuclear medicine • Radiation biology, dosimetry, safety, and protection • Regulatory requirements for administering unsealed radioisotopes

- Administer sedation, when necessary, for adequate paediatric nuclear medicine procedures
- Advise on appropriate radiopharmaceutical doses for children as per recommended dosage guidelines
- Advise referring clinicians on the role of nuclear medicine studies in paediatric cases
- Effectively communicate to patients, families, and/or caregivers the procedure details, associated risks, and precautions
- Gain practical insights on the floor for patient preparation, scan acquisition and its nuances
- Consult and/or refer complex or less frequently performed studies to recognised paediatric nuclear medicine centres
- Importance of child and family-centred care and environment

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Abnormal ECG patterns suspicious for the presence of ischaemia
- Symptoms suspicious for myocardial ischaemia, such as chest pain, dyspnoea, or palpitations, for quantification of left ventricular systolic function

Conditions

- Cardiac failure:
 - » cardiac rhythm disorders:
 - atrial arrhythmias, such as atrial ectopics, atrial flutter, supraventricular tachycardia (SVT)
 - congenital conduction abnormalities, such as Wolf–Parkinson–White syndrome, that may effect method of stress testing
 - fibrillation
 - » ischaemic and non-ischaemic conditions of heart failure
- Coronary artery disease:
 - » infarction / ischaemia
- ECG abnormalities:
 - » atrial arrhythmias
 - » bundle branch block
 - » changes of ischaemia at rest
 - » heart block
 - » left ventricular hypertrophy
 - » myocardial infarction
 - » myocardial ischaemia
 - » pericarditis and left ventricular aneurysm
 - » QT interval abnormalities
 - » ventricular arrhythmias
 - » Wolff–Parkinson–White syndrome
- Ischaemic heart disease

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

Consider other factors

- » Identify individual and social factors and the impact of these on diagnosis and management

Conditions

- Acquired paediatric abnormalities:
 - » Kawasaki disease
- Congenital cardiac disease:
 - » anomalous coronary artery disease
 - » transposition of the great arteries
- Trainees will be aware there are complex congenital cardiac conditions, as well as acquired diseases and the associated cardiac sequelae

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS

Trainees will have a general understanding of these presentations and conditions.

Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.

Presentations

- Known or suspected:
 - » cardiac infiltrative disorder
 - » cardiac manifestation of systemic disorder
 - » congenital heart disease
 - » disorder of sympathetic innervation

Conditions

- Cardiac amyloidosis and sarcoidosis
- Congenital heart disease:
 - » atrial septal defect (ASD)
 - » Eisenmenger syndrome
 - » patent ductus arteriosus (PDA)
 - » septal defects:
 - ventricular septal defect (VSD)
 - tetralogy of Fallot
 - transposition of the great arteries

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES

Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.

Cardiac anatomy and physiology

- Cardiac and coronary artery anatomy, including variants:
 - » identify territories of coronary arteries and how this relates to the myocardial perfusion image interpretation in all three axes
 - » importance of coronary artery anatomy to confidently exclude imaging artefacts
- Effect of different modes of stress on coronary blood flow and tracer uptake into cardiac myocytes
- Effect of previous coronary bypass surgery on perfusion territories
- Left ventricle (LV) and right ventricle (RV) function, both regionally and globally, with rest and exercise
- Myocardial flow reserve
- Myocardial oxygen consumption, and the factors affecting coronary blood flow and flow reserve
- Normal and abnormal LV regional wall motion
- Radiation exposure relating to the different radioisotopes
- Relationship between coronary stenoses and blood flow, both at rest and during stress

Cardiac disease

- Basic pathogenesis of atherosclerosis, with reference to coronary artery disease and its consequences
- Impact of microvascular disease on cardiac tracer uptake and on differences between coronary angiographic findings and myocardial perfusion scans (MPS)

- Myocardial substrate utilisation, energy production, and contraction

Procedural information

- Absolute myocardial blood flow (MBF) quantification during dynamic cardiac PET and SPECT (using solid state detectors)
- Clinical / ECG and pathological features of cardiomyopathy, endocarditis, myocarditis, and valvular heart disease
- Concepts of reversibly dysfunctional myocardium in coronary artery disease (ischaemic stunning), and myocardial hibernation and infarction, and how to confidently diagnose those conditions on MPS with and without thallium / FDG
- Patient preparation needed for nuclear medicine diagnostic studies with respect to imaging indication, modality (e.g. CTCA acquisition, PET, and SPECT), and pharmacological protocols that may be required
- Role of stress-only imaging, including diagnostic performance, long-term follow-up, and radiation safety considerations
- Starling's Law and relate this to preload, afterload, myocardial contractility, and mechanisms of cardiac reserve
- The significance of a change in ejection fraction, including potential sources of error
- Normal and abnormal patterns of lymphatic drainage

INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

- CAD using SPECT radiopharmaceuticals:
 - » assess ventricular function using planar and gated SPECT
 - » radionuclide ventriculography and gated SPECT using MPS agents
- CT coronary angiography and calcium scoring
- ECG
- LV and/or RV ejection fractions planar and SPECT with labelled red cells
- Cardiac shunt function studies
- I-123 MIBG adrenergic cardiac imaging studies in the evaluation of heart failure and movement disorders (Parkinsonian syndromes)
- Cardiac F-18 FDG
- Perfusion PET tracer imaging techniques
- Cardiac amyloid imaging with bone-seeking radiopharmaceuticals and/or PET agents
- Lymphoscintigraphy (assessment of lymphatic drainage)

PCH

- Myocardial perfusion studies

IMPORTANT SPECIFIC ISSUES

Trainees will identify important specialty-specific issues and the impact of these on diagnosis and

Cardiac failure

- Bisphosphonate and FDG PET imaging in the diagnosis of ATTR cardiac amyloidosis and cardiac sarcoidosis, and guideline recommendations for test performance and reporting
- Decompensated heart failure as a contraindication to stress testing
- Ischaemic and non-ischaemic causes of heart failure

management and integrate these into care.

