Code of Nursing Practice for Staff Exposed to Ionizing Radiation (1984)

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APPENDIX XXIII

CODE OF NURSING PRACTICE FOR STAFF EXPOSED TO IONIZING RADIATION (1984)

CONTENTS

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Preamble

This Code provides general guidance on radiation protection for nurses and auxiliary nursing staff engaged in duties which expose them and others to ionizing raiation. It also identifies specific situations where nurses and auxiliary staff should seek advice from the Radiation Safety Officer in the hospital. The advice of the Radiation Safety Officer should always be sought in circumstances not covered by the Code or in cases of uncertainty. The Code is supplementary to radiation control legislation relating to the use of ionizing radiation in medical proactice. Note that in some states there is a requirement to hold a licence before any person operates X-ray equipment or handles radioactive sources.

In the preparation of this document, the principles laid down in the 'Recommendations of the International Commission on Radiological Protection' (ICRP) as inter-

preted by the 'Recommended radiation protection standards for individuals exposed to ionising radiation' (National Health and Medical Research Council, 1981) have been taken into account.

Although the medical practitioner is responsible for a patient's management, including provision of detailed instructions on procedures to be observed when nursing that patient, the registered nurse in charge of the ward is responsible for implementing these instructions. *Any* uncertainties must be resolved with the medical practitioner and Radiation Safety Officer.

It is recommended that hospitals and other bodies draw up their own detailed working procedures based on the ICRP and NH&MRC publications referred to above, appropriate Commonwealth and state legislation and this Code. The preparation of detailed working procedures should be undertaken with the advice and assistance of the Radiation Safety Officer. A limited bibliography is provided for more detailed study should this be required. Annexe A on biological effects of ionizing radiations gives an introduction to the rationale behind the formulation of this Code.

Additional copies of this document may be obtained from the appropriate authorities listed in Annexe B.

1. Introduction

1.1 Use of radioactive materials and X-rays in the management of patients.

Treatment of patients with radioactive sources is well established. These sources may emit beta (β) rays and gamma (γ) rays and may be used singly or in combination to give a prescribed dose of radiation to tissue in a prescribed time. In general, imaging procedures as performed in a Nuclear Medicine Department involve very much smaller radiation exposures than are experienced in therapeutic applications and, except for certain studies with incontinent patients, special nursing radiation protection procedures are not normally required.

Nurses assisting during procedures involving radioactive sources and in the subsequent care of patients in out-patient departments and wards will be exposed to ionizing radiations. It is essential that any dose arising from such exposure be reduced to the minimum value consistent with adequate nursing care. X-ray procedures are frequently conducted outside the Radiology Department, and most nursing staff will have occasional need to assist. Simple, practical guidelines are included in this Code to minimize radiation exposure to such staff.

1.2 Purpose of protective measures

Two main purposes of protective measures for staff required to work in association with ionizing radiation are:

- to keep exposure to external radiation below the limits of the NH&MRC Recommended Radiation Protection Standards and as low as reasonably achievable, and
- to avoid intake or radioactive material into the body and thereby prevent internal irradiation of the body.

Staff not required to assist with or being trained in procedures involving a likely exposure to ionizing radiation should not remain in the immediate area where the procedure is being undertaken.

1.3 Designation, training and monitoring of staff.

Nursing staff referred to in clause 1.1 should not be allowed to be exposed to external and internal radiation without being aware of it at the time. Accordingly, in consultation with the Radiation Safety Officer, it may be required that:

- staff receive appropriate training on the means adopted to achieve the above aims, and instruction on the possible effects of exposure to ionizing radiations;
- staff be subject to monitoring by personal monitors or other appropriate and approved methods. in which case records of exposure shall be kept and made available to these staff on request; and
- arrangements be made to ensure that, if pregnant nursing staff work under such conditions, it is most unlikely that the doses received during the remainder of the pregnancy will exceed three-tenths of the pro-rata annual dose-equivalent limits for radiation workers. For close nursing of patients receiving therapeutic treatment with radioactive substances, it is preferable to assign staff who are unlikely to be pregnant.

2. Protection Against External Radiation From Radioactive Sources

2.1 Factors affecting amounts of radiation received by persons concerned with radioactive sources.

External radiation is received either from exposure to highly penetrating gamma rays or from exposure to beta rays. These may be emitted from both sealed and unsealed sources. The amount of radiation received by the whole body or part of the body is controlled by four factors —

1. The activity of the radioactive source.
2. The distance between the source and the person exposed.
3. The total time of exposure to the radiation.
4. The nature and thickness of material surrounding the source or interposed between the source and the person exposed.

