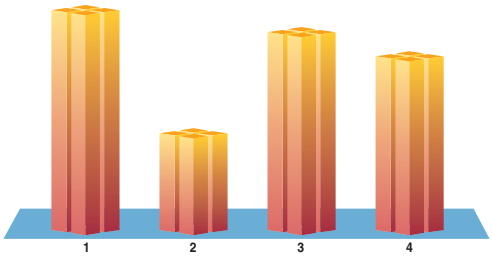
Human Health

Objective

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

Regular budget expenditure: $5 447 756
Extrabudgetary programme expenditure (not included in chart): $81 693



1. Nuclear Medicine: $1 742 732
2. Applied Radiation Biology and Radiotherapy: $758 411
3. Dosimetry and Medical Radiation Physics: $1 572 620
4. Nutrition and Effects of Contaminants on Human Health: $1 373 993

Key Issues and Highlights

- New procedures, developed as a result of Agency activities, strengthened the role of isotope based molecular methods in the management of important infectious diseases.
- Radiotherapeutic treatment of cancer remained a core priority.
- An international symposium was held in Vienna to review the status of standards and codes of practice in medical radiation dosimetry.
- The efficacy of nuclear methods in the management of multi-nutrient food supplementation was reconfirmed.

Nuclear Medicine

The Agency co-ordinated the development of an isotope based molecular method for use in multi-drug resistant tuberculosis (TB). Compared with the conventional technique, this method provides a simpler and more rapid procedure and has improved sensitivity. A total of 2150 samples, including 610 resistant TB strains, were subjected to strain typing. The Russian Federation immediately adopted the method, where it was used to demonstrate active infection transmission in a prison.

Isotope molecular methods were further developed for mutation analysis in 290 patients from Cyprus, India, the Islamic Republic of Iran, Mauritius, Pakistan and Thailand who were suffering from ß-thalassemia (a blood disorder). It was found that a milder form of the disease could be explained through well characterized mutations. The outcome of the study means that it will be possible to develop a simplified diagnosis strategy for families at risk and also to advise on the cost effective management of patients with a milder form of the disease.

Nuclear cardiology can play a significant role as a cost effective tool in patient management. In this regard, the involvement of cardiologists is critical for the expansion of nuclear cardiology services. The Agency convened an international symposium on cardiovascular nuclear medicine in Beijing, which was the largest international nuclear cardiology meeting in terms of the number of participating countries. The conference noted that currently the use of myocardial perfusion imaging in developing countries is quite low as compared with developed countries like the USA. For example, China with a population of over 1.3 billion carried out less than a million nuclear scans in 2001 (0.08% of the population per year), whereas the USA with a population of 275 million had nearly 5 million scans per year (1.8% of the population per year). The expansion of nuclear cardiology services and improvement of the quality of nuclear cardiology practices in developing countries were thus recognized by conference participants as major tasks requiring concerted international action.

Other key issues that were identified included: (a) further expansion of clinical applications, especially risk stratification and prognostication in patients with coronary heart diseases; (b) transfer of information on nuclear cardiology to clinicians, especially cardiologists

and primary care referring physicians; (c) increased training in nuclear medicine and cardiology to increase nuclear cardiology services; and (d) improved technology to produce better and less expensive equipment.

The first issue of the new quarterly *World Journal of Nuclear Medicine* was launched at the 8th Congress of the World Federation of Nuclear Medicine and Biology (WFNM&B) in Santiago, Chile. The main objectives of the journal are to promote research in nuclear medicine globally and particularly in developing countries, as well as to enhance good practices in nuclear medicine. The Agency is providing startup help to the WFNM&B in the publication of the journal with a financial contribution of $10 000 per year for two years (2002–2003).

A prototype of a PC based nuclear medicine computer system for upgrading semi-digital gamma cameras was developed, tested and validated. Eight Internet based teaching/self-study modules were developed on several nuclear medicine topics. The structure of a new Internet home page for instructors in nuclear medicine was developed containing case studies, multimedia training packages, slide shows and links to relevant web sites for collaborative research, teaching and self-study in nuclear medicine.

Thirty renal study and 32 cardiac study software phantoms were tested and validated for quality assurance. The tests were carried out as part of a comparison of clinical application software employed by nuclear medicine laboratories using software phantoms developed by the Agency and the European Association of Nuclear Medicine Sub-committee COST-B2 project.

