Duration and Extent of the Decline in SpO_2 After Bolus Injection of Indocyanine Green

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Summary:
Fourth-generation pulse oximeters display erroneously low oxygen saturation readings after IV administration of indocyanine green (ICG). This phenomenon is assumingly restricted to higher plasma levels of ICG and does not reduce the utility of pulse oximetry in intensive care and anesthesia.

Introduction:
With regard to very few former studies [1] and case reports addressing artifactual low readings of functional oxygen saturation (SpO_2) after injection of indocyanine green (ICG) and other medical dyes, this study was designed to specifically evaluate duration and extent of the spurious decrease in SpO_2 of four newest-generation pulse oximeters after injection of ICG. ICG represents a tricarbocyanine type of dye with infrared absorbing properties, a peak absorption at about 800 nm near the isosbestic point, and is used as a diagnostic aid for blood volume determination, cardiac output, and hepatic function.

Material and Methods:
After institutional approval and informed consent, SpO_2 and pulse rate (PR) of 10 ICU patients (aged 51-80 yrs) receiving 0,25mg/kg ICG IV to evaluate hepatic function (comprising plasma disappearance rate, retention rate, and blood clearance of ICG) were additionally monitored by means of four fourth-generation pulse oximeters (Philips IntelliVue M3001, Masimo Radical, Dolphin Medical 2100, Nellcor N-595) via four randomly placed sensors (digit II-V). Minimum SpO_2 (t_2) as well as the beginning (t_1) and the end (t_3) of the decline of SpO_2 were marked offline and $\Delta t_1 = t_2 - t_1$, $\Delta t_2 = t_3 - t_2$ and $\Delta SpO_2 = SpO_2(t_1) - SpO_2(t_2)$ were calculated. Additionally, arterial blood samples were taken from an arterial line for co-oximetry to determine pO_2 (Radiometer ABL7xx series) at t_1, t_2, and t_3.

Results:
Table 1 (*Tab. 1*) presents the results (mean ±SD).

Table 1

	Philips IntelliVue	*Masimo Radical*	*Dolphin Medical*	*Nellcor N-595*
$\Delta t1$ (s)	8.0±1.7	6.5±3.3	6.6±2.3	5.4±1.9
$\Delta t2$ (s)	4.6±1.7	5.0±1.8	6.6±4.5	6.6±3.1
$\Delta SpO2$ (%)	5.7±1.6	8.3±3.3	5.3±2.5	6.3±3.0

Newest-generation pulse oximeters present with a slight and brief spurious decrease in SpO_2 after IV injection of ICG whereas co-oximetry and pO_2 remain unchanged. Notably, Student's t testing yields no significant statistical differences of Δt_1, Δt_2 and ΔSpO_2 with all pulse oximeters ($p < 0.01$), however, the transient decrease in SpO_2 was significant ($p < 0.05$).

Conclusion:
As ICG holds different molar extinction coefficients for different concentrations which additionally vary if proteins (e.g. albumin) are present, the effective absorption does not linearly increase with higher concentrations, but the primary absorption peak is shifted to the red thereby inducing an erroneous decrease in pulse oximetry readings especially at higher ICG plasma levels.

References:
1.Sidi A et al. J Clin Monit 1987;4:249-56.