2.2 Documenting the activity and nature of radioactive sources

The activity of a radioactive source is expressed in terms of units called the kilobecquerel (kBq) and the megabecquerel (MBq) (1 MBq 1000=kBq). For a radioactive source the intensity of radiation received at any nearby point depends upon its activity. The name of the radionuclide, its activity and the time of adminstration will have been marked on all appropriate containers before use. After the source has been administered, this information should be noted on all documents relevant to the nursing care of the patient.

2.3 Maintaining maximum distance from a radioactive source

Under normal conditions of use of radioactive sources in clinical practice, it may be assumed that the intensity of radiation at any point near a source decreases rapidly with increasing distance. Under all conditions of administration of sources to a patient and subsequent nursing, the maximum practical distance should be maintained between any part of the nurse's body and the source.

2.4 Reducing the time spent near a radioactive source

Under any particular set of circumstances the total amount of radiation received by the body depends directly on the total time of exposure. All nursing procedures involving patients under treatment should therefore be examined carefully, to reduce to a minimum the time spent with a patient. When nursing of patients is necessarily prolonged it should be divided among nursing staff specially trained in these procedures.

2.5 Shielding of radioactive sources

Radiation is not always completely abosrbed by any substance placed in its path. Even for a source implanted deeply in the body (e.g. for gynaecological radiotherapy), the amount of radiation at the surface of the body warrants special nursing procedures. When not in use radiation sources should be stored in specially designed shielded containers. The nature and thickness of shielding necessary in a particular situation to reduce a radiation hazard to a practical minimum requires specialist knowledge. In an emergency situation where trained guidance is unavailable, sources of radiation should be shielded by as thick a barrier of as dense a material (e.g. solid clay bricks) as practicable.

3. Protection Against Internal Irradiation

3.1 Possible causes of internal irradiation

Internal irradiation is caused by ingestion, inhalation or absorption into the body of unsealed beta or gamma-emitting radioactive material. This is usually in liquid form (e.g. radioactive phosphorus and radioactive iodine).

3.2 Ingestion of radioactive material

Accumulation of radioactivity by ingestion generally occurs as a chronic burden from relatively small amounts of radioactive material contaminating the hands. Entry into the body may follow contamination of food, cosmetics, cigarettes and other items handled before being brought to the mouth.

3.3 Inhalation of radioactive material.

Inhalation of radioactive dust, gas or vapour may result from contaminated clothing, rooms, floors, equipment and the atmosphere. Attention is drawn to the risk of droplet contamination arising from manipulation of radioactive solutions and the exhaled breath, saliva and perspiration from patients to whom doses of unsealed radioactive solutions, particularly I-131, have been given by oral administration.

3.4 Absorption of radioactive material through the skin.

Absorption of radioactive material through the skin is potentially dangerous to the skin, and to other organs of the body if the material is transferred to the blood stream. Such absorption takes place more readily if the skin surface is damaged by abrasion or other wounds.

3.5 Precautions to be taken to minimize ingestion, inhalation and absorption.

Adequate protection against internal irradiation can only be achieved by preventing the ingress of radioactive material into the body. A high standard of personal cleanliness, the use of protective clothing (including disposable rubber or plastic gloves), neat and carefully planned work, proper use of remote handling devices, adequate ventilation and controlled disposal of contaminated waste are essential factors for safe working.

4. Ward Procedures

4.1 General procedures to be adopted in wards to minimize radiation risks.

The following general procedures should be adopted as deemed necessary by the Radiation Safety Officer where there is potential radiation exposure:—

4.1.1 In general, single rooms should be used to minimize exposure of other patients and staff.

4.1.2 If it is impossible to use a single room, the bed occupied by a patient being treated with radioactive sources should be located in a less-frequented part of the ward, with solid walls. When two or more patients are being treated it is desirable to group their beds together rather than distribute them throughout a ward.

4.1.3 The bed should be marked with a warning sign indicating the presence of radioactive material in the patient.

4.1.4 Patients in beds close to patients with radioactive sources *in situ* should be beyond reproductive capacity. Consideration must be given to the possible exposure to radiation of patients located in adjoining rooms and on the floors above and below.

4.1.5 In attending patients, staff should work at the maximum practical distance from sources of radiation. Specific instructions should be given to nursing staff as to the method of putting this requirement into effect with varying kinds of treatment and, if necessary, with individual patients.

4.1.6 Staff should not remain longer than is necessary in the vicinity of patients under treatment. When prolonged nursing procedures are necessary this nursing should be divided among the ward staff in order that the radiation received by each individual is kept to a minimum (see also clause 2.4).

4.1.7 Portable shielding screens of adequate lead equivalence near the bed can often be of value in reducing radiation exposure and should be used whenever practicable.

4.1.8 Consideration should be given to the extent to which routine nursing procedures may be curtailed in individual cases if the treatment time is short (e.g. by the use of indwelling catheters or by encouraging patients to carry out their own ablutions).

