

31.0 Medical Imaging Unit – Nuclear Medicine

31.1 Introduction

31.1.1 Description

The Nuclear Medicine Unit provides facilities for the administration of radiopharmaceutical agents to patients and patient imaging for diagnostic purposes and for treatment. The Nuclear Medicine Unit may be provided within the Medical Imaging Unit or as a freestanding Unit. The Unit may or may not include a Radiopharmacy Laboratory. The size of a unit in terms of numbers and type of cameras will be determined by the service plan and clinical needs.

31.2 Planning

31.2.1 Model of Care

The model of care will depend on level of services provided as defined in the service plan and the presence or otherwise of PET as a sub-component of the Nuclear Medicine Unit. In large centers, it will be a discrete unit. If there are only one or two gamma cameras, it may be a discrete sub-unit of Medical Imaging.

All units will have a Hot Laboratory (Hot Lab). Large centers may or may not include a Radiopharmacy Laboratory that will prepare its own radiopharmaceuticals for general use.

31.2.2 Planning Models

Location

A ground floor site is preferred but if this cannot be achieved, consideration should be given to units above, below and adjoining the proposed location with regard to radiation shielding requirements, the weight of equipment and associated shielding and access for equipment and radioactive isotopes.

The Unit should not act as a thoroughfare to other units of the healthcare facility.

Unit Layout

Staff and patient flows in the Unit are critical to ensure that patients, staff and visitors are not exposed to radiation as a result of travel through or adjacent to areas occupied by dosed patients and scanning rooms. Effective layout can also reduce the need for costly radiation shielding.

Layout should address the need for separation of areas particularly patient and staff corridors and entry areas for outpatients and inpatient on beds/trolleys. Unit design and operational Policies should address the management of radioactive substances including how radioactive substances will be delivered to the Unit and how radioactive waste will be removed.

If provided, the Bone Density Room should be located near the entry to the Nuclear Medicine Unit to ensure patients do not unnecessarily cross areas of radioactivity. The Bone Densitometry room should be located away from dosed patients by distance or shielding to avoid interference to the Bone Density Unit from high ambient radiation levels.

31.2.3 Functional Areas

The Nuclear Medicine Unit consists of the following functional areas:

- Reception/Administration
- Waiting areas for outpatients and inpatients, including toilets
- Patient holding, observation and recovery area
- Treatment areas including gamma camera rooms, specialized scanning imaging rooms (SPECT, PET, PET/CT, bone densitometry), stress testing facilities
- Support areas including utilities, staff station
- Hot Lab/Radioactive Waste Store
- Staff areas including offices and amenities
- Teaching and research facilities (Tertiary Centers).

Patient Waiting

Waiting areas should allow separation of dosed and undosed patients, particularly as some patients may need to wait for 45 minutes after dosing for uptake. It is also preferable to separate dosed patients from relatives and visitors to the unit which may include young adults, pregnant women and children. Dosed patients should have access to drinking water and toilet facilities without having to access general waiting areas.

Outpatients should be separated from inpatients for privacy reasons with separate entrances.

Patient Holding, Observation and Recovery Area

An area will be required for patient holding, recovery and observation including the following:

- A dedicated inpatient entry
- Curtained bed/trolley bays for holding, observation and recovery; the configuration of the overall space should permit both dosed and un-dosed patients to be held safely
- A small staff station with hand basin
- Support rooms including Dirty Utility, Linen Bay, Sterile Stock Store
- Resuscitation trolley (trolley may be located near the Stress Testing Room).

Gamma Camera

The gamma camera is a device used in Nuclear Medicine to image gamma radiation emitting radioisotopes to view and analyses images of the human body or the distribution of medically injected, inhaled, or ingested radionuclides emitting gamma rays, producing a two dimensional image.

The gamma camera consists of one or more flat crystal planes (detectors) optically coupled to an array of photomultiplier tubes, the assembly is known as a 'head', -mounted on a gantry. The gantry is connected to a computer system that both controls the operation of the camera as well as acquisition and storage of acquired images. The gamma camera room will require a control area and radiation screening as assessed by Radiation Consultants.

