

# HUMAN HEALTH

## PROGRAMME OBJECTIVE

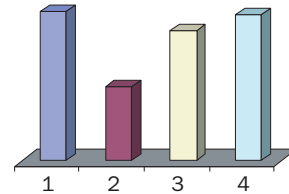
To enhance the capabilities of developing Member States to address needs related to the prevention, diagnosis and treatment of health problems through the development and application of nuclear techniques.

## OVERVIEW

The main focus of the programme was on the development of medical services for the prevention of malnutrition, detection of contaminant levels affecting humans, and diagnosis and management of cancer, nutritional, infectious and genetic disorders. In nuclear medicine there was emphasis on the use of open sources of radioactivity, which have been widely recognized in clinical practice as indispensable tools for the diagnosis and management of a large number of benign and malignant disorders. Radiotherapy techniques for the treatment of cancer were made more accessible to a greater number of Member States. While many States have the capability to ensure the proper accuracy of treatment procedures, a large group (especially those who are not members of the Meter Convention) still lack access to traceable dosimetry standards, or have no means other than the Agency to verify the quality of radiation measurements. For these Member States, the Agency remains the only organization that addresses these needs through its dosimetry programme. In the field of nutritional and environmental studies, nuclear based and related techniques were used to upgrade reference materials for studies of body composition of various elements and micronutrients for people living in Asia (the 'Reference Asian Man' project).

Regular budget expenditure: \$5 470 525

Extrabudgetary programme expenditure  
(not included in chart): \$106 655



1. Nuclear Medicine: \$1 639 432
2. Applied Radiation Biology and Radiotherapy: \$811 609
3. Dosimetry and Medical Radiation Physics: \$1 420 455
4. Nutritional and Health Related Environmental Studies: \$1 599 029

## NUCLEAR MEDICINE

Three severe clinical problems were addressed through separate CRPs. One looked into the role of bone scintigraphy by single photon emission computer tomography (bone SPECT) in chronic back pain. Analyses of results obtained in 400 selected patients revealed that bone SPECT can give valuable information in the early diagnosis of backbone joint disease, which is a common and treatable cause of chronic back pain. Another study evaluated the correlation between recurrent urinary tract infection (acute pyelonephritis) and renal scarring (diagnosed by dimercapto succinic acid renal scintigraphy) in 310 children. The results showed a strong correlation between urinary tract infection and acute pyelonephritis. It was also observed that early and effective antibiotic therapy may lead to complete resolution of acute cortical lesions in the kidneys and reduction the incidence of delayed sequel (scars). The third study, conducted in patients with palpable breast lumps (scintimammography), showed high sensitivity and specificity in correctly diagnosing malignant lesions. It confirmed the usefulness of scintimammography as a complementary method to conventional X ray mammography in the diagnosis and management of patients with breast cancer.

In 2000, the Agency launched its first thematic CRP entitled 'Management of liver cancer using radionuclide methods with special emphasis on trans-arterial radionuclide therapy and internal dosimetry'. This is the first in a series of CRPs that will be linked to post-graduate medical education in universities in developing Member States. For the first time the CRP will have an equal number of research contract and research agreement holders working in pairs. Each pair will supervise a post-graduate student in research work leading to an MD or PhD degree awarded by the local or national university.

Under various national and regional technical co-operation projects, a number of new in vivo and in vitro nuclear medicine techniques were transferred to developing Member States. For example, molecular biology methods for the detection of drug resistant malaria, tuberculo-

sis and Chagas disease were introduced in many countries of Africa and Latin America through two regional projects. The Agency provided an increasing number of Member States with technical support to strengthen their capabilities in the radioimmunoassay of tissue markers for breast cancer, hepatitis C, tumour markers and microalbumin, and in neonatal screening methodology. Other technical co-operation projects provided gamma cameras, SPECT systems and surgical gamma probes to developing Member States. In vivo nuclear medicine services in these countries were enhanced by the transfer of radionuclide

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methods in the management of coronary artery disease, liver cancer, thyroid cancer, bacterial infection and childhood diseases. In an effort to standardize clinical practice, the Agency finalized the protocols for various nuclear nephro-urological procedures for uniform application in the Latin American region through a regional ARCAL project.

## APPLIED RADIATION BIOLOGY AND RADIOTHERAPY

A number of clinical treatment protocols directed at optimizing the use of clinical resources for radiation therapy of cancer were evaluated in a CRP that ended in 2000. One of these protocols, addressing the palliation of dysphagia in oesophageal cancer, proved particularly successful. It evaluated 232 patients treated with a limited number of intraluminal insertions (two or three) of a radiation source into the oesophagus within one week (in contrast to the four or more weeks of external radiation). The protocol immediately received widespread acceptance and is now being promoted in Member States where this cancer constitutes a major clinical problem.

In another CRP involving a protocol on hemi-body irradiation for disseminated bone metastatic pain resulting from various cancers (e.g. prostate and lung cancer), 72 patients were randomized between two fractions of radiation treatment doses in one day, four fractions in two days and five fractions in five days. The study's conclusions regarding the selection of patients for these regimes were that patients with prostate cancer in

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particular appear to respond better to the prolonged fractionation regime. However, with breast or lung cancer primaries, the shorter fractionation regimes may be used with good responses.