4.1.9 Both patient and nursing staff should be clearly instructed as to the restriction imposed on the patient's movements. Restriction to bed, rather than to bed space, may be preferable in crowded wards and when the patient is, for any reason, uncooperative.

4.1.10 Permission for the patient to use toilets and showers must be obtained from the medical officer in charge of the patient because of the risk of source loss or radioactive contamination.

4.1.11 Attention should be given to restricting the time visitors spend in the vicinity of patients under treatment.

4.1.12 In general, women of reproductive capacity and children should not be permitted to visit patients under treatment but, where permitted, adherence to time and distance constraints should be mandatory.

4.1.13 If a patient must leave the ward during treatment, the following procedures should be adopted:

- the Radiation Safety Officer is informed and his instructions followed;
- where a risk of loss or dislodgement of a source exists, checks should be made, on a patient's exit and re-entry to a ward, to ensure that the sealed source complement or array is intact;
- precautions against contamination by unsealed sources in the patient are strictly observed; and
- the patient is escorted by a staff member competent to ensure that any radiation risk presented by the patient's activities outside the ward is minimized.

4.2 Identification of patients undergoing therapy.

A patient being treated with radioactive sources should carry on his person an identification giving the name and activity of the radionuclide, and the date of its activity. This identification should be removed only when —

(a) all sealed sources have been removed from the patient, or

(b) the residual amount of radioactive material in the patient no longer constitutes a radiation or contamination risk.

The period of time for (b) will vary according to the kind of radioactive source, and for any one kind of source may also vary from patient to patient. Responsibility for removing the identification should be clearly defined.

4.3 Action to be taken on the death of a patient.

If a patient dies whilst under treatment, the Radiation Safety Officer should be informed, and any sealed sources should be removed promptly by a competent person. If a contamination risk exists due to the presence of an unsealed source all the appropriate precautions listed in clause 4.6 should be followed. All materials in contact with the body should be assumed to be contaminated and should be treated in accordance with subclauses 4.6.3 and 4.6.4. The body should carry positive identification as being radioactive before transfer to the mortuary (see 'Code of practice for the safe handling of corpses containing radioactive substances', (National Health and Medical Research Council 1966)).

4.4 Procedure for discharge of a patient with residual radioactivity

On occasion, patients may be discharged from hospitals whilst undergoing treatment with radioactive sources *in situ*. In the event that these patients require nursing or attending at home, a number of precautions listed in this Code should apply in these situations. For procedures relating to discharge of these patients see Annexe C. A typical letter to be given to a patient, on or in whom there is a radioactive source at the time of discharge, is given in Annexe D.

4.5 Sealed sources

4.5.1 Nursing staff should be informed of the whereabouts of suitably protected containers in which to place sealed sources on removal from the patient and of the temporary storage area to be used in the ward environs.

4.5.2 The array or complement of sealed sources inserted into, or attached to, a patient should, whenever practicable, be checked to ensure that it is intact at each changeover of nursing staff.

4.5.3 Nursing staff should never touch a radioactive source with the fingers and should be given clear instructions as to the action to be taken if a sealed source becomes dislodged or is known to be, or thought to be, lost. (See also Annexe E, Section 11.)

4.5.4 To minimize the chance of losing a sealed source, a waste bin should be provided specially designated as the receptacle for dressings, etc., removed from the site of application of the source. The contents of this bin should be monitored under the direction of the Radiation Safety Officer before disposal. Bed linen should be monitored also before it leaves the ward.

4.5.5 Sealed sources in a patient in the ward should be removed only by an appropriately qualified medical practitioner or by staff acting under his immediate direction. All sources must be accounted for on removal.

4.6 Unsealed sources

The following procedures should be adopted in all cases where a contamination risk exists :

4.6.1 Immediately the patient is admitted to the ward information in writing should be given to the registered nurse in charge of the ward stating any expected cause of con-

tamination and the expected length of time that it will exist (see also Annexe E).

4.6.2 Whenever practicable, receptacles, fabrics, clothing, handkerchiefs, etc., likely to become contaminated should be of a disposable nature.

4.6.3 All items known or suspected to be contaminated should be stored in containers which can be disposed of or readily decontaminated. They should be tested under the direction of the Radiation Safety Officer to determine the level of contamination, and the method of disposal.

4.6.4 All items of a non-disposable nature should be tested under the direction of the Radiation Safety Officer to determine the level of contamination before and after being cleaned, and returned to general use when declared to be satisfactory.

4.6.5 Nursing staff carrying out procedures likely to result in contamination of skin and/or clothing should wear suitable gloves and gowns.

4.6.6 Nursing staff who have or are suspected to have contamination the skin should be monitored and if necessary decontamination should be undertaken without delay under the direction of the Radiation Safety Officer.