Cardiac rhythm disorders

- Complete heart block and bundle branch block patterns, including tri-fascicular and hemi-blocks
- Identify the following conditions on ECG:
 - » left ventricular hypertrophy and strain pattern
 - » previous myocardial infarction
 - » typical transient ischaemic ECG changes
- Potential lethal arrhythmias – ventricular tachycardia (non-sustained / sustained) and VF ECG abnormalities
- The potential impact of irregular heart rhythms on left ventricular ejection fraction assessment

Cardiac stress testing

- Limitations and requirements of common treadmill and cycle ergometer protocols
- Manage arrhythmias and other cardiac events that may be caused by stress tests
- Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and how these might affect choice of specific protocol
- Perform cardiopulmonary resuscitation if required
- Provide a safe environment for cardiac stress testing
- Radiation protection and patient safety
- Stress testing using pharmacological agents:
 - » infusion protocols used for pharmacological agents, including reversal agents
 - » which agents to use in specific situations, including patient preparation required for use, such as caffeine withdrawal
- The Duke treadmill score

Coronary artery disease

- ECG abnormalities commonly associated with ischaemia / infarction
- Ischaemic ECG changes during stress tests
- Know when to cease / modify stress tests when concerning ECG changes occur
- Normal chronotropic and BP response during stress procedures, and significance of abnormal responses during testing

Electrocardiograms

- Bruce treadmill exercise test or other standard protocols:
 - » criteria for positive, negative, non-diagnostic, and uninterpretable exercise ECGs
 - » terminate exercise stress tests at the appropriate endpoint

Myocardial perfusion stress testing

- Determine the most appropriate method to stress test patients to answer clinical questions
- Evaluate baseline ECG studies
- Know the difference between requests for:
 - » ischaemia imaging
 - » myocardial function assessment (gated cardiac blood pool scan)
 - » myocardial viability imaging (thallium / FDG)
- Patient and environmental safety
- Pre-test probability of myocardial ischaemia and potential contribution of non-ischaemic cardiac conditions and non-cardiac conditions to symptomatology

-
- Resting wall motion abnormality, post-stress wall motion abnormality, and changes in left ventricular function at rest and post-stress, and significance of post stress LV dilation
 - Risks and current management guidelines for performing tests on / off anti-angina medications, such as ischaemia directed management on optimal medical therapy
 - Ventricular function as part of myocardial perfusion imaging

PET

- PET tracers and use in assessment of cardiac perfusion
 - The utility of FDG PET in:
 - » cardiac sarcoidosis
 - » endocarditis (including Duke criteria)
 - » infection of cardiac pacemakers / leads, LVADs, and prosthetic valves
 - » myocarditis
-

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Evaluation of bone mineral density
- Gastroenteropancreatic and lung neuroendocrine tumours
- Hyperparathyroidism
- Pheochromocytoma / Paraganglioma
- Thyroid carcinoma, differentiated and non-differentiated
- Thyrotoxicosis for evaluation

Conditions

- Adrenal hypersecretory syndromes
- Graves disease
- Hyperparathyroidism
- MEN and other genetic conditions associated with poly-endocrinopathies
- Metabolic bone disease
- Neuroendocrine tumour hypersecretory syndromes
- Nodular thyroid disease
- Osteoporosis / Osteopaenia
- Subacute thyroiditis

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

Consider other factors

- » identify individual and social factors and the impact of these on diagnosis and management

PCH

- Child and adolescent conditions:
 - » bone mineral density
 - » hyperthyroidism
 - » thyroid malignancy
- Neonatal conditions:
 - » congenital hypothyroidism

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS Trainees will understand these presentations and conditions. Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.	No presentations / conditions listed	
EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.	PCH • Congenital hyperinsulinism • Genetic disorders associated with endocrinopathies • Hyperparathyroidism	Endocrine anatomy, embryological origin, and physiology • Adrenal glands: » discuss the approach to an adrenal mass on CT, the diagnostic work-up of an adrenal lesion, and hypercortisolism » understand hormone production and secretion of the adrenal glands, with particular attention to pheochromocytomas and paragangliomas • Bone mineral density: » therapies to improve bone health. » calculate whether a significant interval change has occurred » different BMD reference ranges » dual energy X-ray absorptiometry (DXA) in the evaluation of bone mineral density and practical applications » report DXA in accordance with the ANZBMS standards including absolute fracture risk » Trabecular bone score » technical limitations, artefacts, and common anatomical variants that may alter scan interpretation • Parathyroids: » discuss the difference between primary, secondary, and tertiary hyperparathyroidism, and the role of imaging in each of these settings » understand physiology of PTH and regulation of secretion » understand that the embryological origin of parathyroid tissue can help with localisation • Pathophysiology of: » adrenal hypersecretory syndromes » hypo- and hyper-functioning thyroid nodules: ▪ correlate findings with relevant imaging ▪ indications for fine needle aspiration biopsy of thyroid nodules ▪ natural history of thyroid nodules, and the relationship of thyroid nodules to thyroid cancer » primary, secondary, and tertiary hyperparathyroidism • Thyroid gland:

- » embryology and gross anatomy
- » physiology of the thyroid gland and the hypothalamic–pituitary axis
- » the mechanism of uptake of iodine / pertechnetate in thyroid tissue and how this may be affected during thyroid disease
- » thyroid physiology in normal and pathological states, with respect to scintigraphic appearance

PCH

- Embryology and how it impacts on organ development
- Paediatric bone development and the impact on bone mineral density:
 - » bone densitometry in childhood skeletal dysplasias
 - » effect of childhood disease on bone growth and development
 - » reporting criteria for bone densitometry in childhood and adolescence

INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

Investigations

- Functional imaging for neuroendocrine tumours:
 - » MIBG, labelled with I-123 or I-131
 - » PET radiotracers, such as Ga68 DOTATATE, F18 F- DOPA
 - » tektrotide (Tc-99m HYNIC-TOC)
- Parathyroid scintigraphy:
 - » imaging protocols for combined thyroid and parathyroid scintigraphy, including:
 - choice of collimator
 - correlative thyroid scintigraphy
 - delayed imaging
 - image subtraction techniques
 - imaging of the mediastinum
 - oblique imaging
 - role of contrast CT and US in parathyroid imaging
 - typical patterns of parathyroid adenomas / hyperplasia in the neck and in ectopic locations
 - use of FCH PET in parathyroid imaging
 - use of SPECT and SPECT / CT
 - » Tc-99m sestamibi imaging of the parathyroids
- DXA scanning
- ANZBMS reporting guidelines
- Frameworks for report fracture risk
- Thyroid imaging:
 - » RAI and imaging for hyperthyroidism and malignancy
 - » scintigraphy using I-123, SPECT / CT, and technetium, along with the ability to explain when to use them
 - » the role of PET / CT imaging with FDG and other PET radiotracers
 - » the role of ultrasound imaging and imaging guided biopsy in evaluation and diagnosis of thyroid pathology

Procedures

- Patient preparation needed prior to:
 - » mark thyroid nodule(s) so the nodule(s) can be clearly identified and related to radiological findings
 - » MIBG imaging
 - » parathyroid scintigraphy
 - » thyroid scintigraphy
 - » treatment of benign thyroid disease

PCH

- DXA

- Thyroid imaging
- Parathyroid scintigraphy
- F-18 F-DOPA PET / CT for congenital hyperinsulinism
- Functional imaging for neuroendocrine tumours

IMPORTANT SPECIFIC ISSUES

Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.

- Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and the considerations when managing and following up these patients, such as travel from rural to metropolitan areas
- Radiation protection, patient safety
- Radioisotope decay and patient proximity to therapy / examination

PCH

- Administration of radioisotopes to children, and the impact on the family and child

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Gallbladder dyskinesia
- Gastrointestinal (GI) bleeding
- GI motility disorders
- Hepatic disease and hepatic lesions for evaluation
- Inflammatory bowel disease

Conditions

- Gallbladder and biliary function conditions:
 - » acute cholecystitis
 - » bile leaks
 - » biliary dyskinesia / sphincter of Oddi dysfunction
 - » chronic cholecystitis
 - » common bile duct obstruction
 - » obstruction of major hepatic ducts
 - » post-cholecystectomy pain
- GI dysmotility and associated systemic conditions:
 - » diabetes
 - » dysphagia and gastro-oesophageal reflux
 - » Hirschsprung disease
 - » spinal cord injury
 - » systemic sclerosis
- Hepatic disease:
 - » Budd–Chiari syndrome
 - » cavernous haemangioma
 - » chronic liver disease
 - » focal nodular hyperplasia
 - » hepatic adenoma
 - » hepatosplenomegaly
 - » portal hypertension
 - » portal vein thrombosis

PCH

- Child and adolescent conditions:
 - » constipation
 - » gastric dysmotility
 - » gastro-oesophageal reflux
 - » Meckel diverticulum
 - » pulmonary aspiration
 - » swallowing issues
- Neonatal conditions:
 - » Conjugated hyperbilirubinaemia

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

Consider other factors

- » identify individual and social factors and the impact of

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS	Presentations • Evaluate for <i>H. pylori</i> infection with urea breath test • Evaluate for small bowel bacterial overgrowth and fat malabsorption • Inflammatory bowel disease (IBD) and intra-abdominal sepsis • Salivary and lacrimal gland imaging • Splenic lesions or suspected splenunculus • Suspected GI blood loss • Suspected malfunction or to confirm patency of hepatic catheter or peritoneal-venous shunts	these on diagnosis and management
Trainees will understand these presentations and conditions. Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.	Conditions • Abnormal splenic function and ectopic spleen • GI haemorrhage • <i>H. pylori</i> infection • Intestinal malabsorption • Known hepatic catheter and peritoneal-venous shunts • Salivary gland dysfunction • Tear duct blockage	
PCH	• GI bleeding • IBD • Liver and spleen disorders	
EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES	• Epidemiology of GI conditions: » gallbladder pathology » <i>H. pylori</i> infection » hepatic disease » primary and secondary GI motility disorders » small bowel bacterial overgrowth • GI anatomy: » colon and anus » gallbladder and biliary tree » liver anatomy » oesophagus » small bowel » splenic anatomy » stomach » vascular supply of the GI tract • Key radioisotopes and imaging protocols: » technetium and Gallium based radioisotopes » dual isotope imaging » patient preparation required for motility studies, gallbladder and abdominal imaging studies, in vivo testing » use and limitations of quantitative measures in GI nuclear studies » Guideline recommendations for assessing GI motility » alterations to standard GI motility imaging protocols » protocols for use in assessing gallbladder contraction • Pathophysiology of gastrointestinal conditions:	

	» describe the clinical conditions in which Tc99m labelled heat-damaged red blood cell studies may be of use » determinants of GI blood flow » discuss the underlying pathology of small bowel bacterial overgrowth and fat malabsorption » normal GI motility and its influences: ▪ biochemistry of urea / urease in the stomach ▪ mechanisms of transport and food mixing along the gastrointestinal tract ▪ normal patterns of stooling and mechanism of defaecation ▪ secretory functions of the GI tract » pathophysiology of common inflammation and infection in the gastrointestinal tract » physiology of the hepatobiliary system: ▪ biliary kinetics and its disorders ▪ metabolic functions of the liver, including bile production
PCH	• Embryology and development of the gastrointestinal tract
INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure. Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable	Investigations • Catheter and shunt patency studies • Colonic transit • Functional proctography • Gastric emptying • GI blood loss studies • Heat-damaged red cell study to evaluate for functional splenic tissue • Hepatobiliary studies, including pre-procedural quantification • In vitro nuclear medicine studies of the GI system, including: » C-13 / 14 breath tests » C-14 urea breath tests » Cr-51 labelled red blood cell blood loss study • Oesophageal motility and reflux • Salivary and lacrimal gland imaging • Small bowel transit Procedures • Accessing hepatic artery catheters and peritoneal-venous shunts to inject Tc-99m labelled tracers • Administration of Tc-99m labelled tracer into eye
PCH	• GI motility – colonic, gastric, and small bowel • Hepatobiliary scintigraphy for biliary atresia • Meckel scan • Milk scan / reflux • Salivary aspiration
IMPORTANT SPECIFIC ISSUES Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.	• Individual patient clinical indications to determine patients' needs, and the most appropriate approach to investigations and care • Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and the considerations when managing and following up these patients, such as travel from rural to metropolitan areas • Patient preparation requirements for GI disorders, including fasting, medication cessation, opiate use, and modification of protocols as required • Radiation protection, patient safety and consent

-
- Radioisotope decay and patient proximity to therapy / examination
 - Strengths and limitations of nuclear medicine scans and other imaging modalities for the assessment of GI conditions, including the impact of incomplete preparation on obtained scan results

PCH

- Premedication for HIDA study in neonates
 - Role of medications in GI studies, including hepatobiliary, Meckel, and transit studies
-

KEY PRESENTATIONS AND CONDITIONS Trainees will have a comprehensive depth of knowledge of these presentations and conditions.	Presentations - Assess for kidney scarring - Assess for the presence of clinically significant renovascular hypertension - Quantify differential kidney function - Suspected kidney outflow tract obstruction Conditions - Kidney failure - Kidney lesions requiring resection - Kidney tract infection - Kidney transplant - Renovascular hypertension - Urinary tract dilatation	For each presentation and condition, trainees will know how to: Synthesise » recognise the clinical presentation » identify relevant epidemiology, prevalence, pathophysiology, and clinical science » take a comprehensive clinical history » conduct an appropriate examination » establish a differential diagnosis » plan and arrange appropriate investigations » consider the impact of illness and disease on patients and their quality of life when developing a management plan Manage » provide evidence-based management » prescribe therapies tailored to patients' needs and conditions » recognise potential complications of disease and its management, and initiate preventative strategies » involve multidisciplinary teams Consider other factors » identify individual and social factors and the impact of these on diagnosis and management
LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS Trainees will understand these presentations and conditions. Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.	Presentations - Quantify glomerular filtration rate in vivo Conditions - Unexpected results on serum eGFR, for quantification such as unexpectedly high or low eGFR	Manage » provide evidence-based management » prescribe therapies tailored to patients' needs and conditions » recognise potential complications of disease and its management, and initiate preventative strategies » involve multidisciplinary teams Consider other factors » identify individual and social factors and the impact of these on diagnosis and management

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES

Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.

