

USE OF SEALED RADIOISOTOPES TO COMBAT MALIGNANT GROWTHS

Brachytherapy is a collective word covering methods of medical treatment by using radioactive materials on the skin, inside the body or in body cavities. It embraces techniques which have been widely used for more than forty years, from the time when it was found possible to use small quantities of radium and its gas, radon, for the purpose. In recent years, it has been established that certain radioisotopes of other elements are suitable as substitutes for radium or radon, and for a number of techniques offer advantages in use and in cost.

The following notes on a panel held in Vienna during the week of 20-24 June this year contain some information of a technical and medical nature. They are included because of the guidance they give on the developments which have taken place in a branch of medical science important to humanity. It is proposed to publish the full results with those of a previous panel as one Agency report, including a bibliography.

BACKGROUND

In 1964-5 the International Atomic Energy Agency carried out a survey of the stocks and applications of small sealed radiation sources in surface, intracavitary and interstitial therapy. The survey was made in Canada, France, Scandinavia, the U.K. and in a group of Middle Eastern countries. Its results showed that, in all these countries, brachytherapy is to a very large extent synonymous with "intracavitary therapy of gynaecological tumours". The volume of other types of work, such as interstitial implants, has decreased in recent years, but is now tending to stabilize at a low but by no means negligible level. The replacement or supplementation of radium and radon by isotopic sources is proceeding very slowly and (with the exception of ^{198}Au grains) has so far taken place in only a small minority of hospitals in any country. In developing countries brachytherapy remains at a low level in relation to the needs.

It was against this background that the IAEA convened an international panel to consider the physical aspects of brachytherapy using γ -ray emitters. It comprised 6 radiation physicists, 4 radiotherapists and 5 representatives of manufacturers of radiation sources, from 8 countries. In addition, 6 observers attended, two of them representing the World Health Organization.

IS A RADIUM SUBSTITUTE NEEDED ?

The Panel considered that the main danger of radium sources lies not in the possibility of explosion through build up of internal gas pressure, but in the small but finite possibility of damaging sources during use. For radium the hazard in the event of breakage is very great. On this ground alone the Panel felt itself justified in recommending sources of ^{137}Cs , which is now available in insoluble form. In addition, the lower γ -ray energy of this isotope permits easier shielding, both external and within body cavi-

ties. Finally, the capital expenditure in acquiring a stock of caesium sources is considerably lower (approximately one half) than for equivalent radium sources, although the total expenditure over several decades may not be very different. These advantages of ^{137}Cs are felt to outweigh the disadvantage of a decrease in source activity of about 2% per year.

THE RATE OF SUBSTITUTION

In the opinion of the Panel, the slow pace at which radium substitutes are being adopted is a function of the conservatism of long-established radiotherapy departments and the caution of newly founded institutes. The advanced institute usually has a large and satisfactory stock of radium which it employs in well-tried techniques that yield good results. It has no incentive to adopt new materials or techniques that appear to offer few, if any, advantages. The developing institute, on the other hand, is loth to plunge into new methods which are not backed by a large body of clinical experience. However, the Panel considered that there is now sufficient evidence to state that there is no clinical difference between radium and its substitutes (excluding low energy γ -emitters) so that established techniques may be carried over with confidence from one to the other.

Furthermore, while the relative merits of radium and its substitutes can still be argued for conventional applications using rigid sources, there is no doubt that many useful new techniques can be developed using thin flexible sources. For these applications ^{192}Ir is recommended.

AFTERLOADING

Afterloading techniques are those in which guides are initially placed in the patient, and the radioactive sources introduced later into the guides under more favourable conditions of protection. The guides may be, for example, stainless steel or nylon tubes, or more elaborate applicators for intracavitary therapy. If the sources are introduced manually, the technique may be termed "simple afterloading". On the other hand, machines are currently under development in several countries whereby the sources are introduced and withdrawn by remote control. Such machines will virtually eliminate the hazard to personnel and place intracavitary therapy on a par with teletherapy.

The Panel considered that simple afterloading techniques have now reached the stage when they can be recommended even to less advanced institutes. These techniques offer important advantages, relative to conventional preloading methods, in terms of the accuracy of placing the sources and the radiation protection of personnel. However, there is an urgent need for the commercial production of simple afterloading applicators for intracavitary therapy of gynaecological tumours.

Remote controlled afterloading machines cannot yet be recommended to all institutes. There are several problems of a technical, clinical and radiobiological nature. In particular, the use of high activity sources (i.e. a few curies) in these machines will reduce the exposure time to minutes and enable patients to be treated on an outpatient basis. However, such

irradiations introduce difficult questions relating, for example, to dose-rate and fractionation. When these remaining problems have been solved, remote afterloading machines are likely to be widely used. Meanwhile, the Panel urges advanced radiotherapy centres to assist in the development and trial of this type of equipment.

SUMMARY OF RECOMMENDATIONS ON SOURCES AND TECHNIQUES

1. *For temporary applications* by preloading techniques, ^{137}Cs sources are recommended, if a new stock is acquired. Continued use of available double-encapsulated radium sources of modern construction is acceptable. ^{60}Co and ^{192}Ir sources may also be considered, if they can be produced cheaply in an available reactor.
2. As an absolute minimum, but not necessarily ideal, stock, 10 ^{127}Cs tubes of 20 mm overall length, 2.65 mm diameter, 13.5 mm active length and 10 mgm radium equivalent are suggested, plus 12 ^{137}Cs needles of 42 mm overall length, 1.65 mm diameter, 30 mm active length and 1 mgm radium equivalent. These sources should be made available by manufacturers as "packs" and may be supplemented by packs of sources of other activities.
3. *Afterloading applicators* should be used as much as possible and, for intracavitary work, they should accept the same sources as used for pre-loaded applicators. For afterloading of temporary implants, platinum-clad ^{192}Ir wire of 0.3 mm outside diameter is recommended. Remote afterloading machines are expected to be widely used after further development and trial.
7. *For permanent interstitial implants* platinum-clad ^{198}Au grains are recommended. Radon seeds are equally satisfactory medically, where existing plants with trained personnel are available. It is desirable to develop inexpensive seeds of low-energy emitters, preferably with half-lives somewhat longer than that of ^{198}Au .

DOSIMETRY

The Panel considered the practical aspects of dosimetry in brachytherapy and made a number of recommendations. They included a recommendation to IAEA to proceed with the compilation of a "brachytherapy atlas", i.e. an atlas of dose distributions for various arrays of sources, both for perfect and imperfect geometry. The outline of such an atlas has already been formulated. It is not intended as a "cook book" but as a guide to practical therapy with special emphasis on the effect of errors in placing the sources. Arrangements will be made to compute the distributions and it is hoped to publish the volume within two years.

The Panel also made recommendations on many aspects of the storage handling and maintenance of sealed sources, and on protection.