Jelly-like bandage helps heal wounds: Egypt develops hydrogels using irradiated polymers

By Aabha Dixit

"Egypt is a beneficiary of IAEA assistance. An electron beam unit at the National Centre for Radiation Research and Technology is currently being upgraded to meet the growing demand for hydrogel production."

— El-Sayed A. Hegazy, Professor Emeritus and former Chairman of the National Centre for Radiation Research and Technology, Egypt

Patients suffering from burn injuries, skin ulcers and bed sores can find relief using unique jelly-like materials — hydrogels — that are playing an increasingly vital role in the healing process of such wounds. Nuclear technology has been crucial in developing hydrogels that form an important part of treating wounds in many low and middle income countries including Egypt.

The exceptional gel bandage is fast becoming ubiquitous to 'cool' wounds and reduce the painful effects of burns and other injuries. The wounds of diabetic patients have healed much faster and better than with traditional bandages, said El-Sayed A. Hegazy, Professor Emeritus and former Chairman of the National Centre for Radiation Research and Technology (NCRRT) of Egypt, the only facility in the country to develop hydrogels.

A hydrogel bandage can be used on wounds.
(Photo: S. Henriques/IAEA)

"Hydrogel has a very pleasant effect and relieves pain. It reduces the degree of tissue damage caused by the injury, and is transparent, so the doctor can monitor the wound. It reduces the time of recovery by half, but the most important effect is that it helps in the regeneration of new skin, which is scar-free," he explained.

Nuclear derived hydrogels are safe for humans

The science behind making hydrogels is complex but well understood, said Ghada Adel Mahmoud, professor of radiation chemistry at the Centre. "Hydrogels are formed using polymer chains that are crossed-linked and sterilized using gamma radiation or electron beams," she said. The polymers are mixed in water, put into moulds or tubes, packaged, sealed and then cross-linked and sterilized by exposure to radiation. This results in the polymers connecting to form a gel. The gel formed is strong, pliable and transparent.

Hydrogels for wound dressing contain 70–95 per cent water and are biocompatible, added Agnes Safrany, radiation chemist at the IAEA. They do not stick to the wound; they keep the wound moist for recovery, absorb its excretions and are also easy to store and use, she said.

Hydrogels also play a crucial role in delivering medication to the right place in the human body without causing harm elsewhere. They are used as a barrier applied to oral medications to either protect the stomach mucosa from gastric irritant drugs or to protect acid-labile drugs from the harsh environment of the stomach. Research in this area is ongoing, explained Mahmoud.

Researchers are considering using nano-hydrogels for chemotherapy treatment as well, because they go directly through the bloodstream to the tumour without having an impact on the rest of the body, Safrany said.

Advanced nuclear applications benefit the health sector

The IAEA has supported a number of countries through specific tailor-made projects to raise awareness, and train scientists and technicians to develop hydrogels using nuclear technology. "Egypt is a beneficiary of such assistance. An electron beam unit at the NCRRT is currently being upgraded to meet the growing demand for hydrogel production," said Hegazy.

A hydrogel bandage being used on a patient.
(Photo: S. Henriques/IAEA)

The nuclear techniques used to create hydrogels have been around for over 30 years and their production is simple and cost-effective, said Mahmoud.

The IAEA supported the establishment of a laboratory to assess the use of polymers in the development of hydrogels. The research includes examining the features of the polymers, such as their strength, how much they swell, the amount of drug required and its release when used in a hydrogel, as well as potential toxicity and long-term stability.

After the laboratory's investigations, the NCRRT applied for and received a licence for the preparation of hydrogels as wound dressings, and for their distribution from Egypt's Ministry of Health, Hegazy added.

Egypt has also transferred the knowledge and experience it has gained from the IAEA to other countries in the region. Hydrogels have been a life-saver for many patients suffering from serious burn wounds, and more countries should use them, he explained further.

The NCRRT is part of the Egyptian Atomic Energy Authority, the country's leading institution in promoting the peaceful applications of nuclear science and technology in practically all aspects of human life in the country.

With the IAEA's assistance, development of radiation processed products from natural polymers such as chitin (including chitosan, which is derived from chitin and is used for health care applications, see box, page 11) has significantly broadened the use of nuclear technology in the medical sector of Egypt.

The many uses of hydrogel wound dressings

Hydrogel wound dressings produced by radiation technology have the following medical advantages:

- form efficient barriers against bacteria, and also against excessive loss of body fluids;
- allow the diffusion of oxygen to the wound;
- are soft and elastic, but mechanically strong;
- have good adhesion to both the wound and the healthy skin, but without excessive sticking;
- are transparent, keeping the wound visible for health professionals;
- enable easy treatment of the wound with drugs;
- absorb liquid produced by the body in response to tissue damage and bacterial toxins;
- do not incite allergic reactions;
- soothe pain and provide optimal wound healing; and
- are sterile and easy to use.

(Source: mitr.p.lodz.pl/biomat/old_site/dress.html)