

## HUMAN HEALTH

**Regular Budget expenditure: \$7 056 738***Expenditure by subprogramme*

<i>Nuclear medicine</i>	\$1 460 491	
<i>Applied radiation biology and radiotherapy</i>	\$960 513	
<i>Dosimetry</i>	\$1 928 727	
<i>Nutritional and health related environmental studies</i>	\$2 235 996 + \$471 011 (IAEA-MEL):	\$2 707 007

*Extrabudgetary programme resources utilized (not included in chart): \$1 667 542 (including IAEA-MEL)*

Agency activities in the area of human health focus on the common concerns of developing Member States that can be most effectively addressed using nuclear technologies. The programme promotes the diagnosis as well as palliative and curative treatment of cancer, the accurate evaluation of nutritional deficiencies in women and children, the timely detection of infections and communicable diseases, and radiation dosimetry. Advances in molecular biology facilitated the introduction in 1995 of a new area of work centred on genetic disorders which, together with other programme components, such as nutritional studies, is giving increasing emphasis to aspects of preventive medicine.

***Nuclear Medicine***

Agency efforts to adapt nuclear medicine technology to the needs and local conditions in Member States and to significantly reduce the costs of procedures have included the introduction of bulk methodology and the indigenous production of reagents for radioimmunoassay (RIA). These techniques give a four fold to six fold cost reduction per assay in many developing countries. Similarly, the hardware interfaces and applications software developed by the Agency to link gamma cameras to

personal computers for digital data and image processing — obviating the need for costly hardware — make possible a three fold to five fold cost reduction in data processing systems. A limited field trial that started in 1995 is seeking to document these savings.

The Agency has also served indirectly as a catalyst in promoting the production by commercial firms of simple, low cost gamma cameras and single photon emission computed tomography (SPECT) systems, fitted with updated technology, to suit the needs of developing countries. The benefits are increased availability of equipment to Member States and lower costs for technical co-operation projects.

In related work, an inexpensive on-line circuit for field uniformity and photon energy correction has been used to upgrade and restore old, non-operational, analog gamma cameras to working condition. Efforts were initiated in 1995 to repair three 10–15 year old gamma cameras of this type in Argentina, India and Myanmar as part of a plan to upgrade to digital technology or to restore as many old analog gamma cameras as possible. It is estimated that there are about 500 such instruments (more than 65% of which are in developing countries) which can benefit by this upgrading.

Technical co-operation projects were initiated in Ethiopia, The Former Yugoslav Republic of Macedonia and Uganda in 1995 for the production of radiopharmaceutical kits in hospitals. The goal of these projects is to help reduce costs and increase self-reliance.

A randomized clinical trial comparing strontium-89 and phosphorus-32 for the treatment of painful cancer deposits in bone is being conducted to find out whether phosphorus-32 (which is inexpensive and easily available) can replace strontium-89 (which is expensive and not easily available). This study underlines Agency efforts to promote relevant, cost effective and applicable techniques for use in developing countries. The same philosophy is at the root of a recently completed CRP comparing scintigraphy and ultrasonography for the diagnosis of liver diseases.

The Agency has adopted a two level approach to improve the technical skills of nuclear medicine professionals. At one level, a pilot distance training programme for nuclear medicine technicians is being carried out in countries of the RCA region (i.e. India, Indonesia and Malaysia). When completed in 1996, the training materials will be translated into various national languages and will be utilized by more than 3000 technicians presently working without any formal training at nuclear medicine departments in developing Member States. The materials can also be used to complement existing or planned training courses conducted by Member States.

At another level, the Agency has served as a catalyst in the establishment of the Ibero-American Board for the Certification of Nuclear Physicians by the Latin American Association of Societies of Nuclear Medicine and Biology (ALASBIMNM), as well as in the implementation of the first certifying examination in November 1995. The examination was simultaneously carried out in Argentina, Bolivia, Chile, Ecuador, Portugal and Spain. The creation of this Board served as a stimulus for the setting up of the European Board of Nuclear Physicians. At present, the Agency is promoting the foundation of a similar board for the Asia and Pacific region by the Asia and Oceania Federation of Nuclear Medicine and Biology. In the future, it is expected that the three regional Boards will be bound together by a single international body dedicated to developing common question papers that will increase the fairness and validity of examinations for nuclear medicine professionals.

The diagnosis of genetic diseases using radionuclide based molecular techniques is acquiring greater importance as a result of changes in disease patterns observed

in many developing countries. Improved socioeconomic conditions have led to a decrease in infant and childhood mortality rates, which in turn have resulted in an increase in the incidence of genetic (hereditary) diseases. A CRP initiated in 1995 concentrated for the first time on diagnostic methods for common hereditary diseases, such as thalassemia, fragile x-syndrome and certain neurological diseases.

A CRP on nuclear investigations of cerebral function was completed during the year. One beneficial result was that it helped to rationalize the use of certain drugs, such as Nicerogoline, Indobufen and Tanakan, for patients with cerebrovascular disease. It also provided scientific documentation of changes in regional cerebral blood flow following acupuncture.