The Agency plays a vital role in the introduction, promotion and integration of nuclear medicine techniques in the health care systems of developing Member States. One important aspect of this function is facilitating information exchange. To this end, the Agency developed and validated a conversion programme between two international medical file and image format standards, i.e. Interfile 3.3 and DICOM 3, for medical file transmission and exchanges between nuclear medicine centres.

Applied Radiation Biology and Radiotherapy

Brachytherapy, which is radiation treatment delivered by sealed sources placed temporarily into body cavities, is a very important method of cancer treatment, particularly in cancer of the uterine cervix and the esophagus, which are common cancers in many developing countries. Many more patients can be treated by a single high dose rate (HDR) brachytherapy machine than by using multiple low dose rate (LDR) brachytherapy units. However, some developing countries are still using LDR because HDR appears to cost more to install and maintain, thereby depriving patients of treatment in some cases. The Agency has developed a financial model that will help institutions evaluate the costs and benefits of HDR, not just in terms of the absolute cost but the cost per patient treated.

There is much current interest in combining radiotherapy with complementary non-nuclear technologies for improving the outcomes of cancer patients. Research projects in this area were concluded in 2002. The addition of Mitomycin-C, a chemotherapy agent that in some circumstances has been shown to also act as a radiation sensitizer to radiotherapy for cancers of the head and neck, was studied in a clinical trial with nearly 600 patients from 8 institutions. The research will lead to more rational utilization of Mitomycin-C and similar drugs in the treatment of head and neck cancers.

The Agency's activities in radiation therapy also included the study of non-malignant conditions such as atherosclerotic artery disease (blocking of the arteries). Millions of patients all over the world with athero-sclerotic coronary artery disease are treated every year by angioplasty and stent placement (artery clearance and support), but restenosis (re-blocking) of the blood vessels is a major cause of morbidity and mortality. These patients can benefit from endovascular brachytherapy, which assists in retarding further blockages. Using the services of consultants, the Agency assessed the state of the art in the field of endovascular brachytherapy and identified areas that require further investigation for the optimum utilization of this technology.

Dosimetry and Medical Radiation Physics

In collaboration with WHO, the Agency maintains a network of Secondary Standards Dosimetry Laboratories (the SSDL network) within Member States for the correct measurement of ionizing radiation, which is essential for the safe and effective diagnosis and treatment of patients as well as for monitoring radiation levels for persons exposed occupationally.

The SSDL Scientific Committee, an advisory committee to the Agency, conducted a detailed examination of all of its activities in dosimetry and medical radiation physics. Among others, a recommendation for the introduction of a Medical Physics Investigation Team was proposed to resolve and mitigate the possible misadministration of doses to patients, detected either by the IAEA/WHO postal dose audit programme, or upon request by hospitals in Member States.

An international symposium on standards and codes of practice in medical radiation dosimetry was organized by the Agency in Vienna from 25 to 28 November to foster the exchange of information and highlight recent advances in research in this field. A key issue was knowledge of the accuracy of radiation doses delivered to patients, which is essential for the safe and effective diagnosis and treatment of disease. Such accuracy in dose measurement is an integral part of a comprehensive quality assurance programme to ensure that the technology is used properly and has the intended effect on patients. Recommendations were made emphasizing the importance of education and training of health care workers, the need for improved infrastructural services in medical physics and diagnostic radiology to support the new treatment methodologies and quality control and assurance programmes to provide the auditing tools necessary to demonstrate the effectiveness of nuclear technology. Recommendations specific to dosimetry emphasized the need for robust dose standards, with well characterized uncertainty estimates, and wider application of the Agency's dosimetry code of practice, *Absorbed Dose Determination in External Beam Radiotherapy* (IAEA Technical Reports Series No. 398).

A plenary session entitled "Meeting the Needs" was held during the symposium on medical radiation dosimetry. The purpose of this session was to draw attention to the impending crisis in cancer management in developing countries. According to a presentation by WHO's International Agency for Research on Cancer (IARC), the incidence of cancer in developing countries is expected to increase by about 50% within the next decade, primarily because of the increase in lifespan as a result of improved standards of living (Fig. 1). The Agency has a unique opportunity to help its Member States address the seriousness of this prediction by increasing its efforts to transfer cancer treatment technology and to develop expertise locally for its safe and effective use.