4.6.7 Specific precautions should be taken to reduce the risk of a spill of radioactive body fluids. For example, where it is known that urine will be contaminated:

4.6.7.1 Where the patient is, or is likely to be, incontinent or otherwise incapacitated, catheterisation should be considered. (See also subclause 4.6.3).

4.6.7.2 For such Nuclear Medicine tests on infant inpatients, nappies should be changed frequently and the used ones sealed in thick plastic bags and returned to the Nuclear Medicine Department for disposal/storage for radioactive decay. (See also Clause 1.1.).

4.6.7.3 Where the patient is not incapacitated, the ideal method is the use of a special toilet suite connected to delay-and-decay tanks. If this is not available the patient should use an ordinary toilet which has been reserved solely for that patient's use during treatment and which will be monitored and decontaminated as necessary at the end of the treatment.

Collecting contaminated urine or faeces is not recommended as this involves potential contamination problems and unnecessary staff doses during handling. Where collection is necessary, the transfer of all contaminated material to containers for disposal should be carried out on metal or plastic trays large enough to contain the full volume of fluid and lined with absorbed material to prevent splashing. Containers for disposal should remain in the near vicinity of the patient and their subsequent transport and disposal should be under the supervision of the Radiation Safety Officer.

4.6.8 Specific instructions written by the Radiation Safety Officer should be given concerning action to be taken in the event of a spill of radioactive fluid. These instructions should cover the following points:—

(a) Immediate action to prevent spread of contamination i.e., restriction of numbers of persons and their movements in the vicinity of the spill.

(b) Notification of the spill to a person nominated by the Radiation Safety Officer to supervise decontaminations.

(c) Decontamination of the area in the event of a minor spill.

(d) Follow-up reporting of significant spills to the Radiation Safety Officer.

5. Administration of Radioactive Sources

5.1 Treatment by an appropriately qualified medical practitioner.

Therapy using radioactive sources should only be carried out according to the prescrip-

tion of and by, or under the supervision of, an appropriately qualified medical practitioner. The Radiation Safety Officer or a health physicist should be present with a suitable monitoring instrument during administration.

5.2 Nursing staff assisting in administration of sources.

Nursing staff called upon to assist in administration of radioactive sources in theatres, wards or other approved areas should not be expected to carry any reponsibility for the method of administration. They should, however, be thoroughly familiar with the method, and competent to test any apparatus used for the purpose with inactive materials prior to the administration. Reference should be made to the 'Code of practice for the control and safe handling of sealed radioactive sources used in radiation therapy (other than teletherapy)' published by the National Health and Medical Research Council (Special Report Series No. 11 (1962)).

5.3 Responsibilities of registered nurse in charge of theatres.

The registered nurse in charge of the theatres or of the area in which the sources are to be administered should be responsible for the receipt and safe custody of all sources provided for use in her/his area and should be responsible for ensuring that nursing staff are aware of the precautions to be taken in handling these sources.

5.4 Radioactive sources not to be handled directly.

No radioactive sources, whether sealed or unsealed, should be touched by hand — special forceps or other remote control equipment should be used. (See also clauses 2.3, and 3.5 and subclause 4.1.5).

5.5 Containers for radioactive sources.

Containers for radioactive sources should be stable in design and should be so placed on trolleys and tables as to preserve stability against accidental movement. (See also subclause 4.6.7).

5.6 Protection against exposure.

Radioactive sources are generally placed inside radiation-protective containers. However, the principles of maximum distance from the source and minimum time of handling must still be applied. (See also clauses 2.3, 2.4 and 2.5).

5.7 Specific instructions for nursing staff.

Staff should seek specific written instructions from the Radiation Safety Officer describing the safe handling procedures to be adopted for individual radionuclides. Staff not experienced in the nature of these procedures should work only under supervision.

6. X-ray Procedures Requiring Nursing Staff Assistance.

6.1 Within the Radiology Department

Nursing staff working in a Radiology Department should be given comprehensive practical training on their role within the department, particularly in radiation protection. In general, this training should be arranged by the Radiation Safety Officer. It is not recommended that other secondarily-trained staff, e.g. other nurses, conduct such training, since unsafe radiation practices may be unwittingly perpetuated.

The remainder of this section is directed to those areas of a hospital outside the Radiology Department where nursing staff have occasional contact with X-ray procedures.

6.2 Outside the Radiology Department

X-ray units are frequently used in operating theatres, accident and emergency units, intensive care units, neonatal nurseries and other areas.

Fluoroscopy is frequently used in operating theatres and clinics. Extended examination times can result in radiation exposures well in excess of those for radiogaphic procedures.

Nursing staff may be called upon to assist with X-ray procedures and the following sections provide guidance for safe participation. Where any concerns are felt the Radiation Safety Officer should be consulted.