Anatomy and physiology

- Anatomical relations of the bladder, kidneys, and ureters in the abdomen and pelvis, and common variants
- Embryology and anatomy of the bladder, genital tracts, kidneys, and ureters
- Kidney mechanisms involved in blood volume and blood pressure, and the effects of diuretics on these mechanisms
- Physiological changes induced by acute and chronic kidney failure
- Physiological processes of glomerular filtration, kidney blood flow, urine formation, and their control
- Tubular processing of glomerular filtrate

Kidney imaging radioisotopes and imaging protocols

- Different kidney imaging radiopharmaceuticals and their benefits / limitations in relation to assessment of kidney function and physiology
- Diuretic renography
- Methods of quantitation that can be used in kidney studies and their limitations
- The role of post-void images and gravity-assisted drainage
- Timing of kidney cortical imaging studies to episodes of known or suspected infection
- Use of angiotensin converting enzyme (ACE) inhibitor protocol, including identifying when to use it, how to prepare the patient, and when to administer to maximise the diagnostic accuracy of the study

Pathophysiology

- Acute epididymitis and testicular torsion
- Acute kidney failure, including acute tubular necrosis (ATN) and acute cortical necrosis
- Acute pyelonephritis and kidney scarring
- Chronic kidney disease, including kidney failure
- Renovascular hypertension (RVH)
- Transplant rejection
- Types of urinary tract obstruction
- Vesicoureteric reflux

PCH

- Embryology and the impact on kidney tract anomalies
- Pathophysiology of paediatric kidney disease, including infection and subsequent kidney damage

INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Investigations

- Glomerular filtration rate (GFR) analysis
- Kidney scintigraphy:
 - » evaluation of disruption of normal kidney physiology in native and transplant kidneys
 - » evaluation of kidney cortical defects:
 - pinhole imaging
 - SPECT and/or SPECT / CT imaging
 - » evaluation of outflow tract obstruction:
 - diuresis renography protocols
 - isotopes appropriate to kidney function and their differences
 - quantitation parameters

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.	Procedures	• ACE inhibitor protocols
IMPORTANT SPECIFIC ISSUES	PCH	• Dynamic renal scan with diuretic administration • GFR • Radionuclide cystograms • Renal cortical scintigraphy
Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.	PCH	• Appropriate patient preparation for patients undergoing kidney scintigraphy for renovascular hypertension • Identify which ACE inhibitor to administer prior to the radiopharmaceutical, the dose, and the timing between administration of ACE inhibitors and commencement of scintigraphy • Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and the considerations when managing and following up these patients, such as travel from rural to metropolitan areas • Radiation protection, patient safety and consent • Radioisotope decay and patient proximity to therapy / examination • Timing, advantages, and limitations of investigations and procedures • Normal kidney growth and development • Patient age and the impact on kidney function and image interpretation

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Cancer staging with suspected osseous involvement
- Joint pain, stiffness, and swelling
- Musculoskeletal pain and trauma, including sporting injuries and suspected occult fractures
- Complications relating to prosthetic joint replacements and spinal surgery
- Suspected bone and joint infections
- Localising active pathology prior to consideration of targeted interventions / management
- Benign bone lesions:
 - » incidental findings on structural imaging

Conditions

- Arthritis and related conditions
- Musculoskeletal injuries
- Oncological conditions with bone metastases

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

Consider other factors

- » identify individual and social factors and the impact of these on diagnosis and management

- Bone and joint pain
- Bone trauma including non-accidental injury (NAI)
- Musculoskeletal infection:
 - » discitis
 - » osteomyelitis
 - » septic arthritis

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS

Trainees will understand these presentations and conditions.

Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.

Presentations

- Autonomic dysreflexia
- Complex regional pain syndrome (sympathetic dystrophy)
- Skeletal manifestations of metabolic disorders

Conditions

- Infective conditions, including:
 - » discitis
 - » osteomyelitis
 - » septic arthritis
- Metabolic bone disease, including:
 - » hyperparathyroidism
 - » osteomalacia
 - » Paget's disease
 - » renal osteodystrophy
- Post-surgical fusion complications, including:
 - » infection
 - » loosening
 - » peri-prosthetic fracture
- Prosthetic joint complications, including:
 - » infection
 - » loosening
 - » peri-prosthetic fracture
- Soft tissue calcification, including:
 - » heterotopic ossification
 - » myositis ossificans

- Complex regional pain syndrome
- Perthes disease
- Slipped capital epiphyseal injuries

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES

Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.

- Absorption of calcium and phosphate, and their relationship to bone growth and resorption
- Anatomy of skeletal ligaments, muscles, and tendons
- Anatomy of the bones and joints of the pelvis, skull, spine, thorax, and upper and lower limbs
- Blood pool imaging, pinhole imaging, and SPECT and SPECT / CT in bone scintigraphy
- Bone and joint degeneration with age, and typical 'normal' patterns
- Cellular biology of skeletal metastasis
- Differentiate between primary injury and secondary compensatory (adaptive) effects
- Effects of parathyroid hormone and calcitonin on bone metabolism

- Normal and abnormal patterns of lymphatic drainage
- Pathophysiological effect of injury on local bone metabolism and duration of effect
- Patterns of injury associated with sports or practices
- Physiology of normal bone and muscle healing, and pathological changes of post-surgical interventions
- The pathophysiological mechanisms of acute and chronic inflammation with a focus on cell-mediated and humoral immune responses, and their potential application in molecular imaging
- The relationship between extracellular calcium and phosphate concentrations and bone metabolism
- The role of complementary studies, such as:
 - » bone marrow scintigraphy
 - » FDG PET
 - » gallium-67 scintigraphy
 - » leukocyte scintigraphy
-