An international symposium entitled *Tomography in Nuclear Medicine — Present Status and Future Prospects* was held in August in Vienna. The symposium highlighted the increased use of SPECT to obtain data on patients which was hitherto only possible using the much more expensive technique of positron emission tomography. The proceedings will be published in 1996.

### ***Applied Radiation Biology and Radiotherapy***

Special emphasis is being placed on increasing the efficiency and improving the cancer cure rate in radiotherapy units in developing Member States. Since up to 80% of new cancer cases in these countries are detected at the advanced disease stage, the following three converging avenues were selected for attaining these goals:

- Developing a standardized programme on quality assurance, including every step in the clinical procedure from patient selection to radiation dose delivery;
- Evolving optimal protocols for the treatment of advanced cancer types common in developing countries by twinning radiotherapy departments in developing countries with corresponding departments in developed Member States;
- Implementing randomized clinical radiotherapy trials combined with other treatment modalities for different types of advanced cancer.

Significant cost reductions in radiation therapy have been achieved as a result of the Agency's mediation with commercial manufacturers in the production of simple, inexpensive, after-loading systems for low, medium and high dose rate brachytherapy, combined with updated technology to fit the needs and conditions in developing

countries. Efforts are being made with other firms for the production of low cost teletherapy cobalt-60 equipment.

In an attempt to solve common problems affecting the practice of radiotherapy around the world, and in developing countries in particular, a new CRP was initiated on the use of radiotherapy in advanced cancer. Because the majority of the approximately 10–11 million new cases diagnosed worldwide every year occur in developing countries, the aim of this CRP is to interface radiotherapy departments in developed and developing countries in order to formulate optimal therapeutic approaches to the treatment of common cancers. Three protocols are undergoing trials in this CRP: one for half-body irradiation techniques, and one each for cancer of the uterine cervix and intraluminal brachytherapy for carcinoma of the oesophagus.

There was also emphasis on encouraging quality assurance programmes in clinical radiotherapy departments. A new CRP on quality assurance in radiotherapy was started in Latin America on the basis of a protocol recommended by a team of Agency experts. It is expected that the experience from this project will assist the Agency in defining a standardized programme on quality assurance which could be adopted by interested radiotherapy departments among Member States and, in particular, by the participants in 65 ongoing technical co-operation projects on the subject.

A CRP was initiated in 1995 on the application of heavy charged particles in cancer radiotherapy. Only a few centres, mainly located in developed countries, currently possess such facilities. This CRP is expected to provide a much needed *international* forum for the review and co-ordination of national programmes on the use of heavy charged particles in radiotherapy.

## ***Dosimetry***

Radiation dosimetry and medical radiation physics are fundamental in ensuring a patient's radiation safety and in optimizing radiation therapy practices. The main emphasis in the field of dosimetry was on continuing and improving the services provided to Member States.

Following the establishment of facilities and a syllabus for a national training programme in medical physics in Mexico, these activities were upgraded in 1995 to the category of a model project for Latin America. The aim is to replace simpler professional training with post-graduate university degrees in medical physics. The

lessons learned during the implementation of this project will be applied in other Member States.

The number of IAEA/WHO Secondary Standard Dosimetry Laboratories (SSDLs) rose in 1995 to 73 laboratories and 6 SSDL national organizations in 58 Member States; it also includes 14 affiliated members, mainly Primary Standard Dosimetry Laboratories (PSDLs), the International Commission for Radiation Units and Measurements (ICRU) and other international organizations. Support to laboratories in Member States included calibration of their secondary standards for radiation measurements and quality audits of their services, mainly to radiotherapy installations.

As the central point of the network and as the link to the international measuring system, the Agency in 1995 provided calibrations of 22 reference ionization chambers and dosimeters for 12 SSDLs. A total of 59 ionization chambers belonging to SSDLs and hospitals were calibrated (i.e. 410 calibration points at different radiation qualities). The quality audit system based on mailed thermoluminescence dosimeters (TLDs) was used for 6 SSDLs to verify their calibrations of cobalt-60 therapy units and medical accelerator radiation beams.

A new service was begun in 1995 to develop procedures for the calibration of radiation sources used in brachytherapy and related measurement equipment, first at the Agency's dosimetry laboratory at Seibersdorf and later at SSDLs. This unique service is meant to extend the traceability of doses delivered in brachytherapy treatments to international standards.

The IAEA/WHO TLD postal service distributed 425 thermoluminescence dosimeters to radiotherapy centres in developing Member States. These dosimeters are used for dose quality audits of photon and electron beams for cobalt-60 therapy units and medical accelerators. In addition, results from 100 cobalt-60 beams and 134 accelerator photon and electron beams were processed during the year.

Testing of the new method of using TLD dose checks of electron beams was completed in 46 radiotherapy institutions in Europe and the USA, and procedures were developed to expand the TLD postal service to routinely include electron treatment beams. Part of this work was carried out in collaboration with the SSDLs of Argentina and India using Agency technical expertise. Procedures for the follow-up of hospitals that are outside the acceptance limits now include a user-blind repetition of the exercise.