Single Photon Emission Computed Tomography (SPECT)

SPECT is a nuclear medicine tomographic imaging technique using gamma rays, similar to the conventional gamma camera planar imaging system that is able to provide true 3D information. This information is typically presented as cross-sectional slices through the patient, but can be freely reformatted or manipulated as required.

To acquire SPECT images, the gamma camera is rotated around the patient. Projections are acquired at defined points during the rotation, typically every 3–6 degrees. In most cases, a full 360 degree rotation is used to obtain an optimal reconstruction. The time taken to obtain each projection is also variable, but 15–20 seconds is typical. This gives a total scan time of 15–20 minutes.

A SPECT camera may be combined with a computerized tomography (CT) unit to form a hybrid system and fusion imaging of the physiology and anatomy of the area/s being scanned. SPECT/CT requires a separate control room and radiation screening in accordance with CT requirements.

Viewing and Reporting Area

A dedicated room with dimmable lighting will be required for viewing and reporting on scans. Each workstation should accommodate imaging screens, computers for access to imaging and patient information systems, writing and shelving space for reference materials. The number of reporting stations will depend on service level, number of scanning rooms and the staff establishment.

Hot Lab/Dispensary and Radioactive Waste Storage

Radioactive radiopharmaceuticals are stored and prepared ready for administration to the patient in the Hot Lab. A lead screen barrier is required for the dispensary area. The Dispensary should be located adjacent to the patient dosing room.

A radioactive waste storage area may also be incorporated into or adjacent to this space. Provide radiation shielding as advised by Radiation Consultants. The Waste Store will require a sink and basin with hands-free taps for hand washing and equipment decontamination.

The radioactive storage and preparation area would be generally equipped with a special radioisotope fume hood. This system may need to be fabricated from non-ferrous materials. Exhaust registers should be located at floor and ceiling levels.

Radiopharmacy

The Radiopharmacy is used for preparation, compounding, quality control and dispensing of radiopharmaceuticals for diagnosis and treatment. Radiopharmaceuticals are radioactive isotopes attached to pharmaceutical substances.

Only designated units will have an in-house Radiopharmacy laboratory where cold kits are prepared; these may be used in-house or supplied to other Nuclear Medicine Units.

Many nuclear medicine units (e.g. private practices) may receive a daily delivery of the radiopharmaceutical already prepared and dispensed as individual patient doses. Other isotopes/radionuclides (e.g. gallium, thallium) are delivered weekly or monthly as required, pre-packaged into individual doses for dispensing.

Storage – Equipment and Supplies

Storage is required for:

- Collimators and scanning phantoms, within the scanning rooms.
- Mobile equipment such as wheelchairs, trolleys, lifters and ultrasound scanners, may be located in equipment bays
- Technegas unit and large argon cylinder/s that may be located in an equipment bay ; the Technegas unit and trolley is taken to patients in holding bays or in the camera rooms for patient to inhale Tc99m
- Medical consumables and smaller equipment items
- Sterile stock
- Stationery
- Records/files.

31.2.4 Functional Relationships

The Nuclear Medicine Unit should be located with ready access to the Medical Imaging Unit, PET Unit if provided, Emergency Unit, Operating Unit and Critical Care areas. It requires easy access for ambulant patients and beds/stretchers.

31.3 Design

31.3.1 Construction Standards

Construction Standards for a Nuclear Medicine Unit include the following:

- Flooring shall be adequate to meet load requirements for equipment, patients, and personnel.
- Floors and walls should be constructed of materials that are easily decontaminated in case of radioactive spills.
- Walls should contain necessary support systems for either built-in or mobile oxygen and vacuum, and vents for radioactive gases.
- Provision for cable trays, ducts or conduits should be made in floors, walls, and ceilings as required.
- Ceiling height should be a minimum of three meters in procedure or scanning rooms.
- Ceiling -mounted equipment should have properly designed rigid support structures located above the finished ceiling.
- A lay-in type ceiling should be considered for ease of installation, service and future remodeling.

31.3.2 Environmental Considerations

Acoustics

Acoustic treatment will be required to the following areas:

- SPECT/CT scanning rooms (hybrid units may be noisy)
- Viewing/reporting room
- Consulting rooms.

