Nonlinear relation between concentration and fluorescence emission of protoporphyrin IX in calibrated phantoms

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Résumé en anglais	5-ALA-induced protoporphyrin IX (PpIX) has shown its relevance in medical assisting techniques, notably in the detection of glioma (brain tumors). Validation of instruments on phantoms is mandatory and a standardization procedure has recently been proposed. This procedure yields phantoms recipes to realize a linear relationship between PpIX concentration and fluorescence emission intensity. The present study puts forward phantoms where this linear relationship cannot be used. We propose a model that considers two states of PpIX, corresponding to two different aggregates of PpIX, with fluorescence spectra peaking at 634 and 620 nm, respectively. We characterize the influence of these two states on PpIX fluorescence emission spectra in phantoms with steady concentration of PpIX and various microenvironment parameters (surfactant, Intralipid or bovine blood concentration, and pH). We show that, with fixed PpIX concentration, a modification of the microenvironment induces a variation of the emitted spectrum, notably a shift in its central wavelength. We show that this modification reveals a variation of proportions of the two states. This establishes phantom microenvironment regimes where the usual single state model is biased while a linear combination of the two spectra enables accurate recovering of any measured spectra.
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