

ORI monitoring allows a reduction of time with hyperoxia in critically ill patients: the randomized control ORI study.

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Intensive Care Med. 2019 Aug 13. doi:10.1007/s00134-019-05732-9.

After decades of fear of hypoxia, it is now widely accepted that hyperoxia is deleterious too [1, 2]. This is the rationale for recent recommendations to target peripheral oxygen saturation (SpO_2) $\leq 96\%$ [3]. However, SpO_2 monitoring may not be sufficient since elevated partial arterial oxygen pressure (PaO_2) is not recognized once $SpO_2 \geq 98\%$, indeed, critically ill patients may spend as much as 60% of the time with hyperoxia [4]. The oxygen reserve index (ORI), measured non-invasively by a pulse-oximeter, correlates to elevated PaO_2 (for $PaO_2 > 80\text{--}100$ mmHg [5]). We hypothesized that using ORI to set oxygen in critically ill patients would reduce the time with moderate hyperoxia ($PaO_2 \geq 100$ mmHg) compared to monitoring SpO_2 (with upper limits) alone.

We randomized 150 adult patients, mechanically ventilated for a predictable duration ≥ 2 days to either ORI or control group (ClinicalTrial: NCT02878460; see esm). All the patients were monitored using Rainbow® pulse-oximeter sensors connected to ROOT monitors (MASIMO, USA). Nurses were instructed to decrease O_2 rate when ORI was ≥ 0.01 (ORI group) or when SpO_2 was \geq prescribed upper limit (control group) (Supplementary Fig. 1e). Seventy-five patients were analyzed in the ORI group and 71 in the control group (Supplementary Fig. 2e). Patients in both groups were similar, except for the presence of shock at ICU admission (48 (64%) vs 32 (45%) in ORI and control groups, $p = 0.022$; Table 1e). Patients were most often admitted for urgent surgery and had frequent lung damage. The median duration of follow-up was similar (6 (2–13) vs 5 (2–16) days, $p = 0.71$). We analyzed 2455 arterial blood gasses, 1545 days and 36.929 h of oxygen therapy (medians 166 (56–306) vs 111 (40–396) h/patient for ORI and control groups, $p = 0.58$). ORI monitoring allowed a significant reduction in the percentage of days with hyperoxia (14 (0–33) vs 33 (11–56)% for ORI vs control, $p = 0.003$) without an increase in the percentage of days with hypoxia (Supplementary Fig. 3e). The percentage of time (in hours) spent with $PaO_2 \geq 100$ or ≥ 120 mmHg was also much lower using ORI (Table 1). We observed no statistically significant differences in mean daily PaO_2 or FiO_2 , but the time spent with a FiO_2 of 0.21 was greater in the ORI group (Table 1). There was no difference in any other clinical outcome.

The use of ORI monitoring to titrate oxygen rates allowed an important reduction of the time spent with hyperoxia compared with the use of SpO_2 alone, probably because nurses are reluctant to decrease oxygen rates when SpO_2 is in a normal range. A nurse-driven protocol to adjust FiO_2 according to SpO_2 was already in place in our unit, explaining why the percentage of time with hyperoxia we observed in the control group was much less than usually reported (30 vs 60%) [4]. This strategy to decrease oxygen rate according to ORI (which detects high PaO_2) may thus be even more efficient in units where there is no protocol to adjust oxygen rates. SpO_2 could remain a warning for hypoxia and ORI for hyperoxia. Larger studies are needed to evaluate the clinical benefit of this strategy.

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s00134-019-05732-9>) contains supplementary material, which is available to authorized users.