THE COLOUR OF REGENERATIVE SCIENCE
PHOTOBIOMODULATION WITH BLUE LIGHT: A NEW THERAPEUTIC FRONTIER

In human tissues are naturally present certain chromophores capable of absorbing specific light waves in the region of the visible spectrum. By sending specific photonic energy to targeted chromophores it is possible to induce photochemical and photophysical phenomena at different biological scales functional to the healing of a wound. This process has been defined Photobiomodulation and it is a new therapeutic frontier in wound healing.

In particular, it has been observed that Photobiomodulation with Blue Light has an impact in reducing inflammation and producing a faster and better tissue regeneration.

Such effects can be explained by the absorption of Blue Light by the Protoporphyrin IX, the Flavins and the Fibroblasts.

![Visible Light Absorption by Protoporphyrin IX](image)

The Protoporphyrin IX is contained in various proteins and enzymes as the Cytochrome C and the Cytochrome C Oxidases, which are essential elements for cellular respiration.
RAPID TRANSITION OF THE INFLAMMATORY PHASE

Blue Light excites Flavins stimulating the production of ROS, intracellular signaling elements. ROS stimulate the overcoming of the ulcer’s inflammatory phase, inducing a limited increase of inflammatory factors, and promote angiogenesis.

A rapid transition of the inflammatory phase has been observed in the in vivo studies on animal models of acute wounds treated with Blue Light. Clinical observations on chronic skin lesions treated with Blue Light have shown a stimulation effect in the transition from the inflammatory phase, associated with reduction of pain, and a revitalization of the healing process.

ANIMAL MODEL OF ACUTE WOUND. MACROPHAGES TRANSITION
Macrophages of the pro-inflammatory subpopulation (M1, red) and macrophages of the pro-healing subpopulation (M2, green): comparison between treated wound vs non-treated. In the treated wound at 9h there is a majority of pro-healing macrophages, indicating a more advanced transition phase.
FASTER AND BETTER TISSUE REGENERATION

The Cytochrome C and the Cytochrome C Oxidases are hemoproteins within the electronic transport chain; when irradiated with Blue Light they amplify the cells respiration thus increasing the ATP production and consequently the cells metabolisms.

The interaction between Blue Light and Cytochrome C has been observed in the laboratories of CNR-IFAC using Raman spectroscopy. In a cell pellet irradiated with Blue Light an increased presence of Cytochrome C in its reduced form compared to its oxidized form has been recorded. This confirms the impact of Blue Light on cells metabolism.

Fibroblasts are the primary responsible for the extracellular matrix and collagen deposition during the remodeling phase. Blue Light can modulate their metabolic activity stimulating a faster and better restitutio ad integrum of the skin or, on the contrary, it can inhibit it when it is pathologically altered.

IFAC-CNR researchers demonstrated that Blue Light increases the metabolism of Fibroblasts extracted from healty tissue; they also obtained the directly opposite effect of inhibiting the cell activity of Fibroblasts extracted from keloids without tampering with their vitality.

ANIMAL MODEL OF ACUTE WOUND.
COLLAGEN DISTRIBUTION.
Collagen (blue) and extracellular matrix (green) in an in vivo model of acute wound at 8 days from injury: comparison between treated vs non-treated. Collagen (type 1) distribution and morphology are better in the treated wound.
A NEW THERAPY FOR HARD-TO-HEAL WOUND

BLUR (BLUE LIGHT FOR ULCERS REDUCTION) STUDY

In a multi-center, prospective, controlled study with 90 patients suffering from venous, arterial and mixed ulcers and surgical dehiscence (mean age of skin lesions: 67.8 months) the effectiveness of EmoLED used in combination with the standard therapy has been demonstrated: at 10 weeks the difference in the mean percentage lesion's area reduction between treated lesions and control was 125.8% with a treatment of 60 seconds once a week. In patients who at first visit reported pain (VAS ≥ 4) it has been recorded 23%, 42%, 54% reduction of the symptom respectively after one treatment, after 4 treatments, at 10 weeks.

Typical progression of an ulcer treated with emoled in combination with standard therapy.

