Continued from previous page

Clinical characteristics of CLL include a prolonged asymptomatic latent period and then another protracted period with evident disease, and finally a low fatality rate. These characteristics make it relatively difficult to evaluate associations between ionising radiation and the disease via epidemiology. Misclassifications of CLL have been more likely than other forms of leukaemia, and the use of information on death certificates as an indicator for information on incidence of CLL would significantly underestimate prevalence.

Current epidemiological evidence for an association between exposure to ionising radiation and CLL is weak. Limitations of the reviewed studies include insufficient years of follow-up to take account of the slow progression of the disease and, as mentioned above, poor ascertainment of actual numbers of CLL cases.

The review concluded that there was not a persuasive basis for the conclusion that CLL is a non-radiogenic form of cancer.

For further information contact John Le Heron (john_le_heron@nrl.moh.govt.nz).

Nuclear density meter incident

An incident last year involving a nuclear density meter (NDM) has highlighted the need for users to be aware of the potential dangers inherent with these devices, and at all times adopt safe procedures when using, transporting, or storing them.

Having received an NDM at a workshop, it was discovered that the source assembly rod containing a 370 MBq Cs-137 radioactive source was not in its safe position, being exposed by approximately 10 cm. It was possible that the source assembly rod had worked itself loose during transit as the handle of the NDM that secures the rod was found not to have been closed in the safe position. The NDM had been in transit and storage for a number of days. Fortunately, due to the low occupancy near the exposed source no person received a significant radiation dose.

This incident serves as a reminder that whenever NDMs are not in use, and particularly when they are in transit, their radiation sources must be secured in the safe position.

An NDM with the source assembly rod locked in the shielded position

Recent NRPB reports on mobile phones

Two recent reports on mobile phones and health have been published by the National Radiological Protection Board (NRPB).

- *Mobile phones and Health 2004* examines progress in addressing public health concerns about mobile telephony (arising from both cellphones and base stations) since publication of the Stewart report in 2000. While noting that many of the recommendations made in the Stewart Report have already been implemented, the NRPB also notes areas where additional, or new, work is required. The report is available at: http://www.nrpb.org/publications/documents_of_nrpb/pdfs/doc_15_5.pdf
- *A summary of recent reports on mobile phones and health (2000-2004)* summarises the findings of 24 reports published by national and international expert groups and committees in that period, ranging from brief statements to much more detailed assessments. The report is available at: http://www.nrpb.org/publications/w_series_reports/2005/nrpb_w65.pdf

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Mettler balances containing radioactive sources

NRL has become aware that there may be some old balances still in use around New Zealand that contain radioactive sources.

The balances were manufactured by Mettler during the 1960s and 1970s. There were three series of balances produced that have radioactive sources, namely the B5, B6 and M5 series. Examples are shown in the photographs. Each of these units contains a number of radium-226 sources that were installed to act as anti-static devices. The activity of each source is approximately 74 kBq.

Mettler B6 (the B5 looks very similar)

Mettler M5

In normal use and storage the balances pose virtually no hazard. However, if the radioactive sources are directly handled (which could occur only if the machine is opened up or dismantled) there is the possibility for an individual to receive a radiation dose in excess of the recommended dose limits. There are also some concerns regarding the appropriate disposal of these balances.

NRL has already alerted schools and to date six units have been identified in different schools around the country. In most cases the balances had been donated to the schools by research establishments. In conjunction with the supplier, arrangements are in place to collect all such units and deliver them to the NRL. We will remove the radioactive sources and consign them to the overseas manufacturer. The balances can then be returned to the user or disposed of if preferred.

If you are aware of any such units please contact Cris Ardouin (cris_ardouin@nrl.moh.govt.nz).

