

Hyperspectral Imaging in Diabetic Foot Wound Care

Dmitry Yudovsky, M.S.,¹ Aksone Nouvong, D.P.M.,² and Laurent Pilon, Ph.D.³

Abstract

Diabetic foot ulceration is a major complication of diabetes and afflicts as many as 15 to 25% of type 1 and 2 diabetes patients during their lifetime. If untreated, diabetic foot ulcers may become infected and require total or partial amputation of the affected limb. Early identification of tissue at risk of ulcerating could enable proper preventive care, thereby reducing the incidence of foot ulceration. Furthermore, noninvasive assessment of tissue viability around already formed ulcers could inform the diabetes caregiver about the severity of the wound and help assess the need for amputation. This article reviews how hyperspectral imaging between 450 and 700 nm can be used to assess the risk of diabetic foot ulcer development and to predict the likelihood of healing noninvasively. Two methods are described to analyze the *in vivo* hyperspectral measurements. The first method is based on the modified Beer-Lambert law and produces a map of oxyhemoglobin and deoxyhemoglobin concentrations in the dermis of the foot. The second is based on a two-layer optical model of skin and can retrieve not only oxyhemoglobin and deoxyhemoglobin concentrations but also epidermal thickness and melanin concentration along with skin scattering properties. It can detect changes in the diabetic foot and help predict and understand ulceration mechanisms.

J Diabetes Sci Technol 2010;4(5):1099-1113

Author Affiliations: ¹Henry Samueli School of Engineering and Applied Science, University of California, Los Angeles, CA; ²Department of Surgery, UCLA/Olive View Medical Center, Sylmar, CA; and ³Biomedical Inter-Department Program, Henry Samueli School of Engineering and Applied Science, University of California, Los Angeles, CA

Abbreviations: (CCD) charge-coupled device, (LED) light-emitting diode, (MAD) maximum absolute difference, (NIR) near-infrared, (TcPO₂) transcutaneous oxygen tension, (UV) ultraviolet

Keywords: diabetic foot ulcer, hyperspectral imaging, tissue oximetry, wound care

Corresponding Author: Laurent Pilon, Ph.D., Biomedical Inter-Department Program, Henry Samueli School of Engineering and Applied Science, University of California, 420 Westwood Plaza, Eng. IV 37-132, Los Angeles, CA 90095-1597; email address pilon@seas.ucla.edu