1/2 weeks
- Increasing wound edge
- More vital periwound skin
- Decreasing inflammation
- Decreasing hyperemia
- Significant reduction of pain

3/4 weeks
- Improving wound bed
- Increasing angiogenesis
- Increasing granulation tissue

5/6+ weeks
- Reduction of skin lesion
- Increasing periwound skin tropism

Mean (%) reduction of the lesion's area at ten weeks.
Lesions treated with emoled (T) vs lesions treated only with soc (C).
Clinical observations report EmoLED’s therapeutic outcomes in patients with chronic wounds of various etiology non-responding to standard therapies.

**Progression of a deep burn with failed autologous skin graft, treated with EmoLED for 60 seconds every two weeks for a total of 4 treatments.**

Clinical case, Severe Burns Center, Maurizio Bufalini Hospital, Cesena.

start | 2 weeks | 3 weeks | 5 months (follow up)

**Progression of a vasculitic ulcer treated with EmoLED with two consecutive applications of 60 seconds once a week for 4 weeks; age of the ulcer: one year.**

Clinical case, Department of Dermatology, University of Pisa.

start | 2 weeks | 4 weeks | control

**Progression of an acral ulcer on a patient affected by scleroderma, treated with EmoLED once a week for 14 weeks.**

Clinical case, Scleroderma unit, AOU S. Luigi Gonzaga, Orbassano (TO).

start | 4 weeks | 6 weeks | 14 weeks
INSTRUMENT FOR AN EFFECTIVE PHOTOBIOMODULATION SUPPORTING THE HEALING OF SKIN LESIONS

EmoLED is a Medical Device conceived for the healing of skin lesions. It uses LED sources emitting Blue Light and it is provided with a sophisticated optical system to obtain an homogeneous and controlled light beam. The selected wave lengths, in the interval of 400-430nm, correspond to the absorption spectrum of certain chromophores contained in tissues. Interacting with such elements, EmoLED activates the physiological healing process of a lesion in a natural and non-invasive way.

Its mode of action is based on Photobiomodulation: the direct transfer of photonic energy from the device to the patient without the presence of external mediators (chemical or pharmaceutical additives). EmoLED mode of action is covered by an international patent.

EmoLED is designed and produced in Italy, in accordance with Class IIa Medical Device.

Treatment with EmoLED is an aid to conventional therapy and it is applied as part of the wound bed preparation. 60 seconds is the duration of a single application.
EASY TO USE FOR THE HEALTHCARE PROFESSIONAL AND SAFE FOR THE PATIENT

SIMPLE:
Light, compact, portable and instantly ready for use, the device must be employed only by authorized personnel.

INTUITIVE:
Provided with touch screen and user friendly interface: it is possible to insert the lesion dimensions and the device calculates how many applications are needed to cover the entire wound surface.

NO CONTACT WITH THE PATIENT:
the optical head must be kept at 4cm from the patient, an optoelectronic sensor and a timer help the operator to keep the proper distance and time for every single application, ensuring the patient to receive the proper “dose” of energy.

SAFE:
an accessory for visual comfort and protective glasses are provided for the operator. No adverse events or collateral effects have been recorded and treatment is well tolerated by patients.
<table>
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<tr>
<th>PRODUCT:</th>
<th>EmoLED v.1</th>
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<tr>
<td>PRODUCT CODE:</td>
<td>980 0010 001</td>
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<tr>
<td>GMDN CODE:</td>
<td>61721</td>
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<tr>
<td>DIMENSIONS:</td>
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<td>PHOTOBIOLOGICAL RISK GROUP:</td>
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<td>LIGHT SOURCE:</td>
<td>The light radiation is generated by 6 LED sources. The emitted radiation is made uniform over the entire area by the optical system of the Device.</td>
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<td>SPECTRAL BANDWIDTH:</td>
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<tr>
<td>POWER DENSITY/IRRADIANCE:</td>
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<td>IRRADIATED AREA:</td>
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<td>TREATMENT DISTANCE:</td>
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<td>POWER OUTPUT:</td>
<td>2.3 W - max emission variation 1%</td>
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<td>ENERGY DENSITY/FLUENCE:</td>
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<td>POWER SUPPLY:</td>
<td>Lithium-ion rechargeable batteries. Battery life: 150 applications.</td>
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<td>- Battery charger with connection cable</td>
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