The role of radiotherapy in AIDS patients with cancer is a subject of great importance in sub-Saharan Africa, where HIV positivity can reach 35% in some population groups. The disease is also accompanied by a greater than five fold increase in many cancers. An expert group examining this issue prepared a guidelines document on decision making (including the option of not administering any treatment at all) in the radiotherapy management of cancer patients infected with HIV who have limited life expectancy attributable to AIDS.

Technical co-operation projects in radiotherapy have become increasingly oriented towards the provision of the entire ‘package’ of technology — equipment, dosimetry, training, protection and commissioning — necessary for coherent radiotherapy services. Other technical co-operation projects focus on cancer control management. This work is being conducted jointly with the International Agency for Research of Cancer (IARC), which provides support for cancer registries in countries where the Agency is improving treatment facilities. These registries are useful for

assessing current needs of Member States and determining the impact of the national cancer management programme including the effect of radiotherapy technology supplied.

## **DOSIMETRY AND MEDICAL RADIATION PHYSICS**

In 2000 there was a considerable increase in activities in support of X ray dosimetry. This is a result of an Agency survey showing that the calibration methods at diagnostic radiation qualities performed at Secondary Standard Dosimetry Laboratories (SSDLs) are not standardized. Following the survey, a large number of SSDLs have requested guidance on establishing calibration facilities for X ray dosimetry. The capability of the Agency's Laboratories at Seibersdorf in mammography was augmented, along with the calibration of instruments at diagnostic radiology qualities. The mammography standard of the Agency was calibrated and a calibration service was made available to SSDLs. For general diagnostic radiology, an experimental set-up used to analyse the X ray spectra was established at the Agency's Laboratories. In addition, a CRP was launched for the development of a Code of Practice for diagnostic X ray dosimetry. And a new Code of Practice developed for radiotherapy dosimetry based on absorbed dose to water standards was completed.

The IAEA/WHO network of SSDLs currently consists of 73 laboratories in 61 Member States (more than half of which are developing countries) and 20 affiliated members (international organizations and Primary Standard Dosimetry Laboratories). In 2000, three new SSDLs — in Ethiopia, Greece and a second calibration laboratory in Germany — joined the network. Co-operation and collaboration between metrology organizations is critical in ensuring standardization of measurements. Following the signing by the Agency in October 1999 of the ‘Mutual Recognition of National Measurement Standards and of the Calibration and Measurement Certificates issued by National Metrology Institutes’ (the ‘Mutual Recognition Arrangement’, or MRA) for the SSDL network, an intercomparison of measurement standards was held with SIM,

the regional metrology organization for the Americas. An intercomparison with EUROMET, the European metrology body, is planned for 2001.

A total of 56 national standards and reference ionization chambers were calibrated at the Agency for Member States: about 85% were radiotherapy level (including brachytherapy) calibrations and 15% were for radiation protection. And dose quality audits and inter-comparisons were organized for SSDLs to check the traceability of their measurements and to monitor their performance. Seventeen SSDLs participated in the intercomparison of radiotherapy ionization chamber calibration factors and 30 in the thermoluminescent dosimeter (TLD) audit for radiation protection level dosimetry. Ninety-six radiation beams from cobalt-60 units and clinical accelerators operated at laboratories, or supervised by SSDLs, were monitored in the TLD audit for radiotherapy.

The Agency contributed to an international collaborative study of cancer risk among radiation workers carried out by the International Agency for Research on Cancer (IARC), in Lyon. The objective of the study is to provide an assessment of the carcinogenic effects of long term, low level radiation exposures in humans and to test the adequacy of current radiation protection recommendations. A comprehensive set of experiments was also carried out at the Agency's Laboratories at Seibersdorf to assess the response of personal dosimeters to energies and geometries similar to those existing under working conditions. The study involved irradiation of about 650 dosimeters.

The IAEA/WHO TLD postal dose assurance service for monitoring the calibration of radiotherapy beams at hospitals worldwide audited 333 beams, of which 215 were cobalt-60 and 118 were high energy X rays from clinical accelerators. The TLD programme has continued to expand, and the dosimeter return rate now exceeds 95%, with 80% of the results within the  $\pm 5\%$  acceptance limits. An analysis revealed the limitations for hospitals that do not participate regularly in external audits: 109 radiotherapy facilities in 72 hospitals that

had never been audited before were included in the IAEA/WHO TLD programme, with the finding that only 74% of the results of the first round of participation were within the  $\pm 5\%$  limits; 11% showed large deviations (beyond 10%) in these hospitals. This compares with 83% of results within  $\pm 5\%$ , and 6% of large deviations for hospitals that have participated more than once.

Following positive feedback on the assistance given in setting up national TLD programmes for quality assurance in radiotherapy, five more Member States received assistance. And

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as part of a technical co-operation project in Central American and Caribbean countries, a network for reciprocal on-site quality audit visits was established where physicists from various radiotherapy institutions in the region, supported by experienced physicists from the same region, carry out quality control measurements in other hospitals and countries.