Refer also to acoustic requirements identified in Standard Components Room Data Sheets.

Natural Light

Natural light is desirable in all patient areas, staff room and staff offices. Lighting level in reporting rooms needs to be adjustable. External windows provided in scanning and uptake rooms should be assessed by a Radiation Consultant for shielding requirements.

31.3.3 Safety and Security

The Nuclear Medicine Unit shall include a safety shower with an eyewash station for use in the event of radioactive spills.

31.3.4 Finishes

Floor finishes and junctions should be smooth, impervious and non-absorbent in case of radiation spills.

31.3.5 Building Service Requirements

Radiation Protection

Plans and specifications will require assessment for radiation protection by a certified physicist or other qualified expert, as required by the appropriate state authorities. The radiation protection assessment will specify the type, location and amount of radiation protection required according to the final equipment selections and layout. Radiation protection requirements shall be incorporated into the final specifications and the building plans.

Radiation shielding will be required to a number of areas as advised by Radiation Consultants including:

- Reception and rooms adjacent to dosed patient rooms
- Dosing/Consult Exam rooms
- Hot Lab/Dispensing room/Radiopharmacy
- Pre-scan uptake rooms/dosed waiting areas, patient toilets
- Cardiac Stress Testing Room
- Scanning Room/s
- Post scanning waiting areas
- Bone Densitometry Room.

Hydraulic Services

Ceiling spaces above gamma cameras and specialty scanning units should not be used for hydraulic services or air-conditioning ducts, to avoid damage to equipment from leakages.

The need for delayed holding tanks within the Nuclear Medicine Unit will require assessment by the Radiation Consultant.

Mechanical Services

Additional cooling and ventilation will be required to Scanning Rooms and associated computer equipment rooms as the equipment is sensitive to excessive ambient heat. Some scanners may require chilled water for cooling. Large temperature changes (greater than 40°C per hour) within scanning rooms need to be avoided to reduce the risk of crystal fracture in gamma cameras. Additional air extraction or exhaust may be required to Camera Room/s where ventilation agents such as Technegas are administered.

In the restricted areas of Patient Examination Room and Storage and Preparation areas, if radioactive gas Xenon is being used, special ventilation is required. Ventilation requirements would be in accordance with the Nuclear Regulatory Commission, publication 'Guide for preparation of Application for Medical Use Program' Guide 10. 8, Appendix 0, edition August 1987 – revision 2. The restricted area should be kept under negative pressure by exhausting at least 15 % more air than supply air. Recirculation of air from these spaces should not be permitted.

The reviewer recommends: The Storage and Preparation Area would be generally equipped with a special radioisotope fume hood. This system may need to be fabricated from non-ferrous materials. This probably refers to the hot lab.

This is also recommended: Exhaust registers should be located at floor and ceiling levels.

General air-conditioning inpatient and staff areas needs to be adjustable for patient and staff comfort; the temperature of the Unit should not exceed 25°C.

Smoke detectors in treatment rooms should be sensitive to radiation.

Hot Lab room air should be negatively pressured and exhausted, not recirculated. The Hot Lab may include a fume cabinet which will require exhausting.

Rooms in which Technegas is used should be negatively pressured to the rest of the Unit.

31.4 Components of the Unit

The Nuclear Medicine Unit will contain a combination of Standard Components and Non-Standard Components, according to the Level of Service. Provide Standard Components to comply with details in the Standard Components described in these Guidelines. Refer also to Standard Components Room Data Sheets.

31.4.1 *Non-Standard Components*

SPECT and SPECT/CT Scanning Rooms

Description and Function

The SPECT and SPECT/CT Scanning rooms will be used for patient imaging procedures using a SPECT camera or combined SPECT/CT hybrid system. Installation of equipment should be in accordance with manufacturer's recommendations. Room size may vary according to the equipment selected

Location and Relationships

Scanning rooms require ready access from dosing rooms and dosed patient waiting areas. Scanning rooms may be collocated with shared Control rooms to enable monitoring of two rooms simultaneously.

