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The benefit of using Low Power Laser in the treatment of various illnesses – an overview.

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ABSTRACT
The aim of the article is to give an overview of the interesting field of Low Level Laser Therapy. Applications like the treatment of inflammatory processes, acute myocardial infarction, acute ischemic stroke and others are possible but still rarely used in clinical routine. This paper summarizes the most important applications and mechanisms underlying the effects of low level laser.

OVERVIEW
Biomodulation, i.e. the use of Low Level Laser Therapy (LLLT) or light sources of a certain wave length, is a well known method to treat inflammatory processes [1-4], to accelerate wound healing and to alleviate pain in various conditions such as folliculitis, abscess, or rheumatoid arthritis (see Table I). Studies have suggested that infrared laser therapy could also be beneficial for the treatment of acute myocardial infarction, acute ischaemic stroke, injured peripheral nerves and spinal cord injury [5, 6]. The method has become relatively popular in recent years, especially in Europe.
A large number of studies, clinical evaluations and more than 100 double-blind studies have demonstrated the effective use of laser therapy in pathologies mentioned above, especially in the fields of dermatology, neurology, surgery, rheumatology, traumatology, gynaecology, dentistry and veterinary medicine.
The method has been successfully used in more than 40% of the rehabilitation centres in Great Britain and in approximately 30% of the dentistry clinics in Scandinavia for many years [4]. A Norwegian master thesis from 1997 [7] formed the basis for the treatment approval by the Norwegian health insurances.

In spite of many applications in humans the biomodulative effect of low level laser therapy has still not been completely understood. The spectrum of visible to infrared light can cause stimulation as well as inhibition of various organisms [1, 8, 9]. Photobiomodulation involves increased adenosine triphosphate (ATP) formation after energy absorption inside the mitochondria [10, 11]. A compound that absorbs energy in the spectral region of interest is known as a chromophore. There is evidence that suggests that the primary mitochondrial chromophore for photobiomodulation is cytochrom c oxidase [10, 11]. Endogenous porphyrins and cytochromes are probably photoabsorbers. Components of the respiratory chain like flavines and cytochromes might be the first step of a beginning photo-induced reaction [1, 8-11]. In vitro experiments showed that LLLT biomodulation can stimulate the emission of growth factors [12, 13], as well as cell proliferation [8, 9, 13] and collagen synthesis [14].

One group found out that low-level laser irradiation can enhance the proliferation of mesenchymal and cardiac stem cells, which may have an important impact on regenerative medicine [6].
Other studies demonstrated that LLLT improves the local blood microcirculation [15-17]. This phenomenon might be the explanation for improved wound healing and local pain control by the use of LLLT.
As mentioned before, an increased ATP production after laser application might explain beneficial effects of LLLT after stroke [10, 15]. The NEST-1 study, a multicenter prospective double blind randomized trial, involved 120 patients with ischaemic stroke. The randomisation ratio was 2:1, with 79 patients in the active treatment group and 41 in the sham (placebo) control group, 70% of patients from the active group had a successful outcome in comparison to 51% in the control group. The study concluded that infrared laser therapy is safe and effective for the treatment of ischaemic stroke in humans when initiated within 24 h of stroke onset [15].
A significant long-term functional neurological benefit following traumatic brain injury was found in mice when treated with low level laser 4 h after the trauma [6].
In vivo studies have also suggested that LLLT could be beneficial for the treatment of acute myocardial infarction [18].