6.3 Nature of hazard.

Occupational exposure from an X-ray procedure can become quite significant when a member of staff repeatedly assists without adequate precautions. It is necessary to take protective measures against:

- the primary beam that emerges directly from the X-ray tube head, and
- the secondary or scattered radiation that is created by interaction of the primary beam with the patient or other objects.

6.3.1 Primary beam

Under no circumstances should it be necessary for an unshielded part of the body, e.g. a hand, to intercept the primary beam, and nursing staff should refuse any request to hold a patient or film cassette that would require this action. Articulated cassette holders which clamp onto beds are readily available and should be used.

6.3.2 Scattered radiation

Scattered radiation from the patient, although very much less intense than the primary beam, occurs in all directions from the irradiated region.

6.4 Basic protective actions

6.4.1 Distance is the best safeguard.

The intensity of radiation in the vicinity of an X-ray tube and patient decreases rapidly with increasing distance. The maximum practical distance should be maintained between any part of the assistant's body and the source of radiation (the X-ray tube and the region of the patient's body being irradiated). Staff not required to assist during the actual exposure of X-rays should move at least three metres from the region of the patient being examined and well out of the primary beam. Where relevant, restraining and immobilizing devices should be used on the patient.

6.4.2 Time

X-rays travel with the same speed as light. A radiation field in the vicinity of an X-ray machine exists only during actual exposure.

6.4.3 Shielding

Nursing staff required to be close to a patient when assisting with X-ray procedures must wear a lead-rubber/lead-plastic apron. Lead rubber gloves must also be worn when using hands for patient support, and even then the hands should not be placed in the primary beam unless it has been attenuated by the patient. It should be noted that lead-rubber aprons are not designed for protection against the primary beam.

7. Bibliography

1. *'Manual on radiation protection in hospitals and general practice, Vol. 1-5'.*

World Health Organisation, Geneva.(1974).

2. *'Recommendations of the International Commission on Radiological Protection. ICRP Publication No. 26'.* Pergamon Press, London.(1977).
3. *'Protection against ionizing radiation from external sources used in medicine. ICRP Publication No. 33'.* Pergamon Press, London.(1982).
4. *'Recommended radiation protection standards for individuals exposed to ionising radiation'.* NH&MRC, Canberra(1981).
5. *'Code of practice for the safe handling of corpses containing radioactive substances'.* NH&MRC, Canberra(1966).
6. *'Code of practice for the control and safe handling of sealed radioactive sources used in radiation therapy (other than teletherapy)'.*(Special Report Series, No. 11) NH&MRC, Canberra(1962).
7. *'An introduction to radiation protection'* by A. Martin and S.A. Harbison.(2nd Ed.) Chapman and Hall, London(1979).

ANNEXE A

Biological effects of ionizing radiations and limits on exposure to such radiations.

Note: *This statement provides background information. Not all of it is relevant to this Code.*

Considerable knowledge has been gained during this century, and particularly during the past three decades, on the possible biological effects of ionizing radiation on man. These effects may manifest themselves in the exposed individual and they are then referred to as somatic effects or they may arise in the descendants of the exposed individual, in which case they are referred to as hereditary effects. It is important to recognize, however, that many of the biological effects that can be caused by ionizing radiation may also result from exposure to other agents and it is not always possible to determine the cause of a particular effect in an individual.

Man has always been exposed to radiation, and this arises from terrestrial sources, cosmic radiation and radionuclides deposited in the body. This natural background radiation varies from place to place on the earth, but for most of the world's population, the average effective dose equivalent has been estimated to be about 2000 microsievert* (μSv) per year, although there are a few places where the contribution from terrestrial sources results in values which are considerably higher for individuals. Effects on man from natural background, if they exist, are not discernible. On the other hand, radiation-induced effects have been observed in man when individuals have been exposed to very large radiation doses and it is from such doses that our knowledge of biological effects from radiation exposure is derived.

Injury to tissue became evident in the past from a number of different sources — for example, as a result of using radium luminous compounds for painting dials on watches and instruments, some workers developed bone sarcoma; many miners working in uranium mines developed lung cancer; a number of radiologists developed skin erythema and leukaemia as a result of inadequate radiation protection. In addition, there was a

*The sievert is the unit used in radiation protection for dose equivalent and is equal to 100 rem. 1 μSv = 10^{-6} Sv; 10 μSv = 1 mrem.

small excess of leukaemia and other malignant diseases above the expected incidence rates observed among survivors of the atomic bombs in Hiroshima and Nagasaki in Japan following their exposure to large doses of radiation from the bombs. In all the above examples, and there are many more demonstrated radiation-induced effects, the doses received by individuals were large — very many times the doses arising from natural background radiation.

