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LETTER

Organizational aspects of care associated with mortality in critically ill COVID-19 patients

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Dear Editor,

The coronavirus disease 2019 (COVID-19) pandemic has challenged hospital organizations worldwide, not only because of the novelty of the disease, but also because of the high volume of patients in need of critical care over a short time period [1]. ICU mortality of COVID-19 patients depends on patient-related and caregiver-related factors in addition to organizational aspects of the unit, where those patients are hospitalized. We sought to identify various organizational factors associated with ICU mortality among COVID-19 patients.

We performed a nationwide study based on the medical information system from all public and private hospitals in France. All adults admitted to a French ICU for severe COVID-19 acute respiratory failure, with SAPS II greater than 15 and who received invasive ventilation, between January 1, 2020, and April 26, 2020 were included. The primary outcome was all-cause mortality during the ICU stay. We computed a modified Poisson regression model to estimate the influence on patient mortality of organizational factors including a potential weekend effect (death probability among patients discharged from ICU on Saturday or Sunday compared to other weekdays), hospital location in French regions, and ICU team experience over time (cumulative number of COVID-19 patients already admitted to the ICU) [2].

A total of 9809 patients from 350 hospitals were analyzed, with a median of 17 severe COVID-19 patients (range 1–230) and 4 related deaths (0–97) per ICU. Patients mean age was 63.2 years (SD 11.6), SAPS II was 45.4 (16.9) and ICU length of stay 20.5 days (16.1). Overall, 3069 (31.3%) patients died in ICU. After adjusting for patient-related confounders, the risk of death increased among weekend ICU discharges (relative Risk 1.54, 95% CI 1.45–1.64). Patient mortality was also higher within ICUs located in the Paris (1.62, 1.35–1.94) and Northeast (1.24, 1.02–1.49) regions (Table 1).

Three findings result from this large data analysis limited to available medical information that may not always consider all possible confounders accurately. First, weekends were associated with an increased likelihood of patient death at the end of ICU stay. Understaffing frequently occurs during weekends [3] and this result can be interpreted as a lack of available health professionals, given the patients' needs [4]. Second, excess mortality may arise when healthcare organizations are overwhelmed. Paris and Northeast regions exhibited by far the highest number of severe COVID-19 patients to treat in France and corresponding ICUs appeared to be rapidly saturated [5]. Finally, no learning curve for ICU management of COVID-19 patients was evidenced. A potential explanation is that "practice makes perfect" effect may be counterbalanced by high-volume of admissions leading to excessive workload and surpassing bed capacity to provide optimal care.

In the aftermath of the COVID-19 pandemic, ICU organizational aspects significantly influenced patient outcome. The capacity of healthcare systems to reshape quickly seems crucial to population survival in the context of health crises. Solutions to avoid overwhelming situations may include appropriate staffing, temporary units' openings, and close collaborations between ICUs from the same territory for optimal patient repartition.

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Table 1 Factors associated with ICU mortality among COVID-19 patients