Considerations

- Floor structure should support the equipment weight
- Uninterruptible power supply is required to the cameras and associated computer modules to prevent data loss and/or damage during power surges or loss of supply
- Power to patient areas shall be body protected to protect against electric shock
- Individual room temperature and humidity control is required
- Lighting should be placed to avoid lights shining directly into the patient's eyes and should be dimmable
- Radiation shielding will be required according to assessment by the Radiation Consultant
- Bed/trolley access is required to the room.

Fixtures, fittings and equipment within the room will include:

- Collimator rack/s for a range of collimator sizes should be included; the collimator is a directional guide; the size and length of the collimator holes determine which gamma rays reach the detector in the camera; collimator racks vary according to the model/level of Gamma Camera
- Patient ECG monitoring may be required in the room
- CCTV camera may be included (optional in SPECT/CT room)
- Lead apron rack and aprons will be required in the room or immediately adjacent
- Hand basin – Type B with paper towel and soap fittings
- Television, ceiling or wall -mounted is optional.
- Bench and shelving for preparation and storage may be provided.

Services will include:

- Medical gases – oxygen, suction, medical air on service panel
- Nurse and emergency call system
- Power outlets for patient equipment on the medical services panel and additional power on all walls
- Computer data points on patient services panel, near gamma camera unit and in control areas.

Store – Radioactive Waste

Description and Function

This room will store radioactive waste materials.

Location and Relationships

Ready access to the Hot Laboratory is required.

Considerations

Lead lining is required to ensure safe protection of radioactive materials.

Bone Densitometry Room

Description and Function

Bone densitometry is a non-invasive procedure using a special x-ray scanning machine to determine bone density or strength. It is used to identify those at risk of developing osteoporosis and to monitor change in bone density.

Location and Relationships

The bone densitometry room maybe located within the radiology or nuclear medicine department.

Considerations

The room may have radiation shielding to walls and/or glazing as advised by Radiation Consultant.

