Sustainable Use of Nuclear Technology for Medical Application

VCDNP
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Facts about Radioactive Sources

* Since the 1950's, radionuclides produced artificially in nuclear facilities and accelerators, including cobalt(Co)-60, strontium-90, cesium(Cs)-137 and iridium-192, have become widely used as radioactive sources.
* Radioactive sources have wide-reaching benefits when used safely and secured adequately, and are used throughout the world in medicine, industry, agriculture, research and education.
* Co-60 is the most commonly used source of gamma radiation for radiation technology both for industrial and medical purposes.
* A radioactive source is defined as radioactive material that is permanently sealed in a capsule or closely bonded in a solid form.
* The capsule of a sealed radioactive source is designed to prevent the radioactive material from escaping or being released from encapsulation under normal usage and in accidents. If used for malicious purposes the consequences could be lethal.
* Radioactive sources and the practices in which they are used are classified into five categories in terms of their potential to cause harm to human health and the environment. The categorisation enables a graded approach to regulatory control.

IAEA Categorisation of Radioactive Sources

Cat	Description of sources used in medical applications
1	**Extremely Dangerous** Irradiators (Co-60, Cs-137), teletherapy (Co-60) and gamma knife (Co-60)
2	**Very Dangerous** High/medium dose rate brachytherapy (Ir-192, Co-60, Cs-137)
3	**Dangerous** Diagnostic isotope generators (Mo-99)
4	**Unlikely to be Dangerous** Low dose rate brachytherapy sources (I-125, Ir-192) and bone densitometers (I-125)
5	**Most Unlikely to be Dangerous** Low dose rate brachytherapy eye plagues and permanent implants (I-125) and positron emission tomography (Ga-68)

* If unshielded, Category 1 and 2 sources, or high activity radioactive sources, can cause serious or permanent injury or be fatal to someone who comes in contact with them depending on the dose rate of and exposure to the source. If dispersed in a radiological dispersal devise (RDD) or a radiation exposure devise (RED), these sources are unlikely to affect people beyond a hundred metres away. However, such an incident would cause widespread panic, and the clean-up of the area could be expensive, possibly amounting to millions of euros. As a result the primary focus of the international security effort is on high activity radioactive sources.

Benefits of Nuclear Technology

Contributing to SDG 3: Ensure healthy lives and promote well-being for all at all ages

Radiotherapy

* Radiotherapy is one of the most widely used therapies for cancer treatment and can be delivered externally or internally.
* Teletherapy refers to radiation therapy given by an external radiation source at a distance from the body. It is the most common type of radiotherapy and is usually given by a Co-60 unit, which delivers high energy gamma rays, or a linear accelerator (linac), which can deliver high-energy X-rays or electrons to harm or destroy the tumour.
* Brachytherapy uses sealed radioactive sources, such as Co-60 and Cs-137, that are placed directly into tumours or in body cavities.
* Radiosurgery devices are used to apply highly targeted doses of gamma radiation to brain tumours and may use Co-60 sources or linacs.

Blood irradiation

* Currently X-Ray source devices and Cs-137 irradiators are used to irradiate donated blood to inactivate lymphocytes, which cause transfusion-associated graft-versus-host disease. X-Ray devises are shown to be equivalent to or better than Cs-137. Blood banks and hospitals worldwide are replacing Cs-137 with X-Ray devises because Cs-137 is a highly soluble powder that can be easily dispersed in an RDD and remains radioactive for more than 30 years.


Sealed radioactive sources (IAEA)


Cobalt-60 teletherapy unit (Uganda Cancer Institute)

Support Provided by the IAEA

* The IAEA and other global partners work to support low and middle income countries to expand and improve their cancer care capacity and services by integrating radiotherapy into comprehensive national cancer control programmes to maximise therapeutic effectiveness and impact.
* The IAEA provides international requirements, consensus recommendations and guidance on the safe and secure use of radioactive sources as well as dosimetry for linacs.
* The IAEA serves as a worldwide hub for the harmonisation and consistency of radiation therapy dosimetry. Through its new linac facility, the IAEA will provide dosimetry services and support cancer control worldwide, contribute to strengthened procedures in radiation safety and support research in new codes of practice in radiotherapy.
* The IAEA supports physical protection upgrades of medical facilities in its Member States and assists countries in finding solutions for the disposal of disused radioactive sources (i.e., any sealed source of radioactive material that is not currently being utilised and will never be utilised again for the original intended purpose).