PCH

- Differences that occur in the normal physiology of growth and development and the pathophysiology of common paediatric diseases, including common sites of pathology in bone metastases and osteomyelitis
- Knowledge of typical patterns of stress fracture and apophyseal injury in children and adolescents
- Normal distribution of bone, labelled white blood cell studies and PET isotopes in paediatric patients
- Recognition of non-accidental injury, including knowledge of typical sites and role of radionuclide skeletal survey

INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

Investigations

- Bone scintigraphy:
 - » pinhole imaging
 - » planar bone scintigraphy
 - » SPECT
 - » SPECT / CT
 - » three-phase bone scanning
- Infection imaging:
 - » bone marrow scan
 - » Ga-67
 - » In-111 or Tc-99m labelled white cells
 - » PET / CT
 - » radiolabelled monoclonal antibodies
 - » white cell scintigraphy
- Complementary imaging modalities:
 - » CT
 - » MRI
 - » ultrasound
 - » x-ray
- PET / CT:
 - » F-18 FDG PET / CT scans
 - » F-18 NaF PET
 - » other PET radiopharmaceuticals
- Lymphoscintigraphy (assessment of lymphatic drainage)

- Bone scintigraphy:
 - » pinhole imaging
 - » planar bone scintigraphy
 - » SPECT
 - » SPECT / CT
 - » three-phase bone scanning
- Infection imaging:
 - » bone marrow scan
 - » PET / CT
 - » white cell scintigraphy
- Complementary imaging modalities:
 - » CT
 - » MRI
 - » ultrasound
 - » x-ray
- PET / CT:
 - » F-18 FDG PET / CT scans
 - » F-18 NaF PET
 - »

IMPORTANT SPECIFIC ISSUES

Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.

- Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and the considerations when managing and following up these patients, such as travel from rural to metropolitan areas
- Radiation protection, radiation safety and consent

- Determine appropriate studies in paediatric patients, and the techniques required
- Understand the legal ramifications and duty of care involved in cases of non-accidental injury for the paediatric population, including mandatory reporting requirements

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Assess brain function, including:
 - » alterations in cognition
 - » suspected brain death

Conditions

- Brain death
- Brain tumours
- Cerebrovascular disease, including:
 - » chronic ischaemia
 - » moyamoya disease
 - » stroke
- Epilepsy:
 - » non-temporal lobe focal epilepsy
 - » temporal lobe
- Neurodegenerative disorders, including dementia, such as:
 - » Alzheimer disease
 - » dementia with Lewy bodies
 - » frontotemporal dementia
 - » vascular dementia
- Parkinson disease and other movement disorders

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

Consider other factors

- » identify individual and social factors and the impact of these on diagnosis and management

PCH

- Brain death
- Brain tumours and recurrence
- Epilepsy
- VP shunt dysfunction

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS Trainees will understand these presentations and conditions. Advanced Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.	Presentations • Encephalitis • Suspected cerebrospinal fluid (CSF) shunt complications, such as obstruction or leak • Suspected normal pressure hydrocephalus Conditions • CSF leak • CSF shunt blockage • Normal pressure hydrocephalus	
EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.	PCH • Vascular disorders, including moyamoya disease	• Anatomy of the brain and spinal cord, with particular emphasis on cross-sectional anatomy • Cerebral arteries, the territories that they perfuse, and their relations to other cerebral structures • Cerebral blood volume and luxury perfusion • Cerebral veins and sinuses, and their relations to other cerebral structures • Cerebral ventricles and their relations to other cerebral structures, including the spinal cord • Describe the pathophysiology of: » atherosclerosis » cerebral atrophy and neurodegeneration » cerebral ischaemia and infarction » cerebral tumours – primary and secondary » encephalitis • Intracerebral structures of the brain in coronal, sagittal, and transverse planes • Intracranial aneurysms and vascular malformations • Pathophysiology and classification of dementias • Pathophysiology and classification of seizures • Pathophysiology of: » CSF leaks » non-obstructed hydrocephalus » normal pressure hydrocephalus » obstructed hydrocephalus • Pathophysiology of acute and chronic cerebral ischaemia • Pathophysiology of brain death • Pathophysiology of Parkinson disease and other movement disorders • Physiology of cerebral perfusion and autoregulation • Physiology of CSF production and flow: » types of CSF shunts and reservoirs that are typically used in management of obstruction, and how to access them • Surface markings of the cerebral lobes • The basic sciences related to radiotracers used in nuclear medicine imaging of the neural axis • The relationship between cerebral perfusion and cerebral metabolism in health and disease

- The temporal effect of seizures on cerebral blood flow and metabolism

INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

Investigations

- Incorporating complementary imaging techniques into the evaluation of impaired neurological function:
 - » carotid doppler ultrasound
 - » CT
 - » MRI
- PET brain imaging:
 - » PET tracers, including:
 - amino acid tracers, such as F-18 FET
 - beta amyloid tracers
 - F-18 FDG
 - Tau tracers
- Scintigraphic assessment of cerebral perfusion:
 - » SPECT brain imaging, including:
 - ictal and interictal cerebral perfusion imaging
- Scintigraphic assessment of CSF circulation:
 - » CSF shunt studies, including:
 - CSF leak study and pledget radioactivity
 - radionuclide cisternography
 - radionuclide shunt scintigram

Procedures

- Acetazolamide challenge in assessing cerebral perfusion reserve
- CSF shunt access / organising instillation of radiolabelled tracer into shunt reservoir
- Lumbar puncture, as per local practices

PCH

- Cerebral SPECT
- CSF shunt patency
- Epilepsy – ictal and interictal SPECT
- Epilepsy – PET / CT

IMPORTANT SPECIFIC ISSUES

Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.

- Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and the considerations when managing and following up these patients, such as travel from rural to metropolitan areas
- Radiation protection, patient safety and consent
- Radioisotope decay and patient proximity to the procedure

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Evaluate response to oncological treatment
- Known cancer diagnosis for staging
- Preoperative sentinel node mapping
- Suspected recurrence of malignancy for restaging

Conditions

- Breast cancer
- Cancer of unknown primary
- Gynaecologic oncology
- Haematologic malignancies
- Head and neck cancer
- Lung cancer
- Melanoma and non-melanoma skin cancers
- Neuro-oncology
- Neuroendocrine tumours
- Primary and secondary osseous disease
- Prostate cancer
- Sarcoma
- Thyroid cancer
- Upper and lower gastrointestinal (GI) cancer
- Urological and testicular malignancies

PCH

- Central nervous system (CNS) malignancies
- Lymphoma
- Neuroblastoma
- Sarcoma – bone and soft tissue
- Thyroid cancer

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS

Trainees will understand these presentations and conditions.

Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.

Presentations

- Known rare or uncommon cancer diagnosis for initial staging

Conditions

- Other rare and uncommon cancers, including but not limited to:
 - » gallbladder and extrahepatic bile ducts
 - » GI stromal tumours (GIST)
 - » Kaposi sarcoma
 - » Merkel cell cancer
 - » mesothelioma
 - » multiple myeloma
 - » pancreatic cancer

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

Consider other factors

- » identify individual and social factors and the impact of these on diagnosis and management

	» penile cancer » peritoneal cancer » primary liver cancer	
PCH	• Role of nuclear medicine, including PET, in the assessment of less common paediatric malignancies	

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES

Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.

Fundamentals of cancer biology relevant to nuclear medicine

- Cancer genetics (e.g. hereditary cancer syndromes, relevant cancer gene mutations)
- Tumorigenesis (e.g. clonal differentiation)

Basic principles of chemotherapy, targeted therapy and immunotherapy

Fundamentals of radiobiology, radiotherapy and radionuclide therapy

The clinical science, epidemiology, pathophysiology, and staging of key and less common cancer types

Assessment of oncological disorders with PET

- Mechanism and kinetics of PET isotope uptake for common radiopharmaceuticals, including but not limited to F-18 FDG, Ga-68-DOTA-Octreotate and F-18 and/or Ga-68 PSMA:
 - » difference in radioisotope uptake between normal and malignant cells
 - » malignancies are suited for various PET radiopharmaceuticals
 - » optimal timing of image acquisition for different PET radiotracers following injection, including dual time point imaging (where applicable)
 - » patterns of normal physiologic tracer distribution for the different PET radiopharmaceuticals
- Methods of quantitation, such as standardised uptake values, including SUVmax, SUVmean, and SUVpeak, metabolic tumour volume (MTV), and total glycolytic volume (TGV), and their use and limitations
- Partial volume effect and its influence of quantitative parameters

Assessment of oncological disorders with SPECT

- Cell biology of bone tracer uptake in skeletal metastasis
- Flare response in skeletal scintigraphy – timing and management strategies

Treatment of oncological disorders with radionuclide therapies or Theranostics

- Suitable conditions for radionuclide therapies (Theranostics), such as hepatic and osseous metastases, neuroendocrine tumours, prostate cancer, and thyroid cancer

PCH

- Understanding of common genetic associations with childhood cancers

INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including

Investigations

- Liver and lung SPECT / CT for SIRT dosimetry work-up
- Lymphoscintigraphy for sentinel node mapping
- PET / CT staging of tumours using appropriate cancer staging guidelines
- Single photon studies for assessment of bone metastatic disease
- Single photon studies for assessment of eligibility for and effects of cancer treatment (e.g. cardiac and renal studies)

relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure. Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.	• The role of diagnostic CT, MRI and ultrasound in cancer diagnoses and management Procedures • Injection techniques for sentinel node mapping, including pain minimisation strategies PCH • I-123 MIBG for neuroblastoma (including thyroid blockade) and role of other PET agents • PET / CT staging of tumours using appropriate cancer staging guidelines
IMPORTANT SPECIFIC ISSUES Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.	• Diagnostic study reporting: » correlating various imaging modalities for correct interpretation of nuclear medicine investigations » good working knowledge of diagnostic CT and cross-sectional anatomy (minimum standard) » interpretation of images to distinguish non-malignant findings, such as: ▪ benign mimics, such as Warthin tumour ▪ infection / inflammation ▪ normal physiologic uptake ▪ reactive findings ▪ treatment-related adverse effects » knowledge of appropriate use of PET scoring systems, such as Deauville 5-point scale and modified Krenning score » local software for reporting and providing clear and accurate reports for investigations » provide timely, clear, and accurate reports which address the clinical question Assessment of oncological disorders with PET • Acquisition protocols for PET and CT components, including use of contrast CT • Methods of response assessment for clinical trials, such as the Deauville score in lymphoma, PET response evaluation criteria in solid tumours (PERCIST), and response criteria in solid tumours (RECIST), and the limitations of these criteria • Optimum time for scanning in relation to chemotherapy, immunotherapy, radiotherapy, and surgery • PET protocols for management of abnormal blood glucose levels in patients undergoing FDG PET / CT studies • PET protocols for optimising tumour visualisation, such as brown fat suppression and sedation (where appropriate) Assessment of oncological disorders with SPECT • Application of lymphoscintigraphy for staging in breast carcinoma, genitourinary cancers (penile, vulval), and melanoma: » common lymphatic drainage patterns » influence of intra-tumoral, peri-tumoral, and peri-areolar injection in breast cancer

-
- Knowledge of guidelines and recommendations for tumour absorbed dose, normal liver dose, and lung dose during SIRT for various liver cancers
 - Knowledge of the principles of palliative care
 - Management of physical interventions, such as hydration of patients undergoing bone scans
 - Performance of bone scintigraphy for staging and response assessment in different cancer types
 - Quantification of tumour:
 - » background ratio in liver MAA SPECT / CT scans performed for SIRT work-up
 - » calculation of tumour absorbed radiation dose
 - » predicted dose to normal liver and lung
 - The role and limitations of bone scintigraphy in assessing skeletal metastatic disease
 - The role of CT in assessing response in skeletal metastases
 - The role of pre- and post-therapy cardiac and kidney surveillance with serial gated blood pool studies and nuclear GFR studies in patients receiving potentially toxic treatments, such as anti-HER2 therapies in breast cancer (heart) and carboplatin chemotherapy for ovarian cancer (kidneys)
-

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Dyspnoea and/or pleuritic chest pain – suspected pulmonary embolism (PE)

Conditions

- PE

PCH

- Congenital pulmonary and cardiac abnormalities
- PE

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS

Trainees will understand these presentations and conditions.

Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.

Presentations

- Lung segment quantitation prior to lung volume reduction surgery
- Suspected hepatopulmonary, intrapulmonary, and pleuroperitoneal shunt

Conditions

- Chronic obstructive pulmonary disease (COPD)
- Inflammatory and infective lung disease
- Pulmonary hypertension

PCH

- Suspected right to left shunt

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate targeted examination (if relevant)
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management recommendations
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, noting preventative strategies
- » involve and contribute to multidisciplinary teams

Consider other factors

- » identify individual and social factors and the impact of these on diagnosis and management

EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES

Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.