The effects arising from large radiation doses are well known and many studies have been undertaken in order to correlate radiation-induced effects with small doses. However, it has not been possible to correlate any observed effects directly with the doses received. Because of statistical limitations, data available from such studies have not been, and may never be, sufficient to lead to definitive conclusions. Accordingly, studies have been carried out on animals and plants to observe any effects produced and the correlation, if any, with the total dose delivered and/or dose rate. In these latter studies, the incidence of many biological effects produced has been related to the total dose delivered, whilst for other effects, there appear to be threshold doses below which those effects are not detectable. Although it is difficult to apply the results of these studies directly to man, they provide a useful guide in indicating possible dose-effect relationships.

The effects arising from exposure to ionizing radiation fall into two categorises. Stochastic effects are those for which the probability of an effect occurring but not the severity of the effect is regarded as a function of the dose to which the individual is exposed. It is assumed for radiation protection purposes that there is no threshold dose below which the probability of such an effect occurring is zero. On the other hand, non-stochastic effects are those for which the severity of the effect varies with the dose to which the individual is exposed and there may exist a threshold dose, below which such effects do not occur.

From the studies undertaken, it is known that malignancies, including leukaemia, are stochastic effects of radiation, although such malignancies may not become manifest until many years after the radiation exposure. Mutagenic effects are also stochastic effects and these may be propagated through the population for many generations. However, a mutagenic defect causing slight physical or functional impairment, and which may not even be detectable, may tend to continue in the descendants, whereas a severe defect will be eliminated rapidly and not passed on to be passed on to future generations.

Non-stochastic effects arising are specific to particular tissues, for example, non-malignant damage to the skin, cataract of the lens of the eye, gonadal cell damage leading to impaired fertility etc. If an individual receives a dose greatly in excess of the threshold dose, the manifestation of the effect will occur in a relatively short period after the irradiation. However, if the dose is not greatly in excess of the threshold dose, many of the resulting effects will be of a temporary nature and reversion to normal conditions usually occurs.

From our knowledge of biological effects arising from exposure to radiation, it is possible to identify the risks of stochastic effects occurring with the doses received by the various organs and tissues of the body. These risks are derived from exposure of persons to very high doses and from studies on animals etc. As there is very little information on the effects of exposure to low doses, it is cautiously assumed that risk is directly proportional to dose, right down to zero dose and that there is no threshold below which these effects do not occur. These assumptions may lead to overestimates of the risks associated with exposure to low doses of radiation. Although the risks derived from such assumptions may be very small, it is important that they are kept small by ensuring that all radiation exposure of individuals is kept as low as reasonably achievable and that there be a demonstrated net benefit for each exposure. This principle is commonly referred to as the ALARA principle.

Radiation protection is concerned with the prevention or limitation of possible harmful effects of radiation exposure of individuals involved in various radiation practices, as well as of members of the public. It recognizes that various practices involving radiation exposure may be necessary and of benefit to the individuals exposed and to mankind. In undertaking such practices, individuals, as radiation workers or as members of the public, may be irradiated and the exposure resulting from those practices must be minimized in accordance with the ALARA principle. Good radiation protection practice requires the setting of standards for occupational exposure and these are such that the risk of fatalities arising from radiation-induced malignancies from the average doses received in such exposure is no greater than the risk of fatalities arising in other occupations that have high standards of safety. Radiation Protection Standards have been prepared for the National Health and Medical Research Council (1) for use in Australia and are based on the recommendations of the International Commission on Radiological Protection (2). They assume for stochastic effects a linear relationship between risk and dose and that there is no threshold dose below which effects do not occur. For non-stochastic effects relating to specific organs, the Standards set a limit on the dose received, below which such effects would not be manifest. The limit given in the Radiation Protection Standards for an organ is the lower limit of that derived for stochastic effects and that derived for non-stochastic effects when that organ is the only irradiated organ.

For purposes of radiation protection, the limits given in the Standards are specified in terms of annual dose-equivalent limits. For whole body exposure, the annual limit for radiation workers is 50 mSv (or 50,000 μSv). In certain circumstances, it is possible that only partial exposure of the body occurs or that single organ exposure occurs. In these circumstances, limits are prescribed such that the risks associated with partial body exposure or with single organ exposure are the same as the risk with uniform whole body exposure. Accordingly, higher limits are prescribed for these circumstances, for example, annual limits for exposure of the hands, fingers and forearms are 500 mSv and for the lens of the eye, 150 mSv.

When exposure is from external sources only, the doses received can be determined by the use of personal monitors, which give the doses received at the point of wearing. From the everyday point of view, it is not convenient to determine from the monitor reading the dose to the whole body or to specific organs. In practice, if the annual dose for an individual, as determined from monitors worn on the body, does not exceed 50 mSv then the dose-equivalent limits for the whole body and for the various organs will not be exceeded in the case of whole body exposure, provided the monitor has been worn on the body such that it would most likely have received the highest dose to the body.

