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Hyperoxia effects on intensive care unit mortality: a retrospective pragmatic cohort study

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Supplementary oxygen is frequent in the management of patients admitted to the intensive care unit (ICU) [1]. However, some studies have suggested deleterious effects of hyperoxia on these patients [2–4]. This main study objective was to assess the association between hyperoxia, at any time of the ICU stay, and ICU mortality regardless of the cause of patient admission.

Our study was an observational, retrospective, and single-centre study in the Hôpital Européen George Pompidou medical ICU, Paris, France. All patients admitted between November and December 2017 were included regardless of their admission cause and all of their arterial blood gases (ABGs) were analysed. Hyperoxia was defined as a partial arterial pressure in oxygen (PaO_2) superior to 100 mmHg (13.3 kPa). The principal judgement criterion was occurrence of at least one hyperoxia episode during the ICU stay. All statistical tests were two-tailed with a significance threshold of 0.05. Analyses were performed with R v3.2.4. Survival analysis was estimated by Kaplan–Meier methods.

A total of 130 patients, median age 68 (57–79) years and median SAPS II 45 (35–56), were included. The mean reason for ICU admission was respiratory failure (60 patients, 46%) and 83 patients (64%) needed mechanical ventilation. Thirty-five patients (27%) died during their ICU stay.

Eighty patients (62%) presented at least one episode of hyperoxia. Overall survival (OS) was significantly lower in patients who presented at least one episode of hyperoxia during their ICU stay: median OS was 26 days (95% CI 20–NR) versus median not reached, $p = 0.0047$ (Fig. 1).

In univariate analysis, hyperoxia was a risk factor for mortality: 31 deceased patients presented hyperoxia (89%) versus 49 alive patients (52%), $p < 0.001$. SAPS II and mechanical ventilation time were also mortality risk factors in univariate analysis (Additional file 1: Table S1). Multivariate analysis showed that hyperoxia was an independent risk factor for ICU mortality: OR = 3.80 (95% CI 1.08–16.01), $p = 0.047$ (Table 1).

Despite a conservative oxygen policy, 62% of patients presented at least one episode of hyperoxia, which reinforces the statement by Helmerhorst et al. [5]. Previous studies had a focus on specific categories of selected patients [2–4]. On the contrary, our study is a pragmatic study in real-life conditions. We included all consecutive patients admitted to the medical ICU without any exclusion criteria, regardless of the admission cause, mechanical ventilation need, or initial severity, and we collected prospectively a large amount of 1.450 ABG. In this study, we demonstrated that hyperoxia at any time of the ICU stay significantly decreases OS and is an independent mortality risk factor.

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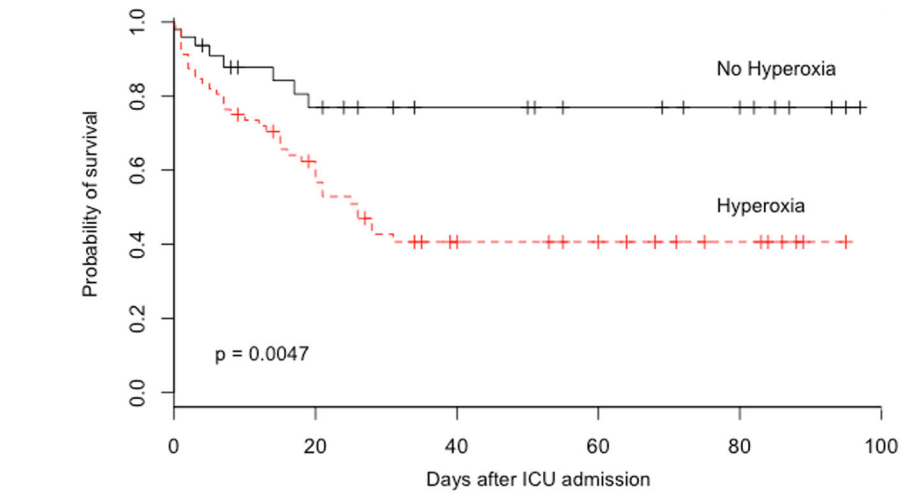

No. at risk						
Hyperoxia	80	33	16	12	7	0
No Hyperoxia	50	20	15	11	9	0

Fig. 1 Kaplan–Meier estimation of overall survival. Hyperoxia group, patients who presented at least one hyperoxia episode during ICU stay. No hyperoxia group, patients who presented no hyperoxia episode during ICU stay. Overall survival median in hyperoxia group 26 days (95% CI 20–NR); overall survival median in no hyperoxia group not reached. ICU intensive care unit

Table 1 Mortality risk factors in the medical ICU, multivariate analysis

Mortality risk factor	Deceased ($n = 35$)	Alive ($n = 95$)	Odds ratio (95% CI)	p
Age (years)	70 (66–75)	65 (61–69)		0.15
SAPS II	64 (56–72)	41 (37–45)		< 0.001
Mechanical ventilation time	9 (7–12)	5 (3–7)		0.074
At least one $PaO_2 > 100$ mmHg (13.3 kPa)	31 (89%)	49 (52%)	3.80 (1.08–16.01)	0.047

Data presented as mean (95CI) or *n* (%)
$R^2 = 0.453$
CI confidence interval, *ICU* intensive care unit, *PaO_2* partial arterial pressure in oxygen, *SAPS* II Simplified Acute Physiology Score II

Additional file

Additional file 1: Table S1. Mortality risk factors in medical ICU, univariate analysis. (DOCX 17 kb)

Abbreviations

ABG: Arterial blood gas; ICU: Intensive care unit; OS: Overall survival; PaO_2: Partial arterial pressure in oxygen; SAPS II: Simplified Acute Physiology Score II

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

MR participated in data acquisition, data analysis, and data interpretation, wrote the manuscript, and created Fig. 1. EG designed the study and revised the manuscript. CB and NA participated in the study and designed and revised the manuscript. JN participated in data acquisition and analysis. CH-B, BH, J-LA, SO, DV, and J-LD are physicians and were involved in patient care. All authors read and approved the final manuscript.

Ethics approval and consent to participate

Data collection and analyses were conducted in accordance with the French national guidelines: under French law, a retrospective study using data from medical charts requires only a declaration to the Commission nationale Informatique et Libertés. The hospital's computerised database was declared at this commission. There is no requirement for declaration to an ethic committee.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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