Pulmonary anatomy and physiology

- Arterial blood supply to the lungs
- Bronchopulmonary segments and their appearance on both two-dimensional and three-dimensional (cross-sectional) imaging
- Knowledge of radiotracers and imaging protocols used in pulmonary nuclear medicine imaging, including:
 - » advantages and disadvantages
 - » biological half-life and pharmacokinetics, including in breast milk
 - » dosimetry estimates for patients (and in pregnancy, for fetus and breast tissue)
 - » method of administration
- Lobes and fissures of the lungs and their anatomical relations within the thorax
- Metabolic functions of the lung and its effects on lung physiology
- Pathophysiology of left to right shunts and pulmonary hypertension, including hepatopulmonary and pleuroperitoneal shunts, and the risks of injecting MAA particles in these settings
- Physiologic features:
 - » gas exchange, measurement of gas exchange, and mechanisms of abnormal function
 - » pulmonary circulation, measurement of pulmonary circulation, and patterns of abnormal circulation
 - » ventilatory function, measurement of ventilatory function, and patterns of abnormal function
- Relationship between pulmonary blood flow and pulmonary ventilation under normal conditions and in PE

INVESTIGATION, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

Investigations

- Novel PET tracers used in ventilation / perfusion scintigraphy, such as Galligas (Ga-68carbon nanoparticles) and Ga-68 MAA
- Ventilation perfusion (VQ) lung scintigraphy:
 - » planar
 - » quantitative planar
 - » SPECT
 - » SPECT / CT

PCH

- VQ lung scintigraphy

IMPORTANT SPECIFIC ISSUES

Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.

- Managing unstable PE patients
- Utilisation of low dose CT in conjunction with VQ SPECT
- VQ lung scanning in specific patient populations:
 - » breastfeeding and pregnant women with suspected PE
 - » contrast allergies
 - » kidney impairment

Ancillary tests and complementary imaging techniques for PE

- Supplementary investigations in assessing and stratifying PE, such as:
 - » arterial blood gas measurements
 - » chest radiography
 - » CT pulmonary angiography
 - » ECG
 - » serum D-dimer assays

Assessment, management, and outcomes of PE and deep venous thrombosis (DVT)

- Bayesian analysis principles applied to diagnostic tests
 - Clinical signs and symptoms of DVT and PE, their sensitivity and specificity in detection, and exclusion of PE and clinical scoring systems, including role of physician bias
 - Describe strengths and weaknesses of planar and SPECT imaging
 - Identification and assessment of VQ mismatch on SPECT and planar imaging
 - Interpretation criteria for planar imaging interpretation, such as Biello or PIOPED II
 - Interpretation of SPECT / CT studies correlating functional and anatomical imaging appearances, including guidelines recommendations, such as EANM
 - Mortality and morbidity of treated and untreated DVT and PE
 - Non-scintigraphy methods of DVT detection, including:
 - » compression ultrasound
 - » contrast venography
 - Recurrence rate of DVT and PE and long-term sequelae
 - Risk factors for DVT and PE
-

KEY PRESENTATIONS AND CONDITIONS

Trainees will have a comprehensive depth of knowledge of these presentations and conditions.

Presentations

- Autoimmune disorders
- Febrile and inflammatory illness
- Occult infections and sepsis

Conditions

- Febrile neutropenia
- Infections:
 - » bone
 - » cardiac
 - » intra-abdominal
 - » metastatic infection and bacteraemia of unknown origin
 - » soft-tissue
 - » vascular
- Inflammatory disorders:
 - » inflammatory arthritis
 - » inflammatory bowel disease (IBD)
 - » large vessel vasculitis
 - » polymyalgia rheumatica
 - » sarcoidosis
- Pyrexia of unknown origin (PUO)
- Undifferentiated 'serious' disease in adults

PCH

- Infections:
 - » atypical infections
 - » bone and soft tissues
 - » febrile neutropenia
 - » PUO
- Inflammation:
 - » vasculitis
 - » inflammatory bowel disease

For each presentation and condition, trainees will **know how to:**

Synthesise

- » recognise the clinical presentation
- » identify relevant epidemiology, prevalence, pathophysiology, and clinical science
- » take a comprehensive clinical history
- » conduct an appropriate examination
- » establish a differential diagnosis
- » plan and arrange appropriate investigations
- » consider the impact of illness and disease on patients and their quality of life when developing a management plan

Manage

- » provide evidence-based management
- » prescribe therapies tailored to patients' needs and conditions
- » recognise potential complications of disease and its management, and initiate preventative strategies
- » involve multidisciplinary teams

LESS COMMON OR MORE COMPLEX PRESENTATIONS AND CONDITIONS

Advanced Trainees will understand these presentations and conditions.

Advanced Trainees will understand the resources that should be used to help manage patients with these presentations and conditions.

Presentations

- AIDS-associated or immunocompromised opportunistic infections and malignancy
- Devices or prosthetic infections
- Immune-related adverse events (irAE) associated with immunotherapy treatment for malignancy
- Post-operative infections
- Rare inflammatory disorders
- Tuberculosis

Conditions

- Endocarditis

Consider other factors

- » identify individual and social factors and the impact of these on diagnosis and management

	• Graft-versus-host disease • Infections of intravascular devices, pacemakers, and prosthetic valves • Infiltrative disease, such as IgG4 disease and Langerhans cell histiocytosis	
EPIDEMIOLOGY, PATHOPHYSIOLOGY, AND CLINICAL SCIENCES Advanced Trainees will have a comprehensive depth of knowledge of the principles of the foundational sciences.	• Aetiology of PUO, including secondary to infective, inflammatory, neoplastic, and miscellaneous conditions • Definition of PUO • Epidemiological risk factors for infections in immunocompetent and immunocompromised patients, including both medical and non-medical factors, such as cultural, geographic, and socioeconomic factors • Localised organ involvement in bacteraemia, especially <i>S. aureus</i> and enterobacteria, and disseminated fungal infections • Pathophysiology of inflammatory conditions, including: » COVID-19 » inflammatory arthropathies, such as: ▪ ankylosing spondylitis ▪ gout ▪ rheumatoid arthritis » inflammatory bowel disease (IBD) » large vessel vasculitis, such as giant cell arteritis and Takayasu arteritis » mycobacterial infections, including mycobacterium avian complex (MAC)HIV and mycobacterium tuberculosis » polymyalgia rheumatica » sarcoidosis • Physiology of normal healing, and pathological changes of post-surgical interventions • The pathophysiological mechanisms of acute and chronic inflammation with a focus on cellular-mediated and humoral-mediated immune responses, and their potential application in molecular imaging	
	PCH • Basic normal physiology of development in organ systems in infants, children, and adolescents • Common disorders of the immune system in the paediatric population, including juvenile idiopathic arthritis and vasculitis	
INVESTIGATIONS, PROCEDURES, AND CLINICAL ASSESSMENT TOOLS Advanced Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.	Investigations • Common laboratory investigations for the initial work-up of infection and inflammation, including biochemical, haematological, and serological markers • Complementary imaging modalities: » CT » MRI » ultrasound » x-ray • Infection imaging: » bone marrow scan » Ga-67 scan » In-111 or Tc-99m labelled white cell scintigraphy » PET, including F18-FDG and other novel radiopharmaceuticals » radiolabelled monoclonal antibodies	

Advanced Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

» three-phase bone scan

PCH

- Labelled white cell scintigraphy
- PET including F-18 FDG and other novel radiopharmaceuticals
- Three phase bone scan

**IMPORTANT
SPECIFIC ISSUES**

Advanced Trainees will identify important specialty-specific issues and the impact of these on diagnosis and management and integrate these into care.