Forty-eight cobalt-60 beam audits were performed for 23 industrial facilities and research institutes in Member States through the International Dose Assurance Service. Five results outside the acceptance limits were followed up.

## **NUTRITIONAL AND HEALTH RELATED ENVIRONMENTAL STUDIES**

The most significant outcome of a CRP on Reference Asian Man completed in 2000 was the generation of reliable data sets for dietary intake by the participating countries. These data will help the participating Member States to resolve national problems of radiation exposure assessment, as well as facilitate

the development of the characteristics of a Reference Asian Man, the primary goal of this regional project. The CRP also strengthened the analytical quality control profile in these countries, enabling them to carry out reliable measurements for a group of trace elements of great radiological significance, namely caesium, iodine, strontium, thorium and uranium.

Differences in bone mineral density (BMD) measured using dual energy X ray absorptiometry (DEXA) in young adults across a range of countries was the subject of another

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CRP that ended in 2000. In examining an age stratified total of 3752 subjects selected at 11 centres in 9 countries, highly significant differences in mean weight, height, and BMD between countries ( $p < 0.001$ ) were found. Following adjustment for age, weight and height, highly significant differences existed in young adult bone mass (for both men and women) that, if they persist into old age, may contribute to a two to three fold difference in the risk of bone fracture.

A regional UNDP/RCA/IAEA project on air pollution and its trends resulted in a network of air samplers being built to collect airborne particulate matter in the participating Member States. The results revealed increased levels of several toxic elements in the air of many of these countries, resulting in several undertaking legislative steps or technical countermeasures. Additionally, capacity for detecting regional air pollution episodes, such as haze due to biomass burning, was established

The application of nuclear techniques to problems of nutrition and health care took various forms in 2000. For example, technical co-operation projects in Latin America made progress

in the use of isotopes for evaluating nutrition intervention programmes. A project in Chile completed a study on isotope techniques to measure iron bioavailability in fortified milk of the National Complementary Food Programme (PNAC). Another project examined body composition and energy expenditure in pre-school children using labelled water ( $^2\text{H}_2^{18}\text{O}$ ).

Priority work in 2000 at the Agency's Laboratories at Seibersdorf included the first compulsory proficiency test for ALMERA, a network of 80 laboratories in 45 countries to measure environmental radioactivity. The test consisted of two sets of samples, one for the analysis of alpha and beta emitting radionuclides including plutonium, americium-241 and strontium-90, and the second for a mixture of gamma emitting radionuclides. A total of 56 sets of samples for alpha/beta analysis and 74 sets of samples for gamma analysis were distributed to 68 laboratories in 40 countries.

Related activities at the Agency's Laboratories included proficiency tests administered to other laboratories involved in the measurement of environmental radioactivity. Two tests, in particular, focused on strontium-90 in an incinerator ash matrix, and on the measurement of plutonium-239, plutonium-241 and americium-241 in soil. The results from the strontium-90 test indicate that the majority (over 80%) of laboratories still have problems determining this radionuclide. However, better results were obtained in the second test for the measurement of transuranium actinides.

The Seibersdorf Laboratories were also involved in the analysis of samples from two technical co-operation projects in Algeria and Jordan, and a follow-up activity connected with the UNEP evaluation of the military use of depleted uranium (DU) in Kosovo. Twenty-three Algerian samples gathered during a mission to former French nuclear test sites were analysed non-destructively for gamma emitting radionuclides (caesium-137, americium-241, europium-154 and barium-133), and destructively for actinides (plutonium, americium-241) and strontium-90. A summary

report of these analyses provided the basis for an Agency estimate of present and future possible doses to persons in the area. None of the sites gives rise to dose levels which might require intervention. It was, however, recommended to the Algerian Government that access continue to be restricted to the contaminated areas, and that further monitoring be continued.

A sampling and analysis mission to Jordan was intended to investigate Jordanian concern about elevated levels of fission products in their environment. In situ gamma spectrometric measurements were performed and 33 samples were analysed for gamma emitting radionuclides. The radioactivity levels found are consistent with a mixture from global fallout and contamination from the Chernobyl accident, and are generally lower than the levels found in southeast Europe.

And in Kosovo, 16 samples were taken by Agency experts and analysed at the Seibersdorf Laboratories for total uranium and uranium isotopic abundances. The results confirmed the presence of varying amounts of

DU at the suspected sites, in addition to a natural uranium level of around 2 mg/kg generally in the Balkan soil. In spite of the extremely sensitive instrumental capabilities, this limits the detection of DU in the environment to about 0.1 mg/kg.

Responding to requests by Member States for environmental reference materials with reference values for primordial radionuclides (uranium, thorium, radium-226, lead/polonium-210), a potential phosphogypsum reference material for these radionuclides as well as three mineral waters for radium-226 were identified and are being analysed. The reference materials are needed to enhance the comparability of radioactivity levels measured by different laboratories on a worldwide scale.

A CRP on radiochemical, chemical and physical characterization of radioactive particles in the environment was approved in 2000. The goal is to develop techniques for identifying and investigating the characteristics of small radioactive particles, which in most cases are the primary species involved in the accidental or intentional release of radioactivity.