NSW GOVERNMENT

AGENCY FOR CLINICAL INNOVATION

CLINICIAN SUMMARY

Nuclear medicine examinations
A reference for nuclear medicine clinicians and referrers

ACI Nuclear Medicine Network

This fact sheet has been developed as a reference to help nuclear medicine clinicians and/or referrers to nuclear medicine services in NSW to convey the benefits and risks of diagnostic nuclear medicine examinations, and radiation doses in particular, in a consistent manner in discussions with their patients.

It is not aimed at the general public and patients seeking further information should be provided with a copy of the ACI *Medical Imaging and You* brochure for consumers.

Background radiation in Australia

The ***effective dose*** is a measure of the cancer risk to a whole person due to ionising radiation delivered non-uniformly to part/s of the body. It takes into account both the type of radiation and the radiosensitivity of each organ being irradiated. It is usually expressed in millisieverts (mSv). The effective dose to a person in Australia from natural sources is about 2 mSv per year. Medical radiation examinations provide a measurable additional radiation dose to natural background radiation exposure.

Benefits of having a nuclear medicine examination

The benefit of any examination using ionising radiation is to assist with the diagnosis of a medical problem or symptom or to confirm whether the patient has a disease or injury. Diagnostic tests can save lives and can also rule out serious illness providing reassurance and peace of mind to the patient.

Risks of having a nuclear medicine examination

All examinations using ionising radiation should be appropriate and performed using the lowest radiation dose that will give the required outcome and information, particularly with children as they are more sensitive to radiation than adults. Epidemiological studies have not demonstrated adverse health effects in individuals exposed to small doses (less than 100 mSv) delivered in a period of many years. Radiogenic health effects (primarily cancer) have been demonstrated in humans through epidemiological studies only at doses exceeding 50–100 mSv delivered at high dose rates and in a single dose. Below this dose the estimation of adverse health effects remains speculative.

Risk estimates that are used to predict health effects in exposed individuals or populations are based on epidemiological studies of well-defined populations, for example the Japanese survivors of the atomic bombings in 1945 and medical patients exposed to relatively high doses delivered at high dose rates.

Risks of examinations with effective doses of greater than 50 mSv for a single study or above 100 mSv for multiple examinations (there is a cumulative effect) would need to be weighed against the benefits of the studies and would need to be individualised.

Most nuclear medicine examinations vary in effective dose between 0.3 and 20 mSv (see Table 1).

Radiation and pregnancy

It is essential to minimise the radiation exposure to a baby in the uterus, because a fetus is more sensitive to radiation than an adult. The patient should have discussed with the referring doctor whether to postpone the examination or if an alternate test that does not use radiation can be performed. In a few cases, where information that can only be obtained from the nuclear medicine examination is of clear benefit to the mother and baby, the examination will be done with a minimal dose to the fetus, well below the level of injury to the fetus. The examination should only proceed after approval by a Nuclear Medicine Physician. It is essential to note that some radiopharmaceuticals cross the placenta (see Table 2).

TABLE 1: APPROXIMATE RADIATION DOSE TO ADULTS FROM DIAGNOSTIC NUCLEAR MEDICINE PROCEDURES – ARPANSA Nuclear Medicine Safety Guide, RPS14-2

Effective dose range [a] (mSv)	Procedures
< 1 mSv	GIT motility, lymphoscintigraphy, cystogram, GFR
1–5 mSv	Biliary system, liver/spleen, lung V/Q, renal, thyroid, parotid imaging with ^{99m}Tc
5–10 mSv	Bone, parathyroid, GHPS, infection, blood pool, brain or tumour imaging with ^{99m}Tc; tumour imaging with ^{123}I-MIBG
10–20 mSv	Myocardial perfusion imaging with all ^{99m}Tc stress/rest protocols; PET/CT[b], SPECT/CT[b]
> 20 mSv	Infection or tumour imaging with ^{67}Ga; tumour imaging or myocardial perfusion with ^{201}TI

[a] Corresponding to the diagnostic reference levels, where available, of radiopharmaceutical activity adminstered to adult patients (www.anzsnm.org.au).

[b] Includes a low-dose CT scan for anatomic localisation and attenuation correction.

TABLE 2: FETAL WHOLE-BODY DOSE RECEIVED FROM COMMON NUCLEAR MEDICINE PROCEDURES IN EARLY PREGNANCY AND AT TERM. The dose includes maternal and fetal self-dose contributions. Adapted from Russell, Stabin, Sparks et al 1997, ICRP, 1988, and ICRP, 1998.

Radiopharmaceutical	Procedure	Administered activity (MBq)	Early (mSv)	9 month (mSv)
99mTc	Bone Scan (phosphate)	750	4.6 – 4.7	1.8
99mTc	Lung Perfusion (MAA)	200	0.4 – 0.6	0.8
99mTc	Lung Ventilation (aerosol)	40	0.1 – 0.3	0.1
99mTc	Thyroid Scan (pertechnetate)	400	3.2 – 4.4	3.7
99mTc	Red Blood Cell	930	3.6 – 6.0	2.5
99mTc	Liver Colloid	300	0.5 – 0.6	1.1
99mTc	Renal DTPA	750	5.9 – 9.0	3.5
67Ga	Abscess / Tumour	190	14 – 18	25
123I	Thyroid Uptake [c]	30	0.4 – 0.6	0.3
131I	Thyroid Uptake [c]	0.55	0.03 – 0.04	0.15
131I	Metastases Imaging [c]	40	2.0 – 2.9	11.0

[c] Fetal thyroid doses are much higher than fetal whole body dose, viz. 5-15 mGy/MBq ^{123}I and 0.5-1.1 Gy/MBq for ^{131}I

Useful websites

NSW Agency for Clinical Innovation. Radiology Resources.
www.aci.health.nsw.gov.au/resources/radiology

NSW Agency for Clinical Innovation. Consumer information.
www.aci.health.nsw.gov.au/resources/consumer-information (Radiology)

Australian Radiation Protection and Nuclear Safety Agency. Radiation Protection Series
www.arpansa.gov.au/Publications/Codes/rps.cfm

Version 1. Released February 2018. For review September 2020