Rationing oxygen use during total intravenous anaesthesia - a proportionate response?

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Editor –

We read Hall and Chakladar's comment on Zhong *et al's* recent study of the environmental and economic impact of fresh gas flows (FGFs) during total intravenous anaesthesia with interest.[1,2] Their concern about oxygen use during the coronavirus disease 2019 (COVID-19) pandemic sadly remains topical, as the disease continues to overwhelm critical care capacity in many hospitals.

Hall and Chakladar suggest that higher FGF rates during the provision of non-inhalational general anaesthesia should be avoided until after the pandemic has abated, citing reports of hospitals that have experienced oxygen shortages.[1] In the UK, which continues to be severely affected by COVID-19, there have been several cases of oxygen supply issues during surges of hospital admissions. However, this appears not to be as a result of a lack of oxygen *per se*, but the per-minute oxygen demand exceeding the flow capacity of supply systems.[3] Internationally, absolute shortages of oxygen have been experienced, for example in sub-Saharan Africa.[4] This appears to be largely due to economic and infrastructure factors, but is not representative of a global oxygen shortage.

Whilst low-flow anaesthesia should form part of a strategy to cope with exceptional surges in oxygen demand, its potential contribution to this endeavour is unfortunately minimal. The total consumption of oxygen per patient using higher FGFs via a circle system is not as great as it may at first appear when considered in context. Using Hall and Chakladar's example, a 6-hour case using FGF of 6 $L.min^{-1}$ and a fraction of inspired oxygen (FiO_2) of 0.3 requires 252 L of oxygen. Whilst this may appear to be a large volume, it represents only 0.7 $L.min^{-1}$ of oxygen gas usage; lower than the minimal requirements of even low-flow nasal cannulae.

Furthermore, it has been shown that FiO_2 may be significantly lower than the fraction of oxygen *delivered* at low FGFs due to both oxygen consumption and increased rebreathing of exhaled gases by the patient.[5] While Hall and Chakladar suggest that providing an FiO_2 of 0.3 at 1 $L.min^{-1}$ requires an oxygen flow of 0.1 $L.min^{-1}$, Hendrickx *et al* found in their *in vivo* study that oxygen flows of 0.2 $L.min^{-1}$ were in fact required to maintain a steady state FiO_2 of 0.31 within the circle system at a total FGF of 1 $L.min^{-1}$.[6] It is likely that an even higher oxygen flow rates would be required for patients with increased oxygen consumption at low FGFs. Consequently, oxygen savings are not proportional to the reduction in FGF for a given FiO_2.

During times of extraordinary oxygen demand we agree that clinicians may be required to take all available steps to safely minimise consumption. But even during the COVID-19 pandemic, increasing the FGF from 1 to 6 $L.min^{-1}$ during non-inhalational anaesthesia remains a reasonable option at most times, representing only a 0.5 $L.min^{-1}$ increase in oxygen gas usage when delivering an FiO_2 of 0.3.

In addition to its tragic impacts on the health and wellbeing of millions of people, the COVID-19 pandemic is responsible for profound adverse economic and environmental effects.[7,8] Measures that clinicians can take to mitigate these problems, including optimising FGF rates, are perhaps now more relevant than ever.[9]

Declarations of Interest

CS is a former member of the editorial board of BJA Education. The authors declare no other competing interests.

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