

Human Health



Prevention, Early Diagnosis and Treatment of Non-Communicable Diseases

The Role of Nuclear Techniques

SUMMARY

1. Non-communicable diseases (NCDs) have become an increasing burden for low-and middle-income (LMI) countries where they account for more than 80% of all premature deaths.
2. NCDs include cancer, cardiovascular diseases and neurological conditions, among others.
3. The double burden of malnutrition in the form of acute and chronic undernutrition, overweight and obesity is a risk factor for NCDs.
4. IAEA support and services focus on nuclear applications to prevent, monitor, diagnose and treat NCDs.

INTRODUCTION

The challenges to human health are growing, particularly in developing countries. Among the most serious issues are NCDs, such as cancer and cardiovascular disorders. Acute and chronic malnutrition, especially in early life, overweight and obesity and deficiencies of essential vitamins and minerals in the diet are responsible for a significant proportion of NCDs, including diabetes, heart disease and some cancers. These diseases affect many people and claim many lives. Major drivers of NCDs include tobacco and alcohol use, physical inactivity and unhealthy diet.

According to World Health Organization (WHO) data, NCDs kill more than 40 million people each year, equivalent to 70% of all deaths globally: cardiovascular diseases account for most of these deaths (17.7 million), followed by cancers (8.8 million),



A radiation therapy machine delivers a beam of radiation in order to treat cancer in a patient. (Photo: D. Calma/IAEA)

respiratory diseases (3.9 million) and diabetes (1.6 million). WHO predicts that the NCD burden will continue to increase by a further 17% over the next ten years, mainly in LMI countries. Alzheimer's disease, the most common form of dementia, is another global concern. It causes problems with memory, thinking and behaviour. Worldwide 35.6 million people live with dementia, and this figure is projected to double by 2030 and triple by 2050.

The IAEA plays a vital role in addressing these global health challenges, where nuclear techniques can play an important role in prevention, diagnosis and treatment.

SNAPSHOT OF CHALLENGES

Cardiovascular disease

Cardiovascular disease (CVD) is still the number-one killer worldwide. CVDs are disorders of the

heart and blood vessels and include heart disease, cerebrovascular disease and other conditions. Over 75 % of CVD deaths occur in LMI countries, and 80% of CVD deaths are due to heart attacks and strokes that can be largely prevented by controlling their risk factors. Access to essential medicines and early detection are key to preventing and reducing the prevalence of this disease.

Cancer

Cancer incidence is expected to rise by 50% by 2030. Cancer is the second leading cause of death worldwide. Over one third of all cancers can be prevented, and some of the most common ones — including cervical, breast, head and neck and colorectal cancers — are curable if detected early and treated appropriately. The global challenge is to support many developing countries in meeting the need for diagnosis and for curative and palliative cancer treatments.

Malnutrition and obesity as a preventable driver of non-communicable diseases

The effects of poor nutrition add to the burdens on health-care systems. Acute and chronic malnutrition, especially in the first 1000 days of life, and overweight and obesity are responsible for a significant proportion of NCDs, including elevated blood pressure, diabetes, heart disease and some cancers. More than a billion adults are overweight worldwide and face serious diet-related health problems while, on the other hand, undernutrition and hunger still persist. Undernutrition is an important factor in about half of all child deaths, translating into the loss of about 3 million young children every year.

HOW NUCLEAR TECHNIQUES CAN HELP

Cardiovascular disease

Medical imaging in nuclear cardiology plays a pivotal role in the appropriate management of patients with CVD. It offers strategic advantages in both diagnostic and therapeutic decision-making and enables

early diagnosis, selection of appropriate therapy and treatment follow-up. The techniques include single photon emission computed tomography (SPECT), positron emission tomography (PET) and computed tomography (CT), as well as non-nuclear techniques such as magnetic resonance (MR) and echocardiography, all of which provide an excellent opportunity to understand the patient's pathology to help facilitate tailored clinical management. Each imaging modality has its advantages and limitations, which need to be understood properly by health-care professionals dealing with CVDs.

