

REDUCING RISKS FROM SEALED RADIOACTIVE SOURCES IN MEDICINE¹

Sealed radioactive sources are commonly used in a variety of medical applications for both diagnosis and therapy. The sources used in medical applications usually have high levels of radioactivity and, therefore, have the potential to cause serious and life threatening injuries if used improperly or maliciously, or risky if they become lost or are stolen.

Sealed radioactive sources used in treatment of diseases include teletherapy sources, which deliver precise doses of radiation from a source outside the patient's body to a well-defined area of the body in order to treat cancer. Teletherapy with sealed radioactive sources commonly uses cobalt-60 as the source of radiation, although some older equipment may use caesium-137. Teletherapy equipment can be used safely and effectively to treat cancerous tumours, but to be effective, it must be properly installed, calibrated, serviced and maintained and should only be used by skilled personnel under appropriate medical supervision. Cobalt-60 sources also need to be replaced regularly, which can be performed only by a licensed source supplier. The preferred option to manage disused sources properly is to return such sources to the supplier after replacement. If this is not possible, disused sources should be disposed of in accordance with national regulatory requirements.

Another common medical use of sealed radioactive sources is brachytherapy, where the sealed radioactive source is placed in direct contact with the patient. It is inserted into a tumour either manually or remotely using special equipment. Remote loading has become much more frequent, as it provides a lower risk of radiation exposure to the medical staff and reduces the risk to patients. Because brachytherapy sources are implanted and subsequently removed, care must be taken to ensure that no source remains implanted following treatment.

Depending on the manufacturers' specifications, some brachytherapy sources need to be replaced every 10 to 15 years. This necessitates not just appropriate procedures for radiation protection during replacement and transfer, but also appropriate procedures and facilities to dispose of all disused brachytherapy sources permanently.

In recent years, sealed radioactive sources have also been used to perform stereotactic radiosurgery, using a device called a Gamma Knife[®] to perform non-invasive treatment of tumours and other abnormalities in the brain. The technology has not been widely deployed, with only about 200 devices installed worldwide in 2012. In the device, multiple sealed radioactive sources of cobalt-60 are arranged in a circular array in order to focus numerous tiny radiation beams to a defined point inside the brain. These sealed radioactive sources must be replaced periodically and this procedure can only be performed by trained and authorized manufacturer's agents. Following the replacement of radioactive sources, the spent sources that have been removed should be returned to the supplier or manufacturer, or disposed of safely and securely.

Sealed radioactive sources are also used in a medical setting for sterilization, where an object placed in the beam is irradiated at levels that inactivate or kill microorganisms in the irradiated material. This process is done routinely for human blood used for transfusions and may be used for a variety of other purposes. These irradiators include a high-activity source of cobalt-60 or caesium-137 inside a heavily shielded vessel of approximately one meter diameter by one and a half meters tall, although the dimensions vary by manufacturer.

The object to be irradiated is placed inside a chamber designed for that purpose, the chamber secured, and the sources exposed inside the chamber for the length of time necessary to achieve a sterilization dose. The irradiator may contain several individual sources in an array designed to give a uniform irradiation field in the chamber. After some years, it is usually necessary to replace the sources. Such source exchanges may only be performed by trained and authorized manufacturer's agents, with the removed sources returned to the manufacturer for disposal.

¹Reproduced from the publication *Sealed Radioactive Sources — Information, resources, and advice for key groups about preventing the loss of control over sealed radioactive sources*, IAEA, October 2013.

Preventing Loss and Theft of Sources

While proper training and experience will reduce the risk of radiation exposure when sealed radioactive sources are used, the vast majority of serious accidents and incidents are usually due to a device and its source that has been lost or stolen. Good operational practices and procedures can reduce such occurrences by preventing a source from becoming lost or stolen in the first place.

The small size and portability of brachytherapy sources are essential for them to perform their intended function, which also makes them more susceptible to being lost, misplaced or stolen. Teletherapy machines and irradiators are significantly larger devices, and it is unlikely that the entire device would be inadvertently lost.

However, after years of not being used at a facility, these devices have been sold to metal recyclers without first having the sealed radioactive source removed. Loss of control in these situations is generally a result of inadequate recordkeeping and inventory management, and workers forget that there is a sealed radioactive source inside the device. The devices are required to be labelled as to their radioactive contents, but such labels may be inadvertently removed or become illegibly worn or damaged.

The most effective means to prevent accidents or incidents with sealed radioactive sources is to adopt work habits and adequate measures that reduce the likelihood of a source becoming lost or stolen. Organizations and companies using sources are responsible for taking the necessary steps to protect the public, the environment, and themselves every time they work with a sealed radioactive source. Sources no longer in use should be returned to the manufacturer, disposed of as radioactive waste, if possible, or conditioned for secure long term storage with the consent of the national regulator.

The radioactive substance within a source is sealed within a protective container. These radioactive substances emit energetic particles or waves, which is called ionizing radiation. Radiation from the sources is used for a specific purpose — by doctors to treat cancer, by radiographers to check welds in pipelines or by specialists to irradiate food to prevent it from spoiling, for example.

Professionals who work routinely with radioactive sources are able to do so safely because of their skill and training and because they are knowledgeable about the safety features and design of the equipment they are using.

When these sources are lost or stolen, however, they can fall into the hands of persons who do not have such training and knowledge or who wish to use them to cause harm intentionally. In such circumstances, radioactive sources may be a serious risk to anyone who comes too close to them, touches them, or picks them up, particularly if the sources are damaged.