A report on the use of bio-dosimetry with tooth enamel was published for use in retrospective dose assessments of accidentally exposed persons. More accurate evaluation of the dose received would enable the selection of appropriate countermeasures to mitigate the effects of the irradiation. A second report was published on standardized methods to calibrate the radiation sources most commonly used in brachytherapy and in the rapidly growing field of cardiovascular angioplasty. Harmonized methods for source strength and patient dose determination should simplify the comparison of treatment results and form a solid basis for the improvement of treatment techniques.

Nutrition and Effects of Contaminants on Human Health

Agency research on stable isotopic techniques for the prevention of degenerative diseases in developing countries was completed, contributing to the search for solutions to the problem of obesity that is reaching epidemic proportions in developing countries. An important outcome has been the development of a harmonized standard protocol applicable to multi-country studies for body composition and physical activity measurements. The results suggest that total body fat and its topography are perhaps the most important predictors of the evolution of the insulin resistance syndrome. Importantly, these studies in several developing countries highlighted the role of dietary intake, including variations in the quantity, composition and quality of the diet and the relationship of body composition to physical activity patterns, in understanding the immediate risk factors associated with non-communicable diseases.

The results of an evaluation of the Community Nutrition Project in Senegal were used to refine the Senegalese Nutrition Programme planned for imple-

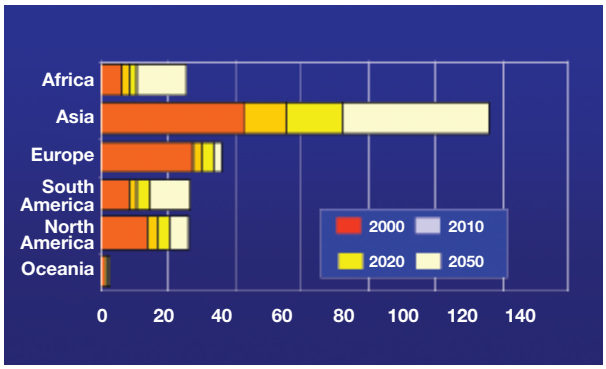


FIG. 1. Increase in the number of cases of cancer worldwide by region. Courtesy of Sharon L. Whelan (IARC).

Isotope Techniques in Action in Developing Countries

An Asian regional technical co-operation project measured the effectiveness of multi-nutrient supplementation, guiding the industrial sector in choosing the best fortificants for national nutrition initiatives that address micronutrient malnutrition. Another regional project, in Latin America, on isotopes for evaluating nutrition intervention programmes, resulted in the extended use of isotopic techniques in understanding human body composition. Such projects build and strengthen capacity in the use of nuclear and related isotopic techniques for nutritional monitoring. For example, a project focusing on Latin America led to modifications of existing programmes for enhancing the effectiveness of national health initiatives in Chile, Cuba and Mexico.

mentation between 2002 and 2012. In related work, the findings from an evaluation of national Supplementary Feeding Programmes in Ghana on the nutritional status of mothers and infants using stable isotope techniques will be used by the Ministry of Health to strengthen future nutrition projects in the country.

The prevalence of low birth weight (LBW) is estimated to range between 3 and 38% worldwide, with the majority of cases occurring in less developed countries (in fact reaching 24% of all births annually and resulting in 30 million infants being identified with intra-uterine growth retardation (IUGR)). Low birth weight is a major determinant of mortality, morbidity and disability in neonates, infancy and childhood, and also has a long term impact on health outcomes in adult life. It also results in substantial costs to the health sector and imposes a significant burden on society as a whole. To address this problem, the Agency, together with WHO, held several meetings on IUGR and the impact of ageing at which common areas in the field of nutrition for joint IAEA–WHO projects in 2003 were identified.

A recently completed regional technical co-operation project on trends in air pollution resulted in the 15 participating countries acquiring the capability to assess air particulate pollution using reliable and standardized methods. In addition, a network of analytical laboratories and institutions involved in environmental pollution monitoring or air quality management was established, and baseline data on airborne pollution in the ambient air in metropolitan centres were collected. Other examples of Agency regional technical co-operation projects are given in the box above.

A novel approach to biomonitoring was used in a research project on the validation and application of plants as biomonitors of trace element atmospheric pollution. Project participants were trained in the use of mosses, lichens or plants in assessing the levels of atmospheric deposition of heavy metals. Biomonitoring surveys were carried out in the 14 participating countries, spread over large geographical areas under different climatic conditions, revealing individual pollution sources for each area. Graphical pollution distribution maps were then created for each country, which provided the authorities with an illustrative assessment of air pollution levels. The results were also disseminated in a range of technical publications.