Although the standards prescribe limits on an annual basis only, it is useful to ensure that doses reported for monitors do not exceed 1000 μSv per week (or 4000 μSv per four-weekly period). By this means it will become obvious during a year if there is any real likelihood of the annual limits either being approached or exceeded.

In determining the total dose equivalent received from occupational exposure, exposures from normal natural background radiation or from radiological procedures to the individual (including radiodiagnosis, dentistry, radiotherapy and nuclear medicine) are not to be included. The Standards make provision for special limits in circumstances involving planned special exposures. They recognize that limits cannot be set for emergency or accidental exposures, but that attempts must be made to assess as carefully and as quickly as possible the dose equivalents received in those situations so that any necessary remedial action can be taken.

The Radiation Protection Standards do not make any special provision for females of reproductive capacity. However, they state that when a pregnancy is confirmed (and this would normally be within a period of two months), arrangements should be made to ensure that the woman works only under such conditions that it is most unlikely that

doses received during the remainder of the pregnancy would exceed three-tenths of the pro-rata annual dose-equivalent limits for occupationally exposed persons.

The Standards do not prescribe limits for individual members of the public. However, they require that the design and operation of radiation facilities be such that, apart from radiation received by individuals undergoing radiological procedures, members of the public most likely to receive the highest dose from the sources, ie., the critical group, are unlikely to receive more than one-tenth of the corresponding annual dose-equivalent limits for occupationally exposed persons. For whole body exposure for this group, the annual dose-equivalent limit is 5 mSv, provided the exposure does not occur over many years. If this should occur, action should be taken to reduce radiation exposures so that in a lifetime, an average annual dose-equivalent limit of 1 mSv is not exceeded.

References

(1) *National Health and Medical Research Council 'Recommended radiation protection standards for individuals exposed to ionising radiation'.* Australian Government Publishing Service,Canberra, (1981).

(2) *ICRP (1977). 'Recommendations of the International Commission on Radiological Protection'.* Oxford: Pergamon Press; ICRP Publication 26 (Annals of the ICRP,Vol 1 No 3).

ANNEXE B

List of State and Territory Authorities

The appropriate contacts for matters relating to the requirements of the statutory authorities in the states and territories and for additional copies of this publication are:—

1. **Australian Capital Territory**
   Consultant, Radiation Safety
   Capital Territory Health Commission
   C/- Royal Canberra Hospital
   ACTON ACT 2601
   Telephone: (062) 47 2899

2. **New South Wales**
   Officer-in-Charge
   Radiation Branch
   Department of Health
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ANNEXE C

Recommendations relating to the discharge of patients undergoing treatment with radioactive substances (1983)*

These recommendations relate to the conditions under which in-patients who are undergoing treatment with radioactive substances may be discharged from a hospital in order to return home. The conditions are presented for general guidance only; the requirements for individual patients should be assessed by the attending physician in collaboration with an experienced health physicist and having regard to the prevailing circumstances. The recommendations are based mainly on considerations of the external radiation from the patient and the need to reduce the exposure of other persons with whom contact may be made.

Patients being treated with the radionuclides shown in the table below may be discharged from hospital under the conditions subsequently stated.

Table

Maximum activities of radionuclides at which patients may be discharged from hospital (see notes below).

Radionuclide	*Activity in MBq*
^{198}Au	2000
^{131}I	600
^{125}I (sealed)	No limit
^{32}P	1200
^{222}Rn	800
^{90}Y	1200

Note 1: A patient shall not be discharged from hospital if it seems likely that a sealed source may be lost or that spread of radioactive contamination may occur as a result of leakage from an unsealed source.

As adopted by the National Health and Medical Research Council at its 96th Session.

Note 2: In deriving the maximum activities shown in the table it is assumed that the time of travel by public transport will not exceed one hour. If it is known that a journey of longer duration is involved either the activity on leaving hospital should be reduced in proportion or the patient should travel by means other than public transport.

Note 3: Patients should be given written and oral instructions to avoid close contact with other members of the household, especially children, young people and pregnant women. Where appropriate, the importance of good personal hygiene in order to prevent the spread of contamination should also be stressed in these instructions.

Note 4: Patients should be instructed to remain at home and follow the instructions in note 3 until the specified date on which it is estimated that their retained activity will be one quarter of that given in the Table

Patients being treated with sealed sources of ^{226}Ra, ^{60}Co, ^{137}Cs or ^{192}Ir shall not be discharged from hospital until the sources have been removed from the patient. Where sealed sources remain in a patient on discharge from hospital (e.g. ^{198}Au, ^{222}Rn and ^{125}I), the possibility of these being dislodged from the patient should be discussed and appropriate action outlined.