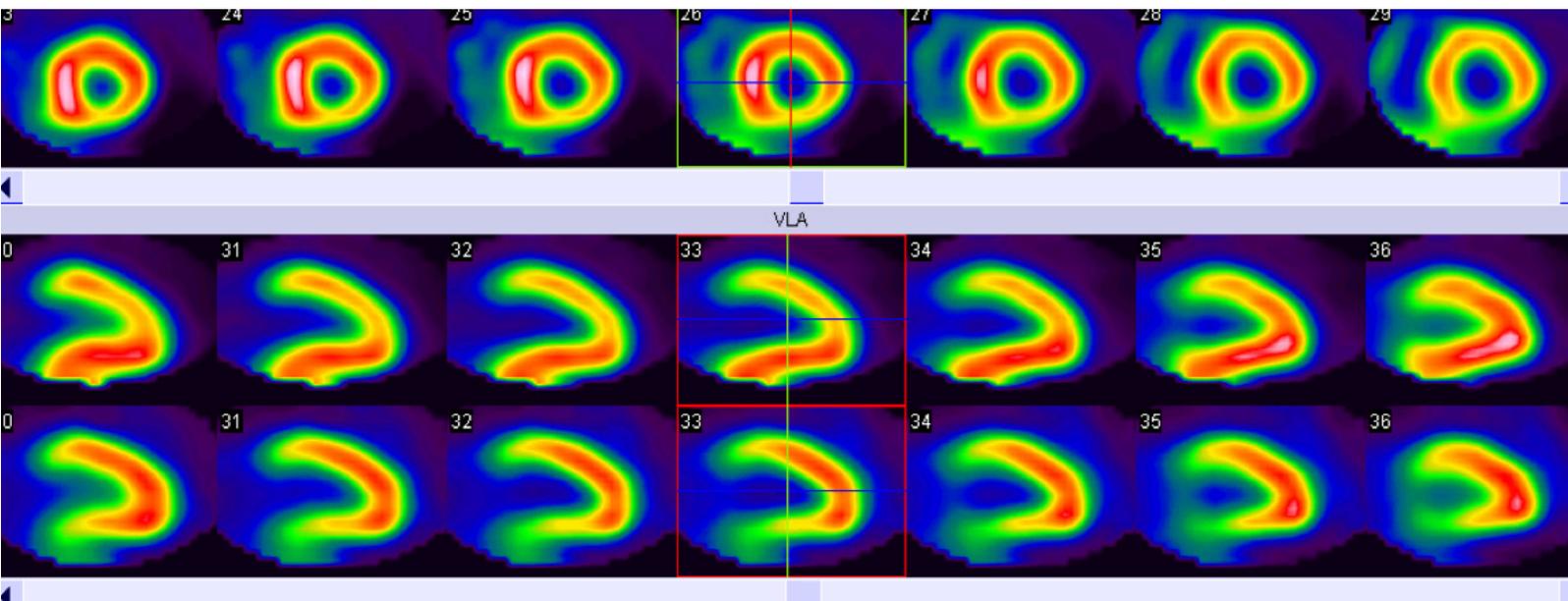
Myocardial perfusion studies work by injecting a radiotracer that tracks the blood supply in the heart muscle. The radiotracer emits small amounts of radiation that are picked up by a sensitive camera and processed into images. These images reveal how well the heart muscle is supplied (or perfused) with blood.

Cancer

The cure rate among cancer patients is strongly dependent on the stage of the disease at the time of its diagnosis, and early detection remains key. In medical imaging, the most common techniques used in detecting and staging cancer use X-rays or radioisotope studies. These techniques include SPECT and PET and play an important role in early screening, accurate diagnosis, disease location/spread, selection of appropriate therapy and follow-up.

Radiotherapy, also called radiation therapy, is the use of ionizing radiation to treat cancer. The most common technique is external beam radiotherapy, in which a medical device (usually a linear accelerator or a cobalt unit) generates rays of ionizing radiation targeting the tumour from outside. Brachytherapy is a form of internal irradiation, where a radioactive source is placed inside the body, close to or in the tumour, for treatment.

Modern radiotherapy allows delivery of a precise dose to the tumour and avoids the surrounding critical structures, giving the patient a chance to recover without side-effects.



