Should critically ill patients with COVID-19 be managed in high-volume ICUs?

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To the Editor: The coronavirus disease 2019 (COVID-19) pandemic has resulted in 38 394 169 cases and 1 089 047 deaths worldwide as of 15 October 2020, although to date, Australia has been relatively spared, with only 11 441 cases and 118 deaths.[1] Globally, health care systems and intensive care units (ICUs) have been under immense pressure and wide regional variation in mortality has been observed, both between[2-5] and within countries.[6] It has been suggested that a higher ICU case volume of COVID-19 may be associated with increased mortality, although this has not yet been systematically investigated. Intuitively, a negative volume–outcome association is plausible under pandemic conditions, as a stretched system running above maximal capacity may not be able to deliver its usual standard of care.

The SPRINT-SARI (Short Period Incidence Study of Severe Acute Respiratory Infection) Australia study aims to provide near real-time observational data on patients with COVID-19 admitted to participating ICUs. Herein, we report results of an interim analysis of the SPRINT-SARI database to determine whether a COVID-19 case volume–outcome association exists locally at participating sites.

Data pertaining to confirmed COVID-19 ICU admissions in the SPRINT-SARI database between 27 February and 30 June 2020 were extracted. The primary exposure variable was case volume. Sites were dichotomised into a low-volume group (LVG) and high-volume group (HVG) based on the median number of COVID-19 admissions to each institution. The primary outcome was hospital mortality. Patients still in hospital were excluded from the mortality analysis. Mixed effects logistic regression was performed using age, Acute Physiological and Chronic Health Evaluation (APACHE) II score, and receipt of mechanical ventilation as fixed effects and site as a random effect, with patients nested within sites. Odds ratio (OR) of death with 95% confidence interval (CI) and *P* values are reported.

We performed sensitivity analyses, defining low and high case volume on the basis of the median ICU-bed hours and an arbitrary cut-off of ten or more confirmed COVID-19 cases, and modelling volume as a continuous variable

Table 1. Patient characteristics and outcomes for confirmed coronavirus disease 2019 (COVID-19) intensive care unit (ICU) admissions

	Low-volume group	High-volume group
Total number of patients	102	130
Demographic characteristics		
Age (years), median (IQR)	68 (57–72)	62 (49–72)
Sex, female	32 (31%)	42 (33%)
Body mass index (kg/m^2), median (IQR)	30 (25–32)	29 (24–32)
Smoking history	18 (18%)	17 (13%)
Comorbidities		
Obesity	23 (23%)	32 (25%)
Diabetes	26 (25%)	38 (29%)
Asthma	12 (12%)	12 (9%)
ACEI/A2RB	23 (23%)	27 (21%)
Chronic cardiovascular disease	24 (24%)	17 (13%)
Day 1 APACHE II score, median (IQR)	16 (12–19)	13 (8–17)
Outcomes		
Mortality	17 (17%)	14 (11%)
Still in ICU	14 (14%)	22 (17%)

A2RB = angiotensin II receptor blocker; ACEI = angiotensin-converting enzyme inhibitor; APACHE = Acute Physiological and Chronic Health Evaluation; IQR = interquartile range.

Table 2. Adjusted hospital mortality and sensitivity analyses for confirmed coronavirus disease 2019 (COVID-19) admissions with completed outcome

	Low-volume group	High-volume group	Adjusted OR (95% CI)	*P*
Primary outcome*				
Median split by site volume	17/102 (17%)	14/130 (11%)	0.96 (0.35–2.63)	0.93
Sensitivity analyses*				
Median split by ICU-bed hours	20/128 (16%)	11/104 (11%)	0.9 (0.32–2.54)	0.85
High-volume arbitrarily set to > 10 COVID-19 admissions	22/134 (16%)	9/98 (9%)	1.41 (0.47–4.27)	0.54
Site volume as a continuous variable	na	na	1.04 (0.98–1.1)	0.17
Site ICU-bed hours as a continuous variable (per 100 hours)	na	na	1.02 (0.99–1.04)	0.27
With sample limited to mechanical ventilation patients only†				
Median split by site volume	14/62 (23%)	12/68 (18%)	0.91 (0.29–2.82)	0.87
Median split by ICU-bed hours	17/79 (22%)	9/51 (18%)	0.81 (0.25–2.62)	0.73
High-volume arbitrarily set to > 10 COVID-19 admissions	19/90 (21%)	7/40 (18%)	1.3 (0.36–4.69)	0.69
Site volume as a continuous variable	na	na	1.04 (0.95–1.13)	0.43
Site ICU-bed hours as a continuous variable (per 100 hours)	na	na	1.01 (0.97–1.05)	0.6

ICU =intensive care unit; na = not applicable; OR = odds ratio. * *n* = 196. † *n* = 130.

(separate models for number of cases and ICU-bed hours as the marker of volume). Moreover, all analyses were repeated with only patients who received mechanical ventilation.

There were 232 confirmed COVID-19 admissions in 47 ICUs, and of these, 196 (84%) were discharged from hospital. There were 102 (44%) admissions in the LVG (median site volume, 4; interquartile range [IQR], 2–5) and 130 (56%) in the HVG (median, 12; IQR, 10–37). Demographic characteristics and outcomes are described in Table 1. The mechanical ventilation rate was 61% in the LVG and 52% in the HVG. Crude mortality was 17/102 (17%) and 14/130 (11%) in the LVG and HVG respectively. After adjustment for age, APACHE II score and mechanical ventilation, there was no statistically significant difference in mortality in the HVG compared with LVG (OR, 0.96; 95% CI, 0.35–2.63; $P = 0.93$).

All the sensitivity analyses (Table 2) also demonstrated that there were no significant differences in mortality based on case volume, regardless of whether all patients or only mechanically ventilated patients were analysed.

While the SPRINT-SARI database offers comprehensive data on critically ill patients with COVID-19 in Australia, there are some important limitations to acknowledge. The overall case numbers were small, limiting the number of covariates that could reasonably be adjusted for. The number of confirmed COVID-19 admissions at each individual site was very small. We also did not have data pertaining to overall ICU capacity at individual sites.

There are currently insufficient data to determine whether there is a case volume–outcome association for COVID-19 mortality in Australian ICUs. As the COVID-19 pandemic is still unfolding, such relationships may emerge, highlighting the necessity of ongoing monitoring via platforms such as SPRINT-SARI.

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Competing interests

None declared.

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