31.5 Schedule of Accommodation

Typical Medical Imaging Unit - Nuclear Medicine at levels 4 to 6

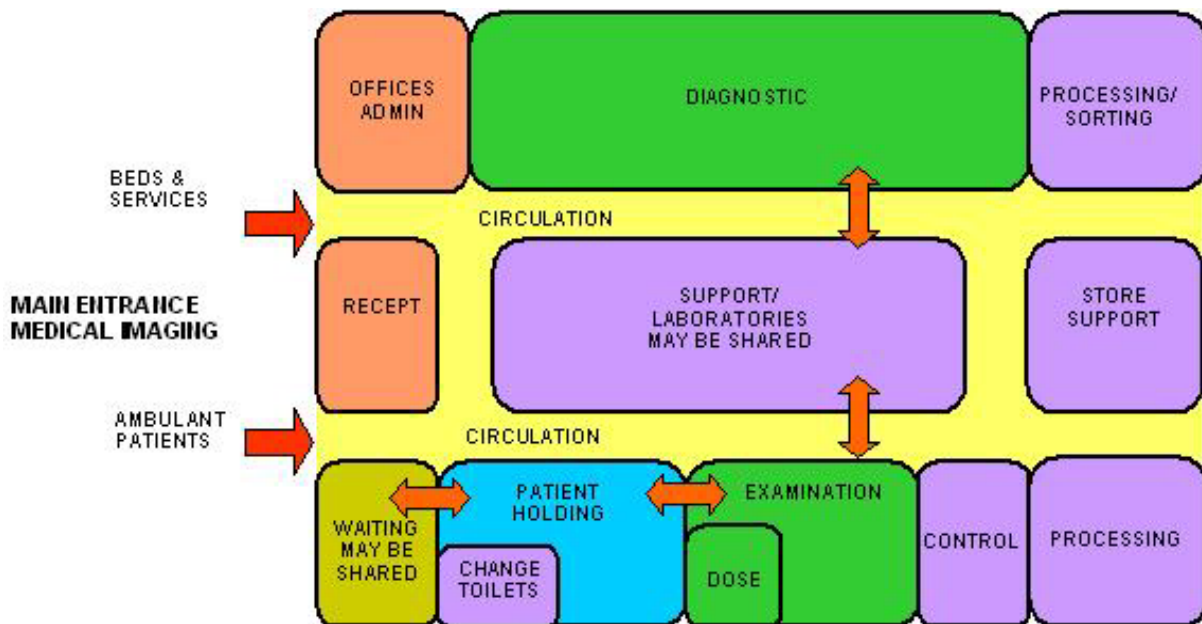
ROOM/ SPACE	Standard Componen	Level4 Qty x m ²			Level 5 Qty x m ²			Level 6 Qty x m ²			Remarks
Entry/ Reception											
Waiting	WAIT-10-SJ Similar	2	x	10	2	x	15	2	x	20	
Reception/ Clerical	RECL-15-SJ	1	x	10	1	x	10	1	x	15	
Meeting Room	MEET-9-SJ	1	x	9	1	x	9	1	x	12	Private meeting or booking
Office - 3 Person Shared	OFF-3P-SJ	1	x	12	1	x	12	1	x	15	Clerical support
Store - Photocopy/ Stationery	STPS-8-SJ	1	x	8	1	x	8	1	x	8	
Store - Files	STFS-10-SJ Similar	1	x	8	1	x	8	1	x	10	
Patient Areas											
Waiting, Undosed	WAIT-10-SJ Similar	2	x	5	2	x	9	2	x	9	Separate Male/Female areas
Waiting- Dosed	WAIT-SEC-SJ	2	x	5	2	x	9	2	x	9	Access to drinking water and toilet facilities, not through general waiting
Toilet - Patient	WCPT-SJ	2	x	4	2	x	4	4	x	4	
Toilet - Accessible	WCAC-SJ	2	x	6	2	x	6	4	x	6	
Shower - Patient	SHPT-SJ	2	x	4	2	x	4	2	x	4	For post- stress testing patient hygiene and incontinent patients
Bay - Beverage, Open plan	BBEV-OP-SJ	1	x	4	1	x	4	1	x	4	
Bay - Wheelchair Park	BWC-SJ Similar				1		4	1	x	6	May also include a patient trolley
Patient Bay - Holding	PBTR-H-10-SJ	2	x	10	3	x	10	8	x	10	Curtained bays
Bay - Handwashing, Type B	BHWS-B-SJ	1	x	1	1	x	1	2	x	1	
Staff Station/ Clean Utility	SSCU-SJ	1	x	9	1	x	9	1	x	10	
Bay - Linen	BLIN-SJ	1	x	2	1	x	2	2	x	2	Part of Inpatient Holding Area
Bay – Resuscitation Trolley	BRES-SJ	1	x	1.5	1	x	1.5	1	x	1.5	
Cleaner's Room	CLRM-5-SJ	1	x	5	1	x	5	1	x	5	
Consult Room	CONS-SJ	1	x	14	2	x	14	4	x	14	
Store - Sterile Stock	STSS-12-SJ	1	x	6	1	x	12	1	x	12	
Dirty Utility - Sub	DTUR-S-SJ Similar	1	x	8	1	x	8	1	x	10	
Disposal Room	DISP-8-SJ	1	x	5	1	x	8	1	x	10	
Treatment Areas											
SPECT Scanning Room (with Control)	GCAM-SJ Similar				1	x	42	2	x	42	Rooms should be rectangular
SPECT/ CT Scanning Room	CTPR-SJ				1	x	48	1	x	48	Rooms should be rectangular
SPECT- Control Room	ANCRT-SJ Similar				1	x	14	1	x	14	
Bay - Mobile Equipment	BMEQE-4-SJ							2	x	4	
Bay - Mobile Equipment	BMEQE-4-SJ Similar	1	x	6	2	x	2	4	x	6	Technogas machine and argon cylinder.
Procedure/ Stress Testing Room	STRT-SJ Similar	1	x	12	1	x	12	1	x	16	
Procedure Room	PROC-20-SJ Similar							1	x	20	Optional. Ideally adjacent to the Hot/Dispensing Lab
Dosing/Consult /Exam Room	CONS-SJ							5	x	12	For dose administration and examination.
Bone Density Measurement Room								1	x	12	