A cardiac SPECT scan of a patient that shows the short (upper row) and long (lower rows) axes of the heart in which no detectable abnormalities were found in the stress test undertaken. (Photo: F. Giammarile/IAEA)

Malnutrition

To formulate effective nutritional programmes to prevent NCDs, accurate data are required on nutritional status, diet quality and the impact of relevant interventions. Accurate nuclear techniques have been used to design and evaluate interventions to address malnutrition in all its forms, with a specific focus on: infant and young child feeding; maternal and adolescent nutrition; diet quality; prevention and control of NCDs; and healthy ageing. These techniques assess body composition, bone mineral density, breastfeeding practices, total daily energy expenditure, micronutrient bioavailability and vitamin A status, all of which directly relate to prevention of NCDs. For example, such data have enabled countries to implement school-based nutrition programmes that have reduced obesity rates. Malnutrition is also a significant factor affecting treatment outcomes and survival in NCDs. Nutritional support therefore has a key role to play in improving outcomes and quality of life for patients undergoing treatment for NCDs.

Other benefits of nuclear medicine

Nuclear techniques also are valuable for evaluating other disorders. They include congenital urological

abnormalities involving the bladder and kidneys in new-borns, and the functional assessment of the central nervous system for degenerative diseases, with tests becoming more frequent as populations age. For example, in Alzheimer's, advanced molecular brain imaging, using PET brain imaging with the radiopharmaceutical fludeoxyglucose, and brain perfusion SPECT are vital tools for diagnosing this disease as well as other forms of dementia.

Quality care: safety first principle

The IAEA helps Member States ensure that patients and medical personnel are protected from unnecessary exposure to ionizing radiation during procedures, which includes patients receiving accurate prescribed radiation doses during treatment.

The IAEA/WHO Secondary Standards Dosimetry Laboratory at Seibersdorf, Austria audits the accuracy of reference dose measurements in hospitals. This is done by providing international traceability for dosimeters that are used to calibrate the radiotherapy equipment in the clinic. Postal dosimetry audits provide an additional independent check of the radiation doses at the hospitals, assuring medical physicists and clinicians that their radiotherapy

equipment is calibrated according to an international standard.

IAEA SUPPORT

The IAEA continues to support its Member States in building sustainable capacity in nuclear techniques to deliver better health care safely and effectively. Support includes developing, adopting and strengthening practices, technical advice, training, coordinated research projects, provision of equipment, technical publications and public information.

Providing education and training has assisted over 100 LMI countries in addressing issues related to NCDs, such as establishing diagnostic and radiotherapy services. Additionally, the IAEA has supported the production of radioisotopes and radiopharmaceuticals, both of which are essential ingredients for nuclear medicine.

GLOBAL PARTNERSHIPS

Collaboration with stakeholders and partners includes public-private partnerships and partners including WHO, the United Nations Children's Fund (UNICEF) and dozens of other health bodies, institutions and donors. These partnerships generate more resources for building sustainable programmes in the health field.

For instance, the IAEA and several United Nations agencies have worked closely to address the prevention and control of NCDs through the establishment of an NCD task force, after the United Nations adopted a high-level political declaration

on NCDs in September 2011. A core principle of the political declaration was that the health sector cannot combat the effects of NCDs by itself; it requires cooperation and strategic collaboration with other sectors to do an effective job.

Another significant collaboration is the UN Joint Global Programme on Cervical Cancer Prevention and Control, in which seven United Nations agencies are working together through joint inception missions and support for the development of joint work plans that address the cervical cancer challenge, all the way from prevention and vaccination against human papillomavirus (HPV) to diagnosis and treatment, including radiotherapy and palliative treatment.

AREAS WHERE MEMBER STATES MAY BENEFIT FROM IAEA ASSISTANCE

- Build capacity to improve quality of services and develop new treatment approaches with nuclear techniques to prevent, diagnose and treat patients.
- Improve quality assurance programmes for nuclear medicine to ensure safe and accurate treatment of NCDs.
- Design evidence-based programmes to mitigate NCD risk factors.
- Participate in IAEA-supported projects that range from nutrition interventions, through cancer diagnosis and treatment, to cardiovascular and neurological disease diagnosis.

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