Country Experiences

Albania

According to the Ministry of Health, cancer accounted for 27% of all deaths in Albania in 2017. Over the last few years treatment techniques in Albania have been expanded from Co-60 teletherapy to linacs. Linac allows doctors to treat complex cases of cancer faster and with more precision. It uses electricity and is therefore not regulated. Albania made the decision to replace cobalt units with linacs to improve treatment options and to reduce the costs related to the lifetime management of radioactive sources and their disposal. As Albania does not have a nuclear research facility or a nuclear power facility, it lacks the infrastructure and technical capacity to dispose of these sources. The IAEA is supporting Albania to find solutions for the disposal of its remaining Co-60 sources. The IAEA has also, through cost-sharing, supported Albania in purchasing three linacs and is providing training support.

Ghana

Ghana, supported by IAEA/Programme of Action for Cancer Therapy (PACT) and the World Health Organisations Regional (WHO) Office, developed a 'bankable' project in September 2005 to expand national radiotherapy and nuclear medicine services. In November 2005, an Integrated mission of PACT (imPACT), involving IAEA and WHO personnel, was carried out to assess each component of national cancer control in Ghana. This imPACT mission resulted in a proposal submitted to the Government of Ghana entitled, "Building Comprehensive Cancer Control Capabilities in Ghana." The document addressed all aspects of a National Cancer Control Programme, including prevention and early detection, expansion of nuclear medicine and radiotherapy, as well as palliative care. With support from the IAEA, the Government of Ghana secured two long-term development loans from the OPEC Fund for International Development and the Arab Bank for Development in Africa. Including its own contribution, the funds available to the Government of Ghana amount to approximately 12.1 million euros. The loan is being used for upgrading and strengthening radiotherapy and nuclear medicine at the Korle Bu Teaching Hospital in Accra and Komfo Anokye Teaching Hospital in Kumasi, as well as early detection and palliative care initiatives.

Pakistan

One million people are treated annually in 18 nuclear hospitals run by the Pakistan Atomic Energy Commission (PAEC), of which 300,000 patients receive radiation therapy annually. Pakistan uses both Co-60 teletherapy units and linacs for cancer treatment. Whilst linacs provide more precision treatment, Co-60 units require less maintenance and can be used in most environments, including hospitals in remote locations. The combination of Co-60 and linacs therefore provides Pakistan with more options for care. The IAEA supported the security upgrades in PAEC hospitals, which included the installation of closed circuit televisions and intrusion detection systems. In Pakistan, all sealed radioactive sources are imported and Pakistan has a national policy of repatriating disused sources. Sources that are not under these agreements are disposed of in special facilities for waste management in Karachi and Lahore.

Key Takeaways

* Cancer is a growing global health and development challenge. Governments are under increased pressure to meet rising demands from cancer patients for a greater number of affordable, high-quality services.
* Sealed radioactive sources, due to their security risk, are subject to regulation and costly to transport, secure, store and dispose of. As a result it is becoming increasingly expensive and complicated to trade in and use these sources.
* The IAEA has established safety and security guidance for an appropriate and sustainable regulatory system to control radioactive sources and supports security upgrades for facilities using these sources.
* The most common alternative to a Co-60 unit is the linac, which uses electricity to produce high energy X-rays. Linacs can provide variable dose rates and have the ability to deliver very high-energy radiation for precision treatment.
* Co-60 teletherapy units are still in widespread use worldwide as machinery using Co-60 is robust, relatively reliable, requires limited operational maintenance and is favoured in remote areas and areas where electricity is unreliable.
* Many countries are choosing to replace irradiation units that use radioactive sources with alternative technologies to reduce security risks and improve the quality of their cancer care.

For More Information

* Appropriate Technology for Palliative Radiotherapy, Ken Shortt and Barry J Allen, in *Workshop on Palliative Radiotherapy for Developing Countries*, Health Technology and Training Task Group, 2008.
* IAEA Categorization of Radioactive Sources, *IAEA Safety Standards Series,* No. RS-G-1.9., 2005, https://www.iaea.org/publications/7237/categorization-of-radioactive-sources.
* Ghana develops a comprehensive National Cancer Control Strategy, *IAEA,* 2009, https://www.iaea.org/newscenter/news/ghana-develops-a-comprehensive-national-cancer-control-strategy.
* Radiation Therapy with Cobalt-60 Vs 6 MV Photons for Palliative Care: Comparison of Beam Characteristics, N. Suntharalignam, in *Workshop on Palliative Radiotherapy for Developing Countries*, Health Technology and Training Task Group, 2008.
* Radioactive Sources and Sustainable Development, VCDNP Panel Discussion, 2018, https://vcdnp.org/radioactive-sources-and-sustainable-development/.
* WINS International Best Practice Guide 5.4 Security of Radioactive Sources used in Medical Applications.