This issue of Photonics & Lasers in Medicine addresses the role of photonics and lasers in the skin, which we often refer to as the largest human organ. Due to the skin’s easy accessibility it was the target for the earliest attempts of photon-based therapies in humans. Examples include the application of ultraviolet phototherapy for the treatment of cutaneous tuberculosis by Niels Finsen [1–3], as well as the first trial using photodynamic therapy (PDT) of basal cell cancer of the skin by Hermann Tappeiner [4, 5]; both of these pivotal innovations happened over a century ago.

Skin is our border and defense barrier to the outside world and it is continuously exposed to a range of outside stimuli [6, 7]. The sun plays a central role, and is both good and bad as ultraviolet exposure is necessary for vitamin D synthesis in the skin but can also cause sunburn and skin cancer [8].

Several articles in this issue concentrate on diagnostic tools. The article by Meschieri et al. [9] reviews the value of in-vivo reflectance confocal microscopy as a tool in cutaneous oncology. One of his co-authors, Millind Rajadhyaksha has been crucial in developing this technology and bringing it to practical application [10–14]. As the major technical limitation of this method is the image depth of up to 300 μm, its main role may be in early detection of skin malignancies, specifically in directing necessary biopsies and avoiding unnecessary ones. In their latest work, the research group combines reflectance confocal microscopy and optical coherence tomography (OCT) imaging for skin burn assessment [15]. The difference between OCT and reflectance confocal microscopy is the ability of OCT to image to a depth of 1 mm; however, this increased penetration depth comes at the cost of reduced resolution. Ultimately, of course, this method also aims at reducing the need for invasive biopsies by providing reliable images that allow for diagnostic decisions and for treatment response monitoring [16–18].

Rollakanti et al. [19] review the use of fluorescence measurements as a tool to optimize aminolevulinic acid (ALA)-based PDT of non-melanoma skin cancer. The exogenous exposure of skin cancer precursors and skin cancers to a physiological heme precursor (ALA) results in selective accumulation of porphyrins, predominantly protoporphyrin IX, in the neoplastic cells. The major advantage of PDT over surgical methods of skin cancer treatment is a better cosmetic outcome (little to no scarring) [20–23]. The challenge here is how to improve on a suboptimal response rate that has been attributed to variations in porphyrin formation rates between different tumors and between different patients. One proposed remedy for this problem is to quantify porphyrin accumulation via fluorescence measurements, preferably in real time, so that the dose could be adjusted to make PDT more effective and reliable as a good alternative to surgery [24].

The article by Yu and Baron [25], on evaluation of photoaging, offers a review of current optical rating systems that attempt to quantify wrinkling and photodamage in the skin. Despite an intense interest by pharmaceutical companies and physicians in performing reliable cosmetic assessments, the article clearly highlights an urgent need for quantitative, objective alternatives to current photonic scales (which are, for the most part, entirely descriptive). Perhaps one or more imaging techniques described elsewhere in this issue may eventually be brought to bear to help solve this problem.

All the imaging methods that are featured in above articles may have significant impact on the practice of medicine. One of the inherent challenges is that the optimal use of the described techniques requires not only new devices but also operators that are familiar with the novel images that these deliver. Added physician time and device cost will only be acceptable if the respective method promises improved patient care, and thus potentially reduced long-term cost.

Li et al. [26] discuss in their review the current state of enhanced transdermal drug delivery using laser ablation. The top part of the epidermis, the stratum corneum, is an amazingly specialized layer that is nearly impervious and provides a barrier to unwanted chemicals and pathogens. While such protection is desirable, the stratum corneum also inhibits transcutaneous delivery of drugs and vaccines that we consider desirable [27]. Laser technology and nanoparticles can provide an approach to fine-tune disruption of that barrier and allow penetration of larger...
The stratum corneum is also the topic of a report by Andree et al. [29] who used diffuse light reflectance to assess carotenoid accumulation in palmar skin as a function of time and cumulative ingestion of carrot juice. The lipophilicity of carotenoids causes their accumulation not only in the fatty tissue but also in the stratum corneum, which is readily accessible for spectral analysis. Incidentally, the dermatological term for the visible discoloration of palmar skin due to carotenoids is aurantiasis, meaning the “orange color” of the palms.

The issue is completed by two free contributions. Zabarylo et al. [30] report about image processing methods for the registration of scattered light pictures and X-ray radiographs. This image fusion is superior compared to a separate interpretation of radiographs and optical images. Three laser diodes emitting in the visible and near infrared range are used to optimize distinction between normal and diseased tissue. Early detection of disease activity by novel methods such as the one described here can inform timely intervention in inflammatory joint disease. Increased sensitivity in the detection of localized disease activity may help reducing morbidity and long-term sequelae of joint inflammation in conditions such as rheumatoid arthritis.

Ribeiro et al. [31] conducted a study with the aim to evaluate the influence of low-level laser therapy (LLLT) on epiphyseal cartilage in the femur and tibia of rabbits. They found that HeNe laser irradiation (632.8 nm, 6 J/cm²) stimulates the cartilage ossification to bone, causing some delay in growth and development of the epiphyseal plate. Their results highlight the importance of studying cartilage morphology and its interaction with LLLT in order to prevent disturbances in epiphyseal plate in growing individuals.

In addition to the scientific contributions you will find the abstracts from the 20th Annual Meeting “Unmet Needs in Biophotonics and Laser Medicine” of the Deutsche Gesellschaft für Lasermedizin (DGLM) e.V., which was held on May 14, 2013 as part of the LASER World of PHOTONICS Congress and Exhibition, supplemented by the protocol of the general meeting of the DGLM. Our international readers will hopefully excuse the fact that the protocol is written in German language as it specifically addresses the members of the DGLM.

Finally we would like to stress, that it has been a privilege to be guest editors for Photonics & Lasers in Medicine, and we want to thank Prof. Lilge for his invitation. We also want to thank the authors for their contribution to the dermatology theme of this issue. Human skin is a fascinating organ with a diversity of crucial functions. Light-based methods will continue to enable research and ultimately help physicians to improve skin health.

References


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