- Clinical impact of treatment, including antimicrobials and corticosteroids, on image interpretation and test utility
 - Patient demographics, including geographic location, socioeconomic status, ethnicity, and cultural background, and the considerations when managing and following up these patients, such as travel from rural to metropolitan areas
 - Patient preparation prior to scan, including fasting, dietary modifications, and importance of glycaemic control
 - Provide specific instructions to modify patient preparation, and study acquisition protocols tailored to specific inflammatory or infectious conditions of interest
 - The limitations and pitfalls of imaging studies in identifying causes of infection and inflammation
-

**EPIDEMIOLOGY,
PATHOPHYSIOLOGY,
AND CLINICAL
SCIENCES**

Trainees will have in-depth knowledge of the topics listed under each clinical sciences heading.

For the statistical and epidemiological concepts listed, trainees should be able to describe the underlying rationale, the indications for using one test or method over another, and the calculations required to generate descriptive statistics.

- Diseases suitable for therapeutic nuclear medicine and Theranostics
- Evolving application and technology, including limitations
- Indications and roles of therapeutic nuclear medicine treatment options relevant to different treatment settings
- Link between radioisotope and radiopharmaceutical efficacy and other treatment modalities and the impact on treatment planning, including altered disease microenvironments, radiosensitising agents, and regulation of molecular target
- Molecular target and properties suitable for therapeutic nuclear medicine
- Personalised care and disease heterogeneity, and roles of dual or multi-tracer Theranostics imaging, as well as multi-modality therapy, combination, or sequential approaches
- Radiopharmaceutical- and radiation-related side effects / toxicity, including general and organ specific, both acute and chronic, including cumulative radiation dose limitation to critical organs
- Radiopharmacy, radionuclide therapy, and radioligand therapy, and recognition of Theranostics pairs
- Selection of radioisotope and radioligand based on disease types, patient factors, properties, and target molecules

PCH

- Impact of therapy on the patient and family:
 - » age of patient
 - » child-friendly environment
 - » continence and disposal of radioactive waste
 - » method of administration
- Radiation precautions and impact on family members
- Theranostics for the treatment of:
 - » neuroblastoma
 - » thyroid cancer

**INVESTIGATIONS,
PROCEDURES,
AND CLINICAL
ASSESSMENT TOOLS**

Trainees will know the scientific foundation of each investigation and procedure, including relevant anatomy and physiology. They will be able to interpret the reported results of each investigation or procedure.

Trainees will know how to explain the investigation or procedure to patients, families, and carers, and be able to explain procedural risk and obtain informed consent where applicable.

- Theranostics imaging including PET and planar / SPECT imaging

**IMPORTANT
SPECIFIC ISSUES**

Advanced Trainees will identify important specialty-specific issues and the impact of these on diagnosis, management and outcomes.

Clinical trials

- Adherence to trial protocols
- Conflicts in care decisions or wishes
- Consenting for trials
- Escalation pathways for deviations
- Identification of trial-suitable candidates
- Liaising closely with clinical trial units

Collaboration and longitudinal care

- Appropriate restaging and surveillance protocols
- Common and less common side effects of radioligand therapies
- Incidental findings identified through Theranostics imaging during therapy
- Patient reassessment imaging modalities and surveillance schedule
- Post-therapy imaging, clinical, and biochemical monitoring
- Response assessments to determine durability of treatments, treatment pauses, and criteria for re-treatment
- Pain management, advanced care planning, recognition of terminal decline and end-of-life care

Diagnostic and assessment

- Different disease imaging phenotypes and relationship with disease behaviour and heterogeneity, in context of Theranostics
- Imaging interpretation of anatomical correlated structural imaging, PET, scintigraphic planar, and SPECT, including imaging phenotypes recognition and imaging features quantifications assessment, relevant to treatment suitability and planning
- Incorporate clinical assessment and biomarkers to guide personalised treatment decision and planning
- Interpretation and application of imaging features quantification to guide personalised treatment decision and planning, including dosimetry and response assessment
- Suitability assessment through recognition of disease heterogeneity, including molecular target through relevant nuclear medicine Theranostics imaging

Patient-centred consideration

- Cultural, geographical, psychological, and socioeconomic factors in the accessibility and suitability of therapeutic nuclear medicine treatment modalities
- Effects and adverse events related to radioisotopes and radiopharmaceuticals therapy, including prompts for emergency escalation
- Identify individualised patient condition, risk factors, and comorbidities relevant to therapeutic nuclear medicine, including radiation exposure and contamination risks

Therapeutic and management

- Administration logistics of therapy and radiation safety practice, including:
 - » management of patients during treatment and observation periods
 - » management of potential radiation contamination
 - » radiation shielding of staff
 - Appropriate preparations in consideration of patients' conditions, disease types, risk factors, specific radioisotope or radiopharmaceutical, and, if applicable, concurrent treatments
 - Infusion extravasation, radiation contamination, and reaction
-

-
- Management of administrations or applications of therapeutic radioisotopes and radiopharmaceuticals appropriate for disease types and in line with radiation safety practice
 - Personalised, multidisciplinary treatment plans and dosing to individual patients, disease response pattern, toxicity, and post-treatment imaging data, including dosimetry and biomarkers
 - Radiopharmaceutical- and radiation-related toxicities, including general and organ specific, as well as treatment related adverse events

Quality control considerations

- Impact of supply chain availability, and shelf life on treatment planning
 - Quality control of radioisotope, radiopharmaceutical, and imaging data, including verification of QC of each radiopharmaceutical batch
 - Radiation safety guidelines and regulatory requirements
 - Awareness of published recommendations for Theranostics service and facility design and relevant regulatory requirements
-