Tissue oxygenation using different oxygen delivery devices and flow rates

We read with interest the recent comparison by Blake et al. of the tissue oxygenation achieved using different oxygen (O_2) delivery devices.[1] This study explored the tissue partial pressure of O_2 ($P_{tc}O_2$) in healthy volunteer scuba divers administering O_2 with a non-rebreather mask (NRB) or with a demand valve with oronasal mask. The authors found that tissue oxygenation was greatest when O_2 was delivered via the NRB at 15 L·min^{-1}. We believe that these conclusions are unwarranted because of a critical methodological flaw of the current study.

As the authors noted, the nasal cannula for measuring end-tidal carbon dioxide may have contributed to a compromised mask seal. Additionally the valve of the demand valve device required an inspiratory pressure for opening. Significant differences between four demand systems have been demonstrated previously.[2] In some systems the inspiratory valve needs a higher pressure difference, whereas a relatively low pressure difference opens the expiration valve and thus leads to the inflow of ambient air. In the present study, the findings for the demand valve were unexpected. We believe that the low tissue oxygenation is a hint to this phenomenon. Meanwhile Blake et al. reported a measurement error associated with the use of incorrect membranes that cover the oxygen sensors.[3] This resulted in $P_{tc}O_2$ measurements that were consistently lower. In our opinion the direction and implications of the significant associations reported in this study were still the same.

We also studied an oxygen delivery device at 15 L·min^{-1} with an open mask (OxyMask™ Adult, Southmedic, Ontario) in an anesthesiology setting prior to cardiac surgery. All patients provided informed consent for an arterial line and blood sampling as part of their routine care. In accordance with the findings of Blake et al., we found similar arterial oxygen partial pressures (P_aO_2) while breathing O_2 spontaneously. We used continuous mandatory ventilation (CMV) in intubated patients as a reference (Table 1).

On-site 100% oxygen first-aid treatment remains unchanged in guideline recommendations.[4] This is difficult to achieve in practice. However, based on the reported $P_{tc}O_2$ or P_aO_2 values of the continuous-flow-rate delivery devices, a demand system would be the best alternative.

Table 1
Demographics and arterial oxygen measurements in five patients

Characteristic	Mean	SD
Age (years)	69.3	5.2
Heart rate (beats·min^{-1})	73	8.8
Respiratory rate (breaths·min^{-1})	16	1.7
P_aO_2 on room air (mmHg)	64	11.6
P_aO_2 on 15 L·min^{-1} for 3 min (mmHg)	249	56.6
P_aO_2 on CMV F_iO_2 1,0 for 10 min (mmHg)	339	60.4

References

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