



Using Light To Treat Mucositis and Help Wounds Heal

Arrays of LEDs would generate biostimulatory radiation.

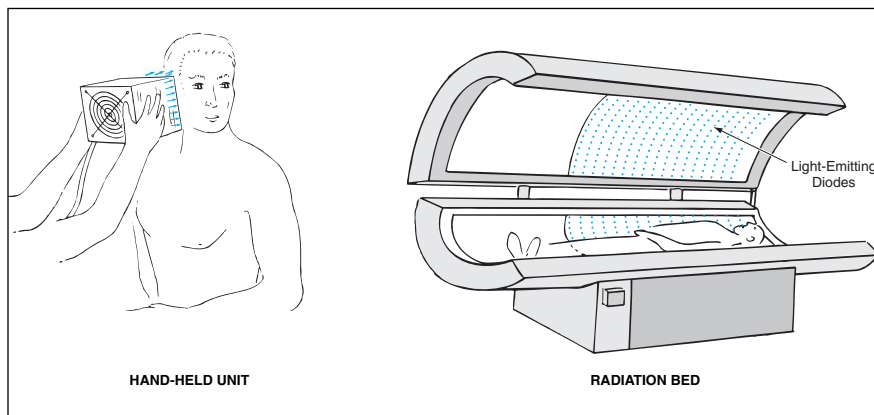
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A continuing program of research and development is focusing on the use of controlled illumination by light-emitting diodes (LEDs) to treat mucositis and to accelerate healing of wounds. The basic idea is to illuminate the affected area of a patient with light of an intensity, duration, and wavelength (or combination of wavelengths) chosen to produce a therapeutic effect while generating only a minimal amount of heat.

This method of treatment was originally intended for treating the mucositis that is a common complication of chemotherapy and radiation therapy for cancer. It is now also under consideration as a means to accelerate the healing of wounds and possibly also to treat exposure to chemical and radioactive warfare agents.

Radiation therapy and many chemotherapeutic drugs often damage the mucosal linings of the mouth and gastrointestinal tract, leading to mouth ulcers (oral mucositis), nausea, and diarrhea. Hyperbaric-oxygen therapy is currently the standard of care for ischemic, hypoxic, infected, and otherwise slowly-healing problem wounds, including those of oral mucositis. Hyperbaric-oxygen therapy increases such cellular activities as collagen production and angiogenesis, leading to an increased rate of healing. Biostimulation by use of laser light has also been found to be effective in treating mucositis. For hyperbaric-oxygen treatment, a patient must remain inside a hyperbaric chamber for an extended time. Laser treatment is limited by laser-wavelength capabilities and by narrowness of laser beams, and usually entails the generation of significant amounts of heat.

The present method offers an attractive alternative to hyperbaric-oxygen and laser treatments: It is not necessary to confine the patient to a hyperbaric



Apparatuses Containing Arrays of LEDs could range from a hand-held unit for treating oral mucositis to something as large as a radiation bed or a radiation booth (not shown here) for treating mucositis throughout the gastrointestinal tract from the head down through the intestines.

chamber, treatment times are relatively short, LED arrays can illuminate large areas, and the exposure of the patient to heat generated by an LED array can readily be limited.

The figure depicts two examples representative of the range of sizes of treatment apparatuses according to the present method. The preferred sources of light in an apparatus of this type are substantially monochromatic double-heterojunction GaAlAs LEDs arranged in an array large enough to expose the affected area of a patient uniformly at the required intensity. If light of a single wavelength is to be used, then the wavelength believed to be optimal for treating mucositis is 688 nm. If LEDs of 688-nm wavelength are not available, then one could use a three-wavelength combination (680, 730, and 880 nm) that is believed to be an optimal combination for treating mucositis; in this case, the LEDs of the three different wavelengths would be placed side by side in an array. Other single wavelengths and combinations of wavelengths may also be suitable.

In addition to the wavelength(s), the energy density should be chosen to max-

imize the biostimulatory effect. Moreover, the power density must exceed a threshold level in order to exert a biostimulatory effect. The optimal energy density has been determined to be about 4 J/cm^2 . This energy density could be delivered, for example, at a power density of 60 mW/cm^2 (which exceeds the threshold) during an exposure time of 70 seconds. Such a short treatment time is particularly desirable for treating a young child.

This work was done by Robert W. Ignatius, Todd S. Martin, and Charles Kirk of Quantum Devices, Inc. for Marshall Space Flight Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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