A photonic band aid using the healing power of blue light

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Credit: MEDILIGHT Consortium

A smart dressing that uses blue-light therapy for wound healing and which can also monitor and treat infections has been developed by an EU-funded consortium.

Blue light is already known for its anti-bacterial and anti-inflammatory effects, but now the EU-funded MEDILIGHT consortium has harnessed it to aid the healing of chronic wounds such as those suffered by patients with diabetes.

"The aim is to have a non-chemical solution for chronic wounds," says project coordinator Dionysios Manessis of the System Integration and Interconnection Technologies Department, Technical University Berlin. "We found that blue light originally thought to be good for disinfection

also produces good results for proliferation of keratinocytes and fibroblasts—the types of skin cells needed for wound closure."

With EUR 3 million of EU funding for just over three years, the research team was able to produce a smart wearable device from scratch. The prototype consists of a soft, flexible foil with blue LEDs (light emitting diodes) and sensors. This is inserted into a transparent pocket over the wound dressing.

Attached to the foil is a small electronic box containing the circuit board with, among other components, the LED driver that regulates the intensity of blue light and a microcontroller or smart interface that acquires and analyses the sensor data so that adjustments to the light therapy regime can be made for each individual patient.

"The three—the flexible foil, the electronic box and the wound dressing—fit together as one holistic MEDILIGHT device," Dr. Manessis explains.

The foil's sensors monitor temperature and blood oxygen levels at the wound site—oxygen levels indicate that the wound is healing while raised temperatures can be a sign of inflammation and infection. This data is communicated to the electronic box.

Testing of light therapy effects

In the first stages of healing, blue light irradiation inhibits the formation of bacterial colonies. Once the wound is disinfected, blue light intensity can be adjusted to prevent premature skin growth. "There has to be a good synchronisation of therapy schedules so that the wound does not close before it is disinfected and the risk of trapping bacteria inside the wound is completely eliminated," says Dr. Manessis.

In vitro studies on different bacterial strains revealed that blue light can prevent several strains common in infected wounds from reproducing and kills some types of bacteria.

"The effect of blue light on skin cell proliferation was tested in vitro, using different light intensities and wavelengths, and in vivo on mice, and has been patented," says Dr. Manessis.

Innovative materials and software

The biggest technical challenge was minimising light loss so that sufficient blue light reaches the wound and ensuring heat generated by the LEDs is dissipated efficiently. "LEDs can generate heat and the temperature can rise up to 42–50 degrees, depending on the length of the light therapy," Dr. Manessis explains.

To address this, new wound dressing materials were developed by consortium partner URGO, France, and an advanced flex foil was designed and manufactured that enhances heat management. An innovative sensor acquisition interface and new software were developed under the project to transfer data wirelessly to a smartphone for evaluation and therapy adjustments.

A functional prototype flex foil that can be worn under the foot in a special shoe was also developed, connected wirelessly to the electronic box and controlled by a smartphone app that a health professional can use.

Human clinical trials on healthy and diabetic individuals will be conducted by URGO in the next stage of development towards product commercialisation.

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