ROOM/ SPACE	Standard Componen	Level4 Qty x m ²			Level 5 Qty x m ²			Level 6 Qty x m ²			Remarks
Bone Density Measurement Room					1	x	16	1	x	16	Trolley/bed access
Store - Equipment/ General	STEQ-10-SJ Similar							1	x	12	
Computer Equipment Room	COEQ-SJ	1	x	8	3	x	8	4	x	8	For scanning equipment
Uptake Room								1	x	12	Radiation Shielded.
Uptake / Induction Room								1	x	18	Radiation Shielded. With GA capacity.
PET/CT Scanning Room								1	x	50	
PET/CT Control Room								1	x	16	May need to be radiation shielded
PET/CT Plant/ Equipment Room								1	x	18	
Viewing and Reporting	XRRR-SJ	1	x	12	1	x	12	1	x	20	4 workstations
Hot Laboratory											
Entry/ Lobby - Isotope Delivery	AIRL-6-SJ	1	x	6	1	x	6	1	x	6	Dual access from main corridor and inside the unit, unless delivered directly
Hot Lab/ Therapy Dispensing	HTLB-SJ	1	x	10	1	x	12	1	x	12	Fume hood, dose calibrator, balance centrifuge etc
Radioactive Waste Holding Store					1	x	20	1	x	20	
Shower - Staff Emergency	BES-SJ	2	x	1	2	x	1	2	x	1	Decontamination
Bay -PPE (Personal Protective Equipment)	BPPE-SJ	1	x	1.5	1	x	1.5	1	x	1.5	
Staff Areas											
Office - Single Person	OFF-S9-SJ Similar				1	x	12	1	x	12	Unit Director
Office - Workstation	OFF-WS-SJ	3	x	5.5	4	x	5.5	6	x	5.5	Shared use, As per service plan
Office - Single Person	OFF-S9-SJ	1	x	9	1	x	9	1	x	9	Nurse Unit Manager
Workstation (Registrars)	OFF-WS-SJ							2	x	5.5	
Office - Single Person	OFF-S9-SJ Similar							1	x	12	Chief Physicist
Workstation (Physicists)	OFF-WS-SJ	2	x	5.5	2	x	5.5	4	x	5.5	Optional; as per service plan
Office - Single Person	OFF-S9-SJ							1	x	9	Chief Technologist
Workstation (Technologist)	OFF-WS-SJ	2	x	5.5	2	x	5.5	4	x	5.5	
Office - Single Person	OFF-S9-SJ							1	x	9	Radiopharmacist. Optional.
Workstation (Medical Typists)	OFF-WS-SJ	2	x	5.5	2	x	5.5	4	x	5.5	As per service plan
Staff Room	SRM-25-SJ Similar				2	x	20	1	x	40	May be shared
Meeting Room	MEET-L-15-SJ Similar	1	x	15	1	x	15	2	x	20	
Change - Staff (Male/Female)	CHST-12-SJ/ CHST-20-SJ	2	x	20	2	x	14	2	x	20	
Total Net Department		361.5			626			1189			
Circulation %								35			
Grand Total		488.0			845.1			1605.2			

Notes:

- Areas noted in Schedules of Accommodation take precedence over all other areas noted in the FPU
- Rooms indicated in the schedule reflect the typical arrangement according to the Role Delineation
- Exact requirements for room quantities and sizes will reflect Key Planning Units identified in the Service Plan and the Operational Policies of the Unit
- Room sizes indicated should be viewed as a minimum requirement; variations are acceptable to reflect the needs of individual Unit
- Office areas are to be provided according to the Unit role delineation and staffing establishment; Executives and Managers may be responsible for more than one area but should have only one office assigned within the campus
- Staff and support rooms may be shared between Functional Planning Units dependent on location and accessibility to each unit and may provide scope to reduce duplication of facilities.

31.6 Functional Relationship Diagram



31.7 Further Reading

- Australasian Health Infrastructure Alliance (Aus.). 'Australasian Health Facility Guidelines'. Retrieved from website: www.healthfacilityguidelines.com.au 2014
- Department of Health (UK). 'Facilities for Diagnostic Imaging and Interventional Radiology HBN 6' 2001. Retrieved from website: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/149183/HBN_6_V1_DSSA.pdf 2014
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