Safety Guide

Radiation Protection in Nuclear Medicine

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Working Group

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Working Group

- First meeting on 16 September 2003
- A draft Safety Guide and Code of Practice was forwarded to the Radiation Health Committee in July 2005.
- Most of the material in the Nuclear Medicine Code has now been incorporated into the combined Medical Code.

The Nuclear Medicine Safety Guide

- Is designed to :
  - Complement the Medical Code of Practice
  - Be a stand-alone "best practice" guideline to radiation protection in Nuclear Medicine
  - Be sufficiently comprehensive that practitioners should rarely need to look up other references.
  - Apply to central radiopharmacies as well as to Nuclear Medicine practices.
- Most requirements of the SG will already be in place in most Nuclear Medicine practices.
- It is not a regulatory document.

The Nuclear Medicine Safety Guide

- Introduction (Purpose, Scope, etc)
- Justification
- Duties and Responsibilities
- Optimisation of Protection for Medical Exposures
- Protection of the Embryo/Fetus
- Protection of an Infant
- Quality Assurance
- Radiation Incidents
- Occupational Exposure
- Environmental Issues
- Training
- Transport

Definitions of Personnel

- Nuclear Medicine Specialist
  - (Medical Practitioner (Radiation))
- Administering Person
- Nuclear Medicine Technologist
- Radiochemist/Radiopharmacist
- Nuclear Medicine Physicist (Qualified Expert)
- Radiation Safety Officer

Radionuclide Therapy

Confirmation of absence of pregnancy

- "All female patients of childbearing age who are to be administered therapeutic radionuclides need to have pregnancy excluded by a definitive biochemical test e.g. serum β-HCG, within 24 hours before the commencement of the treatment. It is preferable to also determine the β-HCG result on a separate occasion in the week prior to the treatment. However, a careful clinical history is necessary at all times to facilitate accurate interpretation of these laboratory investigations (ANZSNM 1999)."

Radionuclide Therapy

- **Avoidance of conception**
- "Advice is to be given to females and males concerning the avoidance of conception after therapeutic administrations, if appropriate to the particular radionuclide therapy."

- **Table 1 was derived from the ARSAC Guidance Notes and ICRP Publication 94**

Table 1: Periods for avoiding pregnancy after radionuclide therapy to ensure that the dose to the fetus will not exceed 1mGy

Nuclide and form	For treatment of	All activities up to (MBq)	Avoid pregnancy (months)
^{198}Au-colloid	Malignancy	10,000	2
^{131}I-iodide	Thyrotoxicosis	800	4*
^{131}I-iodide	Thyroid carcinoma	6,000	4*
^{131}I-MIBG	Phaeochromocytoma	7,500	3
^{32}P-phosphate	Polycythemia	200	3
^{89}Sr-chloride	Bone metastases	150	24
^{90}Y-colloid or microspheres	Malignancy	4,000	1
^{90}Y-colloid	Arthritic joints	400	0

Periods of Restriction after receiving Radioiodine

- Table 2: Thyrotoxicosis – partner & children
- Table 3: Thyrotoxicosis – return to work
- Table 4: Thyroid cancer – partner & children
- Table 5: Thyroid cancer – return to work

Derived from:

- Woodings S *Aus Phys Eng Sci Med* 2004, 27:118-128
- EC Radiation Protection 97, 1998

Using a dose constraint of 1 mSv (5 mSv for partner/carer)

Table 2. Periods of restriction for patients receiving radioiodine (iodine-131) therapy for thyrotoxicosis

Dose Equivalent Rate at a distance of 1 metre from the patient	Corresponding to an administered activity of	Recommended periods for following instructions		
		Close contact with children under age of 5 years	Close contact with children over age of 5 years	Sleeping with non-pregnant partner
<30 µSv/h	<600 MBq	20 days	14 days	9 days
<20 µSv/h	<400 MBq	16 days	11 days	6 day
<10 µSv/h	<200 MBq	10 days	4 days	1 day
<5 µSv/h	<100 MBq	4 days	1 day	1 day
<3 µSv/h	<60 MBq	2 days	1 day	None

Protection of an Infant

- It is preferable to use a dose constraint of 0.3 mSv rather than the dose limit of 1 mSv as this will ensure that the sum of both internal and external irradiation will be below the dose limit.
- Table 6 gives advice to patients concerning the need to restrict close contact with an infant and/or the need to interrupt breast-feeding in order to ensure that the infant receives no more than 0.3 mSv from either external or internal irradiation. The close contact pattern is that typical of a fretful, sick or demanding infant. The contact time restrictions may be relaxed for a less demanding child.

