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Covid-19 and Critical Care capacity: Can we mitigate demand?

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The COVID-19 pandemic has placed unprecedented demand on modern healthcare resources. As such, there has been much research and debate on how to best manage patients with COVID-19. Previous studies have shown the benefits of neuromuscular blockade and prone positioning in the management of ARDS [1], as seen in COVID-19 pneumonitis [2], while more recent studies have explored the benefits of different medical treatments. These have included dexamethasone, sarilumab, and tocilizumab as demonstrated by the RECOVERY [3] and REMAP-CAP trials [4]. None of these therapies have mitigated the demand for intensive care capacity which remains, at best, extremely limited or more usually overwhelmed. In such circumstances, there is a need to predict which patients with a significant oxygen dependency will avoid the need for mechanical ventilation. Such patients could safely be cared for in other parts of the hospital thereby preserving intensive care unit capacity for mechanically ventilated patients.

With a view to optimising our intensive care capacity prior to surging into other areas of the hospital, we describe our experience identifying which patients will avoid the need for mechanical ventilation despite currently requiring advanced respiratory support (high-flow nasal oxygen (HFNO) or continuous positive airway pressure (CPAP)). With concerns around the timing of intubation and duration of non-invasive ventilation (NIV), we were also interested in whether early intubation and increasing dexamethasone dose reduces critical care unit length of stay (LOS).

The ROX index is the ratio of $\text{SpO}_2 / \text{FiO}_2$ to respiratory rate, measured 12 hours after the instigation of HFNO. A value greater than 4.88 predicts that a patient with non-COVID-19 pneumonia will not require mechanical ventilation with a positive predictive value approaching 90% [5]. More recent work suggests that this predictive value may extend to patients with COVID-19 pneumonitis [6]. Within our intensive care unit, patients alternate between HFNO

and CPAP as tolerability and oral intake allow. Hence, we pragmatically applied the ROX index to this cohort of patients as a whole. Doing so on day 1 (once established on HFNO or CPAP) and day 5 (at midday) of admission to our unit allowed us to correctly predict success of NIV in 64% and 87% of cases respectively. We felt that a positive predictive value of 64% was inadequate to influence a patient's care pathway, but in our experience, patients can be located non-critical care areas based on their Day 5 ROX score.

We have, on an *ad-hoc* and empirical basis, increased the dose of dexamethasone in our patients with increased BMI, following advice from our local ECMO centre and evidence in non-COVID-19 acute respiratory failure [7]. We also maintain the dose detailed in the RECOVERY trial (6 mg) in our underweight adult patients. With a view to prescribing dexamethasone on a mg/kg basis, resulting in a larger dose for many of our patients, we considered the relationship between dose and outcome with the expectation that we could reduce ICU LOS. Using linear regression we observed no relationship between relative dose of dexamethasone and LOS in our COVID-19 population. We have therefore abandoned this approach.

Finally, we must consider whether we are harming our patients, and increasing their LOS, by delaying intubation. With concerns about mortality approaching 30% [8] in our COVID-19 patients following instigation of mechanical ventilation, we have persisted with NIV support for longer than is our usual practice. However, the concept of patient self-induced lung injury (P-SILI) [9], in which vigorous spontaneous ventilation leads to lung injury and poorer outcomes, may mean this is the wrong approach. We reviewed LOS in patients intubated before or after day 5 of their ICU admission. Linear regression again demonstrated no relationship between these two variables in our centre, allowing us to consider timing of intubation on a case by case basis.

As the northern hemisphere approaches its second COVID-19 winter season, intensive care provision will be further stressed as normal healthcare demands, the continuing pandemic, and staff shortages combine to overwhelm capacity. Clinicians will need to apply triage strategies and mitigation measures to manage access to intensive care units. The ROX index has previously been validated as one mechanism for doing this in COVID-19 patients treated with HFNO. In our experience, the use of this tool also applies to patients receiving CPAP therapy. It appears to be increasingly accurate as patients reach day 5 of their NIV treatment. The ROX index is a useful and pragmatic tool that can help clinicians identify patients who will avoid the need for invasive ventilation. A relative increase in the dose of dexamethasone did not reduce LOS in our patients. This is in keeping with larger-scale, ongoing work that fails to show any survival or LOS benefit resulting from larger doses of dexamethasone [10]. Concerns regarding excessive exposure to NIV in patients with COVID-19 resulting in P-SILI and a presumed increase in LOS are not borne out in our experience.

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