References

1. *'Precautions in the Management of Patients who have received Therapeutic Amounts of Radionuclides'*, NCRP Report No. 37, Washington, D.C., (1970).
2. *'Code of Practice for the Protection of Persons against Ionising Radiations arising from Medical and Dental Use'* Her Majesty's Stationery Office, London, (1972).
3. *'Radiation Protection in Hospitals and General Medicine'*, IAEA/WHO/ILO, (Nov. 1972).
4. *'Practical Problems in Radionuclide Therapy: The Patient as a Gamma radiation Source'*. E E Pochin and J C Kermode Brit.J.Rad. 48, 299, (1975).
5. *'The Handling, Storage, Use and Disposal of Unsealed Radionuclides in Hospitals and Medical Research Establishments'*, ICRP Publication 25, Report of Committees 3 and 4, (1976).
6. *'Monitoring of I Excretions and Used Materials of Patients Treated with ^{131}I'* K Nishizawa et al, Health Physics 38, 467, (1980).
7. *'Radiation Safety in Nuclear Medicine: A Practical Guide'*, Ed: V.J. Sodd, HHS Publication FDA 82-8180, (Nov. 1981).

ANNEXE D

Letterhead

Sample Discharge form I-131 Patients

Draft
TO:_____

Your treatment with radioactive iodine has resulted in your body retaining some radioactive material for a period of time. The amount of this material is, however, decreasing rapidly.

For the next three days we would ask you to keep the time you spend close to others, say within touching distance, as short as reasonably possible. Pregnant women, and children particularly should remain at a distance if with you for some time, although occasional brief contact such as a hug would be fine.

You should not return to work or travel in public transport after going home or visit cinemas etc for this period so that other people do not receive radiation unnecessarily.

Be especially careful when passing urine, since it is via this route that residual radioactive iodine leaves your body. It is a good idea to give the toilet two flushes after use.

Please ask your doctor or one of the staff if you have any worries.

All these precautions can cease on _____.

RADIATION SAFETY OFFICER
CONTACT TELEPHONE NUMBER:

ANNEXE E

Pro forma suggested as a source of information and instruction to nurses in wards where patients are undergoing treatment with radioactive sources.

(The numbers refer to the notes which follow the pro forma)

PATIENTS RECEIVING TREATMENT WITH RADIOACTIVE SOURCES

Patient's name:(1) Hospital number:

Radioactive source:(2)

Nature of hazard:(3)

Instructions relating to patient

Identification:(4)

Movement:(5)

Nursing:(6)

Hygiene:(7)

Visitors:(8)

Instructions relating to control of radioactive source

Body fluid:(9)

Linen, etc:(10)

Emergency:(11)

Relaxation of precautions(12)

1. Patient's name

Record name and other relevant details, in accordance with normal hospital practice.

2. Radioactive source

Record the name and activity of the radionuclide with date, time and method of administration of the radioactive source (e.g. Caesium 137, 7500 MBq, 22 March, 1983, 11.30 a.m., implantation or, Iodine-131, 4000 MBq, 22 March 1982, 11.30 a.m., oral administration).

3. Nature of hazard

e.g. from beta or gamma rays,
from inhalation of radioactive material e.g. iodine vapour,
from ingestion of radioactive material,
from surface contamination.

Display the above information on the warning sign attached to the bed.

4. Identification

State the method of identifying the patient as containing a radioactive source and the person responsible for removing the identification when the radiation or any contamination hazard ceases.

5. Movement

Define restriction on patient movement as follows:-
restricted to bed;
restricted to bed space;
restricted to ward; or
NO restriction.

6. Nursing

State any specific nursing procedures to be followed.

7. Hygiene

List the items (if any) to be reserved for the use of the particular patient, e.g. pans, urinals, sputum mugs, toilet bowls, cutlery, crockery, etc. Give a clear statement that the patient —
is/is not permitted to use toilet;
is/is not permitted to use shower;
is/is not permitted to use bath.

8. Visitors

Give precise instructions concerning the permissible conditions under which visitors may be allowed (e.g. number of visitors, pregnant women, children, length of each visit and distance from patient).

9. Body fluid

List the body fluids (if any) which may be expected to be contaminated (e.g. saliva, blood, urine, faeces, exudate from wou: ', vomitus, sweat) and the method of collection and disposal of these fluids.

10. Linen etc.

List the items of linen, etc., which may be contaminated (e.g. personal linen and clothing, bed linen, gloves, gowns, aprons, dressings, paper tissues, etc.). Define the methods of collection and the arrangements for checking and disposal of such items.

11. Emergency

Give instructions for the procedures to be followed in the event of a spill of radioactive material and in the loss or suspected loss of a sealed source. These should include the name and telephone numbers (both day and after-hours) of the Radiation Safety Officer and any other person to be notified.

12. Relaxation of precautions

Earliest date at which precautions may be relaxed, in whole or in part, should be stated. The earliest date for release of patient as far as possible radiation hazard is concerned should be defined.