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## Letter to the Editor – Reply to: Trajectories of vital signs in patients with Covid-19

### Authors

Oliver C Redfern<sup>†</sup>, Clinical Researcher, Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, UK

Marco AF Pimentel<sup>†</sup>, Postdoctoral Researcher, Institute of Biomedical Engineering, Department of Engineering Science, University of Oxford, Oxford, UK

Robert Hatch, Clinical Research Fellow, Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, UK

J Duncan Young, Professor of Intensive Care Medicine, Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, UK

Lionel Tarassenko, Professor of Electrical Engineering, Institute of Biomedical Engineering, Department of Engineering Science, University of Oxford, Oxford UK

Peter J Watkinson, Associate Professor of Intensive Care Medicine, Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, UK

<sup>†</sup> joint first authors

### Response

We thank Machiwenyika et al., for their interest in our paper. We are encouraged that their study of post-operative patients also demonstrates how incorporating inspired FiO<sub>2</sub> can aid the identification deteriorating patients [1].

In our study, we chose to combine vital signs into a novelty score as the COVID-19 cohort was insufficiently large to develop and validate a new scoring system on the primary outcome (continuous positive airway pressure/non-invasive positive pressure ventilation, ICU admission or death in hospital). The novelty score allowed us to explore the rate at which patients with COVID-19 deteriorate. The rapid deterioration observed in patients with COVID-19 is seen more clearly when using a novelty score that incorporates FiO<sub>2</sub> (Figure 3) than one that does not (Figure S3).

One advantage of unsupervised learning methods, such as those used in our novelty score, is that they are developed independently from how “deterioration events” are defined. Indeed, we have previously argued that optimising early warnings scores to identify patients at risk of specific adverse outcomes (e.g. death and unplanned intensive care admissions) risks missing early, yet clinically significant, deterioration [2]. Moreover, although we exploit similar methods to centile-based early warning scores, the novelty score is multivariate, and we do not suggest cut-offs for clinical intervention.

As Machiwenyika et al. highlight, the novelty score equally weighs positive and negative deviations from “normal” vital sign measurements (e.g. bradypnoea and tachypnoea). While this could misrepresent the relationship between respiratory rate and the risk of specific outcomes, it is worth noting that bradypnoea is relatively uncommon. Only 6 of 374 COVID-19 patients in our study had a respiratory rate < 12. These cases may well merit review.

We agree that the absence of non-respiratory vital sign abnormalities observed in our study raise the question of whether NEWS2 is optimal for patients with COVID-19. In contrast, the recent editorial by Subbe and Thorpe discusses the simplicity of using a universal early warning score in

clinical practice [3]. We would argue that NEWS2 should be extensively validated in much larger cohorts of patients with COVID-19 before being reassured that these patients are not disadvantaged. Our study supports the suggestion from Machiwenyika et al., that “one standard scoring system” could be sub-optimal in some patient groups. However, different scoring systems could increase “cognitive load” for clinical staff [3].

We agree that our novelty score and estimation of FiO<sub>2</sub> could be challenging to implement in hospitals without an appropriate electronic vital signs system. Our FiO<sub>2</sub> estimate was used a previously published formula, which could potentially be improved or simplified [4]. We hope a future NEWS3 steering committee will consider the emerging evidence that incorporating FiO<sub>2</sub> could help identify patient deterioration. In a previous study, we have demonstrated how this might be achieved [4]. Moreover, we emphasise again the need to validate any changes introduced in NEWS3 robustly, prior to implementation in the NHS [5].

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### Conflicts of Interest

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