ReSources

Newly available on the NRL website (www.nrl.moh.govt.nz):

- **Core of knowledge: Industrial Processing (Sealed Source Irradiators)**
  (Follow the menu choices: Legislation & Licensing – Non-medical licensee training – Core of Knowledge – Industrial Processing)
- **ELF/RF Interagency report to Ministers**
  An interagency group convened by the Ministry of Health meets every six months to provide the Director-General of Health with independent scientific and technical advice on potential health effects from exposures to extremely low or radiofrequency fields. Periodically this group produces a report to Ministers in order to update them on its activities and recommendations. The most recent report was published in November 2004 and can be downloaded from the NRL website. Follow the menu choices Publications - Miscellaneous items - ELF/RF Interagency report to Ministers

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NRL is a specialist business unit of the Ministry of Health

Biological Effects of Ionising Radiation

Deterministic effects

Continuing our brief overview of the biological effects of ionising radiation, in this issue of *The Source,* we discuss the clinical symptoms associated with deterministic effects. Deterministic effects arise due to excessive cell death or prevention of cell division within a certain organ, and are characterised by having a threshold below which no effects are apparent, and above which the severity of the effect increases with dose. In the table below, a summary is given of deterministic effects that may occur following an acute (ie, within a timeframe of hours or less) radiation exposure to a specific organ.

Dose (Sv)	Organ	Effect
> 0.15	Testes	Temporary sterility
3.5	Testes	Permanent sterility
3	Ovaries	Sterility
> 2.5	Skin	Erythema, possible permanent hair loss
3.5	Eye	Later cataract formation
0.5	Bone marrow	Reduced blood cell formation

Note that the doses given in the table are the doses to the affected organ. If the dose is less acute (ie, received over several weeks), then the threshold at which the effect occurs is considerably higher (up to 100 %).

In the situation where an individual receives a large acute whole body dose, then the resultant effect is known as Acute Radiation Syndrome (ARS), or radiation sickness. The major cause of this syndrome is depletion of immature stem cells in specific tissues. Examples of persons who have suffered from ARS are victims of the Hiroshima and Nagasaki atomic bombs, fire-fighters who first responded after the Chernobyl reactor accident in 1986, and some accidental exposures to sealed source sterilisation irradiators.

The required conditions for ARS are:
- The radiation dose must be large (ie, greater than about 1 Sv).
- The dose is usually delivered to the whole body in the form of penetrating radiation such as x-rays or gamma-rays. Radioactive materials deposited inside the body have produced some ARS effects only in extremely rare cases.
- The entire body (or a significant portion of it) must have received the dose. Most radiation injuries are in fact local, frequently involving the hands, and these seldom cause classical signs of ARS.
- The dose must have been delivered in a short time (usually a matter of minutes or less).

The four stages of ARS are:
- Prodromal stage. The classic symptoms for this stage are nausea, vomiting and possibly diarrhoea (depending on dose) that occur from minutes to hours following exposure. The symptoms may last (episodically) for minutes up to several days.
- Latent stage. The person looks and feels generally healthy for a few hours or even up to a few weeks.
- Manifest illness stage. Appearance of symptoms that depend on the dose received and hence specific syndrome (see below). Symptoms may last from hours up to several months.
- Recovery or death. Most persons who do not recover will die within several months of exposure. The recovery process lasts from several weeks up to two years.

The three classical ARS Syndromes are:
- Bone marrow syndrome (haematopoietic syndrome). This usually occurs with a whole body dose in the range 1 – 10 Sv. The survival rate of such exposed persons decreases with increasing dose, with doses in the range 3 – 5 Sv being fatal in about 50 percent of cases. The primary cause of death is the destruction of the bone marrow, resulting in infection and haemorrhage. Death, if it occurs, is usually several weeks after exposure.
- Gastrointestinal (GI) syndrome. This usually occurs with whole body doses above approximately 10 Sv. Survival is extremely unlikely. Destructive and irreparable changes in the GI tract and bone marrow usually cause infection, dehydration, and electrolyte imbalance. Death usually occurs within two weeks.
- Cardiovascular (CV)/Central Nervous System (CNS) syndrome. This occurs with a dose greater than 100 Sv; death will always ensue within three days. Death is likely due to collapse of the circulatory system as well as increased pressure in the confining cranial vault as the result of increased fluid content.