Protection of an Infant

Radiopharma-ceutical	Administered activity (DRL) to mother (MBq)	Advice to patient concerning the need to restrict close contact with child	Advice to patient concerning the need to interrupt breast-feeding	Milk activity concentration at which breast-feeding can resume (kBq/mL)
^{18}F-FDG	400	Restrict contact for 1 h	7 h interruption	4
^{99m}Tc-MDP or HDP	900	Restrict contact for 0.5 h	Not required	Not required
^{67}Ga-citrate	400	Restrict contact for 10 days	Cessation	0.06

Patient Activity Surveys and Diagnostic Reference Levels (DRLs)

- As part of the nuclear medicine practice QA program, patient activity surveys should be undertaken periodically to establish that the activities are acceptable when compared with currently published DRLs.
- To encourage institutions to perform activity surveys it is recommended that accrediting bodies, such as the ANZAPNM and the Australian Council on Health Care Standards (ACHS), consider including compliance with DRLs for a core set of examinations as one element in achieving accreditation .

Diagnostic Reference Levels

- DRLs being repeatedly and substantially exceeded may indicate an underlying fundamental problem that warrants investigation.
- However, DRLs should be applied with flexibility to allow higher activities if these are indicated by sound clinical judgement.
- Furthermore, as emphasized in the Safety Guide, patient activity surveys should always be undertaken in parallel with image quality assessments.

Occupational Exposure

Pregnant staff

- For external irradiation from Tc-99m or I-131, a dose of 1.3 mSv to the surface of the maternal abdomen has been shown to give rise to a dose of 1 mSv to the fetus.
- For higher energy photons, such as those from positron emitters, the dose to the fetus may be similar to the dose at the surface of the abdomen.

Occupational Exposure

Lead Aprons

- In certain circumstances staff may need to wear a protective lead apron. This may be necessary if staff need to be in close contact with patients containing greater than 800 MBq of Tc-99m, such as during myocardial perfusion studies or gated cardiac blood pool studies. Protective aprons should preferably have a thickness of 0.5 mm lead equivalence.
- Lead aprons provide little or no protection for higher energy photons and should not be used for radionuclides such as Ga-67 or I-131 or for positron emitters.

Radiation Safety Training

- Staff other than radiation health professionals often get little or no radiation safety training.
- Nurses working in nuclear medicine departments and who care for patients undergoing nuclear medicine procedures should have appropriate training.
- Additional training should be provided for staff who care for patients receiving radionuclide therapy.

Annexes to the Safety Guide

- A - Guidelines for the Radiation Management Plan
- B - Radiation safety information for patients undergoing radioiodine therapy
- C - Quality Assurance
- D - Test Procedures for Dose Calibrators
- E - Survey Meters
- F - Monitoring of ambient radiation and surface contamination
- G - Transport

Missing from the Code and Safety Guide

The July 2005 NM Code included a section entitled **Hazard Control** including:

- Laboratories, radiopharmacies and other work areas where unsealed radioactive substances are handled must be provided with equipment designed to minimise external exposure of the operator and to minimise the likelihood of radioactive contamination occurring. Activities greater than 10 GBq of iodine-131 in liquid form must be handled in a hot cell.
- All radioiodination reactions where less than 10 GBq of iodine–131 in liquid form is used must be handled in an adequately shielded fume cupboard or fully enclosed pharmaceutical isolator.

Missing from the Code and Safety Guide

- All personnel handling greater than 100 GBq of iodine-131 in liquid form in a year must be subjected to bioassay.
- The frequency of monitoring must be set so that intakes corresponding to more that 5 per cent of the annual dose limit are not missed (IAEA 1999).
- As a minimum, periodic measurements must be conducted annually (NRC 1993).

Future work for the Working Group

- Reviewing the comments and suggestions from the professional bodies and individual submissions.
- Reviewing our previous draft versions to see which sections may have been omitted when the Code was restructured.
- Additional sections – eg table of absorbed dose and effective dose for routine procedures.