Factors	Unadjusted Relative risks (95% CI)	Unadjusted *p* value	Adjusted Relative risks (95% CI)	Adjusted *p* value
Day of ICU discharge				
Weekend	1.65 (1.54–1.77)	< 0.001	1.54 (1.45–1.64)	< 0.001
Other weekdays	1	Reference	1	Reference
ICU location in France				
Paris region	1.59 (1.3–1.95)	< 0.001	1.62 (1.35–1.94)	< 0.001
Northeast	1.35 (1.1–1.68)	0.005	1.24 (1.02–1.49)	0.029
Northwest	1.07 (0.83–1.37)	0.604	1.14 (0.93–1.4)	0.194
Southeast	1.28 (1.03–1.58)	0.024	1.11 (0.93–1.33)	0.258
Southwest	1	Reference	1	Reference
ICU team experience over time[a]				
Very high [44–229 patients]	0.82 (0.74–0.9)	< 0.001	0.97 (0.86–1.1)	0.664
High [20–43 patients]	0.86 (0.79–0.94)	0.001	0.98 (0.9–1.07)	0.661
Low [8–19 patients]	0.88 (0.81–0.96)	0.004	0.94 (0.87–1.02)	0.147
Very low [0–7 patients]	1	Reference	1	Reference
Patient ICU admission date				
April 13 to April 26	0.88 (0.76–1.02)	0.092	1.14 (0.97–1.35)	0.113
March 30 to April 12	0.72 (0.65–0.8)	< 0.001	1.01 (0.89–1.15)	0.873
March 16 to March 29	0.81 (0.73–0.9)	< 0.001	1.08 (0.97–1.2)	0.164
January 01 to March 15	1	Reference	1	Reference
Patient sex				
Male	1.06 (0.99–1.13)	0.080	1.04 (0.98–1.09)	0.229
Female	1	Reference	1	Reference
Patient age, year				
80+	5.38 (3.62–8)	< 0.001	3.92 (2.96–5.2)	< 0.001
75–79	3.91 (2.64–5.78)	< 0.001	2.77 (2.11–3.64)	< 0.001
70–74	2.96 (2.01–4.35)	< 0.001	2.12 (1.61–2.78)	< 0.001
60–69	2.36 (1.6–3.48)	< 0.001	1.78 (1.37–2.3)	< 0.001
40–59	1.34 (0.92–1.95)	0.127	1.17 (0.91–1.51)	0.218
18–39	1	Reference	1	Reference
Patient SAPS II[a]				
Very high [56–120]	3.03 (2.66–3.44)	< 0.001	1.79 (1.6–2.01)	< 0.001
High [43–55]	2.12 (1.87–2.4)	< 0.001	1.39 (1.25–1.55)	< 0.001
Low [33–42]	1.65 (1.46–1.88)	< 0.001	1.27 (1.13–1.42)	< 0.001
Very low [15–32]	1	Reference	1	Reference
Charlson comorbidity index				
3+	1.36 (1.36–1.51)	< 0.001	1.03 (0.94–1.13)	0.553
2	1.15 (1.15–1.27)	0.010	0.96 (0.89–1.05)	0.403
1	1.3 (1.17–1.43)	< 0.001	1.07 (0.97–1.18)	0.179
0	1	Reference	1	Reference
Hemodynamic support				
Yes	2.1 (1.84–2.4)	< 0.001	1.60 (1.42–1.8)	< 0.001
No	1	Reference	1	Reference
Renal replacement therapy				
Yes	2.23 (2.07–2.4)	< 0.001	1.84 (1.72–1.97)	< 0.001
No	1	Reference	1	Reference
Patient median household income[a]***, €***				
Very low [11,726–18,115]	1.19 (1.1–1.28)	< 0.001	1.23 (1.14–1.33)	< 0.001
Low [18,125–20,083]	1.11 (1.01–1.22)	0.025	1.12 (1.03–1.22)	0.009
High [20,083–22,582]	1.08 (0.99–1.18)	0.094	1.11 (1.03–1.2)	0.009
Very high [22,583–43,350]	1	Reference	1	Reference

Table 1 (continued)

9809 critically ill COVID-19 patients from 350 hospitals were analyzed. Using modified Poisson regression model (with a robust error variance) accounting for patient clustering within hospitals and for patient related confounders (sex, age, SAPS II, Charlson comorbidity index, hemodynamic support, renal replacement therapy, patient median household income) and the date of patient ICU admission, we estimated adjusted relative risks with their 95% confidence intervals (95% CI)

[a] Categorized into quartiles

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Author contributions

AD, LP, SP, and TR prepared this paper; AD and TR collaborated in the concept and design of the study; AD and TR was responsible for study governance and logistical support; all authors contributed substantially to analyzing and interpretation of data; AD and TR drafted the manuscript which then was critically revised by all the authors; All authors have read and approved the final manuscript.

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Compliance with ethical standards

Conflicts of interest

All authors declare no conflicts of interest.

Ethical approval

This observational study was based on anonymous data and declared to the National Data Protection Commission (MR-4423250520) before any analysis.

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