This concludes our summary of the main aspects of deterministic effects. In the next issue of *The Source,* we will discuss the other group of radiation exposure health effects known as stochastic effects, and their particular attributes.

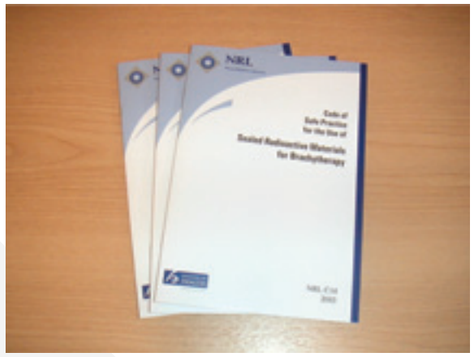
For further information, contact Cris Ardouin (cris_ardouin@nrl.moh.govt.nz).

New Codes of Safe Practice

NRL Codes of Safe Practice continue to play a major role in the implementation of radiation protection requirements in New Zealand. The mechanism is a licence condition requiring compliance with the Code of Safe Practice appropriate to the particular use of radiation covered by the licence.

The NRL has an on-going programme of reviewing current Codes, as well as identifying areas of radiation use where new Codes are needed. As part of this programme, two new Codes will be issued in April 2005:

- *Code of safe practice for the use of industrial gauges containing sealed radioactive sources, NRL C19;*
- *Code of safe practice for the use of x-rays in veterinary diagnosis, NRL C21.*



NRL C19 is a new Code, rather than a revision, aimed specifically at the use of gauges in industry, whereas *NRL C21* replaces the previous *Code of safe practice for the use of x-rays in diagnosis (veterinary), NRL C8.* In line with all recent NRL Codes, both of these Codes have the cornerstone requirement for a Radiation Safety Plan.

NRL Codes of Safe Practice are available on our website (www.nrl.moh.govt.nz). Follow the menu choices Publications – Codes of safe practice.

For further information, contact John Le Heron (john_le_heron@nrl.moh.govt.nz)

Ionising radiation and chronic lymphocytic leukaemia

The connection between radiation exposure and an increased risk of leukaemia became evident amongst survivors of the Hiroshima and Nagasaki only a matter of a few years after the bombs exploded. Japanese doctors had noted an unusual number of leukaemia cases among survivors, and this was confirmed in data published in the early 1950s.

Leukaemia is classified clinically according to the degree of cell differentiation (specialisation) and the predominant type of cell involved. The term acute is used for the disease involving cells with little or no differentiation, while chronic is used where well-differentiated cells are involved. And for cell types, the term myelogenous is used to indicate leukaemia involving cells originating from the bone marrow and lymphocytic for leukaemia involving lymphocytes – cells found in the blood, lymph and lymphoid tissues.

When the Japanese data were examined by leukaemia subtype it appeared not all forms of leukaemia were equally radiogenic. The acute forms could clearly be induced by radiation, as could chronic myleoid leukaemia. But chronic lymphocytic leukaemia (CLL) showed no such excess.

A similar pattern emerged in the expression of leukaemia among male patients in the UK who had undergone x-ray therapy in the 1950s for an arthritic condition. Here to, there was no excess CLL.

These findings in particular led to the hypothesis that there were differences in the radiogenicity of the various leukaemia subtypes, and in particular that CLL was much less readily inducible by exposure to ionising radiation than the other types of leukaemia. The passage of time has tended to lead to this hypothesis becoming accepted as fact. An example of this is that the US Department of Health and Human Services has taken the position that the risk of radiation-induced CLL is zero when considering claims via the US Energy Employees Occupational Illness Compensation Program.

A recent paper in *Environmental Health Perspectives* (Vol 113, pp 1-5, Jan 2005) has reviewed the basis for the current presumption that CLL incidence is entirely unaffected by exposure to ionising radiation. The review considered molecular, clinical and epidemiological evidence regarding the radiogenicity of CLL. At the molecular level, current understanding of the roles of radiation in inducing cancer suggests that exposure to radiation should increase the risk of CLL. CLL is multi-staged, with important roles being played by mutational events – hence a possible role for ionising radiation.

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