Experts are now being recruited to resolve confirmed deviations.

The International Dose Assurance Service (IDAS) for industrial dosimetry in radiation processing facilities was continued. A new batch of alanine-ESR dosimeters was calibrated with traceability to the National Physical Laboratory, the PSDL in the United Kingdom. Sixty-eight dosimeter sets were distributed to 20 participating institutes from 16 Member States. This service has, since its initiation, been limited to cobalt-60 radiation. However, following the recommendations of a CRP on electron dosimetry, a transfer dosimetry system for electrons with energy higher than 4 MeV based on alanine-ESR is being implemented to extend the IDAS to electron beams. In related work, a study is being conducted to evaluate the therapeutic use of the alanine-ESR dosimetry system, which is already being used very effectively in industrial applications.

An intercomparison of gamma ray irradiation beams between nine calibration laboratories, organized in collaboration with the Bureau International des Poids et Mesures, was completed. The last such intercomparison was held about ten years ago. The standard deviation of the population was 2.1% at 15 kGy and 2.4% at 45 kGy. The Agency's value agreed with the mean value to within 1% for both dose levels. In practice, this means that variations between the nine calibration laboratories are very small and that their overall deviation from the Agency's mean value is even smaller.

A new Agency Code of Practice for the calibration and use of plane parallel ionization chambers in therapeutic electron and photon beams was submitted for publication. This document complements and updates the 'IAEA Protocol' for the calibration of clinical beams used in external radiotherapy (Technical Reports Series No. 277), which is the Code of Practice most widely used in Member States.

### ***Nutritional and Health Related Environmental Studies***

Malnutrition afflicts more than 800 million people in developing countries, with children and women during pregnancy being most affected. Nutrition is therefore one vital area of human health where nuclear techniques can be applied to prevent disease and help people achieve their full potential. An essential component of any intervention seeking to improve nutritional status is the ability to

perform accurate evaluations. Isotopic tracer techniques are unique in that they can be used to measure people's nutritional stores and predict long term outcomes, such as school performance, worker productivity, pregnancy outcome, morbidity and mortality. Their growing use should increase the cost effectiveness of intervention programmes, because programmes can be adapted and corrected during the early phases to the results of the early predictors. In addition, they can reduce the population sample size to obtain statistically significant information because the coefficient of variation of isotope measurements is considerably smaller than that of conventional measurements.

Nuclear techniques are being used for the first time to measure vitamin A reserves in people at risk of deficiency. This programme has led to a major collaborative effort involving the Agency, WHO and two Member States. Another project is under way in Peru to evaluate the nutritional impact of a national school breakfast programme which is delivering breakfasts each school day to 500 000 children over a four year period.

Significant progress was achieved in 1995 through improved quality management in environmental programmes using nuclear analytical techniques, particularly in a regional RCA programme supported by UNDP. New quality assurance materials and proficiency testing procedures have been developed with the assistance of the Agency's Laboratory at Seibersdorf, and a comprehensive new database on certified analytical reference materials has been created (which will shortly be made available on the Internet). For air pollution studies, a standard design air sampler is now operational in more than 30 Member States. This will, for the first time, allow accurate comparative data to be obtained on pollution levels and sources in a large number of developing Member States.

A gas chromatograph-isotope ratio mass spectrometer was installed in 1995 at IAEA-MEL. This instrument is being used to 'fingerprint' non-nuclear pollutant sources and to search for novel chemical markers of pollution.

Within the framework of an umbrella project with UNEP, IAEA-MEL provided comprehensive technical support in the assessment of marine pollution. Regional training courses were held in Morocco, Peru, the Russian Federation and Ukraine. Courses in Monaco were conducted on the analysis of trace elements and organometals, organochlorine compounds and petroleum hydrocarbons. Twenty advisory and technical missions

were carried out in 13 countries. Instrument maintenance services were also provided to ten Mediterranean Pollution (MEDPOL) laboratories in seven Mediterranean countries.

The preparation of IAEA–UNEP–IOC reference methods and technical bulletins for marine pollution studies was given high priority. Thirteen methods were revised, eight new methods were issued, two methods were translated and one technical bulletin was prepared. The series now includes over 65 volumes.

Activities in the Analytical Quality Control Services programme included the distribution of a sea plant homogenate (IAEA-140) to 207 laboratories worldwide for the intercomparison of organic contaminants. In addition, two intercomparison samples for the determination of trace

elements in biota and sediments (MA-MEDPOL-1/TM and SD-MEDPOL-1/TM) were distributed to 80 laboratories in the Mediterranean Sea area. They were specifically organized for MEDPOL laboratories in order to test the reliability of procedures and the viability of analytical data, as well as to target future areas of technical support.

A report on worldwide and regional intercomparisons for the determination of organic contaminants in Mussel Homogenate (IAEA-142) was completed. In total, 93 laboratories reported results for organochlorine compounds and petroleum hydrocarbons, and 12 laboratories reported results for the quantity of total mercury and methyl mercury. On the basis of the data evaluation, the IAEA-142 sample can now be considered for certification as a Reference Material for the above analytes.