Dual-function Microneedle Array for Efficient Photodynamic Therapy by Transdermal Co-delivering Light and Photosensitizer

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Supplementary Data S1

Parameters of illumination simulation

	Refractive	Absorption	Scattering	Anisotropy
	index	coefficient	coefficient	factor
Stratum	1 /	158 5 am-1	162 2 am-1	0.7
corneum	1.4	138.5 Cm ²	403.2 Cm ⁻	0.7
Epidermis	1.4	25 cm ⁻¹	130 cm ⁻¹	0.74
Dermis	1.4	2.8 cm ⁻¹	184.4 cm ⁻¹	0.774
PVA	1.488	0.2 cm ⁻¹	27.9 cm ⁻¹	0.9

PVA1.4880.2 cm⁻¹27.9 cm⁻¹0.9Table S1 Table S1 provides the optical parameters for Monte Carlo simulation.

Supplementary Data S2 Current photodynamic therapy steps



Figure S2 Figure S2(a) shows a patient with port-wine stains (PWS). Figure S2(b) illustrates the method of photosensitizer injection, where the patient is required to be injected intravenously. Figure S2(c) presents the treatment process. The healthy skin of the patient, including eyes, should be covered as much as possible with a black cloth when light is applied. After treatment of about 20 minutes, patients are instructed to avoid strong light exposure for at least 14 days as shown in Figure S2(d). However, the lesions of a patient usually cannot disappear completely and should be treated again after 4 weeks with the same steps.

Supplementary Data S3

Image processing and data analysis



Figure S3 Figure S3(a) illustrates a logical flowchart of the image process to quantify the vasoconstriction in the dorsal skin-fold window chamber (DSWC), which consists of 4 main parts: threshold segmentation, edge detection, Hough transformation and counting pixels of the final binary result image. Figure S3(b) shows the original image of the vessel area to be quantified. Because the red blood vessels in the computer image differ greatly from the background color, a threshold value can be set to extract the blood vessels. Since the image noise of window edge is complex and easy to be wrongly classified into blood vessels (Figure S3(c)), the Hough transformation algorithm is adopted to determine the region of interest. Edge detection is performed before this to find the Hough circle (Figure S3(d)). Next, reduce the radius of the circle in the edge detection step by 50 pixels to reduce the outliers (Figure S3(e)), save the contents inside the circle, and make the pixels outside the circle white (Figure S3(f)). Finally, count and output the number of black pixels (vessels pixels) in the image.

Supplementary Data S4 Establishment of HMME plasma standard curve



Figure S4 HMME solution with a concentration of 1 mg/ml was used as the stock solution. Working HMME solutions of 0.1, 5, 10, 20, 30, and 40 μ g/ml were obtained by serial dilution. Subsequently, 10 μ l working solutions were added to mice blank plasma (300 μ l) to prepare plasma standards, which were analyzed using LC/MS/MS method. The linear regression equation between the HMME concentration (X) and peak area (Y) was given by Linear regression analysis.