The effects of LLLT biomodulation or of other light sources like LED [13] are

Effect	Mechanism	Examples
Inhibition of inflammatory reaction	• Improved phagocytosis • Inhibition of mast cell degranulation • Activation of immune cells via increased mobilisation of leucocytes • Increased microcirculation via vessel dilatation • Decrease of inflammatory swelling via stimulation of the lymphatic flow • Reduced prostaglandine synthesis	• Folliculitis, abscess, boil, carbuncle • Viral dermatoses (warts, herpes simplex, zoster and genitalis) • Rheumatoid arthritis I+II, arthritis septica and allergica • Tendinopathies, achillodynia, coracoiditis etc. • Adductor muscle syndrom • Tonsillitis, otitis, rhinitis etc. • Mucositis after radiotherapy and chemotherapy
Analgesia, hypalgesia, pain inhibition	• Improved beta-endorphin distribution • Increased ATP-production (cell energy) • Increased measurable potential at nerve cell membranes • Muscle relaxation and increase of the stimulus threshold of nerve cells for pressure pain • Decrease of pain	• Peripheral polyneuropathy • Carpal tunnel syndrome, tarsal tunnel syndrome • Muscular tenseness • Myofascial pain syndrome, fibromyalgia • Cervical and lumbar syndrome • Facial neuralgia (trigeminus neuralgia) • Facial palsy
	mediators (e.g. substance P) • Reduction of trigger- and tender-point activity • Activation of acupuncture points	• Intercostal and zoster neuralgia • Traumatic and postoperative pain • Needle substitute
Tissue regeneration	• Enhanced mitosis rate and collagen synthesis, activation of fibroblasts, chondrocytes, osteocytes etc. • Enhanced ATP-production • Improved granulation and epithelisation • Improved peripheral nerve regeneration after trauma • Reduced degenerative CNS-processes • Supported survival of brain cells after transient ischaemia • Reduced or eliminated scarring	• Improved wound healing after injury or postoperative • Decubitus, burns, rhagades • Ulcus cruris and diabetic ulcer • Muscle fibre and ligament rupture, cartilage lesion • Chondropathy, arthrosis • Fracture, disturbed osteosynthesis • Infarct rehabilitation
Circulation improvement	• Improved lymphatic drain • Enhanced microcirculation • accelerated resorbtion of haematomas • Decreased release of vasoactive amines • Increased hyaluronidase activity	• Postthrombotic lymphatic edema • Dizziness, tinnitus, migraine • Chronic postmastectomy lymphatic edema • Posttraumatic swelling

Table I. Indications for laser therapy as cited in the international literature. Laser therapy is a regulatory medical treatment modality which is applied in most of the medical disciplines: dermatology, traumatology, sports medicine, orthopaedy, dental medicine, urology, gynaecology, general medicine, veterinary medicine, physiotherapy, nature medicine etc.
(Adapted from the Lasotronic web site)

often used in vivo in Europe, especially in the treatment of herpes zoster, diabetic ulcers, burns, wound healing disorders, pain and inflammatory processes [13, 16, 19-22].

Despite its longterm use, there still is an on-going controversy in scientific medicine regarding the application of laser biomodulation therapies with low power laser light or other monochromatic light.

It is important to emphasize that light therapy with different wave lengths has been accepted as a low-risk treatment by the FDA [13] and that the application of light as a therapy method has been approved [13].

Low Power Laser Therapy evokes a clinical effect without thermic side effects [16] and at relatively low costs (see Table II).

Acute pain due to polyarthritis, myogelosis, tennis elbow, capsule distensions and tendosynovitis is conventionally treated with cortisone and analgetics. This conventional therapy is, however, frequently ineffective and may moreover cause severe side effects, not to mention the considerable cost factor. The possibility to treat these symptoms fast, easily and cost effectively with low power laser offers an effective therapeutic alternative. Another advantage is that the therapy can be repeated as there are no known side effects.

Mastitis caused by radiotherapy after breast conserving surgery occurs in 20% of patients [23]. Its therapy with cortisone and antibiotics is also costly and may lead to considerable side effects. The treatment of radiotherapy-induced mastitis with LLLT improves the quality of

Explanation of costs		Laser size	
	small	medium	large
Acquisition value - average in Euro	2000,00	3000,00	13000,00
Economic life time - in years	5	5	5
Leasing duration - average in years	2	3	4
Monthly costs based on the life-time - without interests in Euro	33,33	66,67	216,67
Monthly costs based on the life-time - with 5% interests in Euro	41,67	83,33	270,83
Treatments per month	100	100	100
Amortization costs per treatment - in Euro	0,42	0,83	2,71
Average treatment time - in minutes	15	15	20
Time costs (120 Euro/hour)	30,00	30,00	40,00
Total costs per therapy - in Euro	30,42	30,83	42,71
Small: handheld laser devices for acupuncture, 30-70mW			
Medium: table stations with handheld sensor, 50-300mW			
Large: Scanner devices with automatic, up to 500mW or 4W			

Table II. Cost evaluation of laser therapy (By courtesy of Felix Kramer from Lasotronic)

life and is very economical [16].

Other side effects of radiation therapy, especially in patients with tumours of the head and neck region have also been successfully treated with LLLT at low costs [24].

To summarize, biomodulation by LLLT has been demonstrated to be an effective treatment option for inflammatory processes and various other illnesses.

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