

Illumination profile characterization of a light applicator

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Background: When surgery is part of a multimodal treatment for malignant pleural mesothelioma, an aggressive tumor of the pleura, it is crucial to combine it with a local adjuvant treatment to kill residual tumour cells. Recently, intrapleural photodynamic therapy (iPDT), has emerged as a promising treatment, with major impact on survival and minimum toxicity [1]. Complete and homo geneous illumination of the pleural cavity is essential to the success of iPDT, but remains a challenge. Knowing the repartition and prop-agation of light around the light device could be the first step towards optimizing dosimetry. Here we propose a characterization method of the illumination profile of a specific light device.

Methods: The light wand was made of a cylindrical diffuser (Medlight[®] S.A. Switzerland) located inside an endotracheal tube and connected to a medical diode laser 635 ± 3 nm (Ceralas[®], Bio-litec). The wand was fixed horizontally in a tank filled with dilute 0.01% intralipid. Light dosimetry was performed around the tip of the wand using two complementary methods: accurate measure-ments of light power (nW) with an isotropic probe (Medlight[®]) connected to a wattmeter (Newport[®] 841-PE) and measurements of pixel intensity with digital photography. An effective attenua-tion coefficient (μ_{eff}) was to be defined. Fluence rate measurements were to be confronted with those of a 1 cm^2 flat sensor located at the device's surface.

Results: The experimental measurements obtained with the isotropic probe allowed to estimate an effective attenuation coefficient $\mu_{\text{eff}} = 0.56 \text{ cm}^{-1}$. Combined with the photography's spatial representation, a theoretical illumination profile was established: it showed an ellipse-shaped illumination with iso-surfaces of flu-ence rate, defining a gradient light dose according to the distance from the diffuser. For instance, 20% of light power is delivered at 23 mm from the center of the diffuser. Fluence rate obtained with the flat sensor at 14 mm from the diffuser (0.023 W/cm^2) matched the one calculated from the illumination profile (0.02 W/cm^2). This work has also been transposed to the same light device, but with a bare optical fiber (FiberTech[®]), also used for iPDT.

Conclusion: A theoretical illumination profile of a light wand for iPDT was established and could be used in the future to improve peroperative dosimetry, as part of a spatial tracking system.

Reference

[1] J.S. Friedberg, Ann. Thorac. Surg. 91 (6) (2011) 1738–1745.

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