Editorial

Diving and hyperbaric medicine in the SARS-CoV-2 pandemic

The world is living through a tragic and historic event. It is difficult to overstate (or even appreciate) the scale of medical, social and economic upheaval wrought by the SARS-CoV-2 (Covid-19) pandemic, and few would expect the fabric of life to return to normal any time soon.

The fields of diving medicine and hyperbaric medicine stand to be impacted in multiple ways, not least because hyperbaric oxygen treatment (HBOT) appeals as an intuitively obvious means of improving oxygenation in a disease process where hypoxia is a prominent and sometimes fatal feature. There would be few HBOT providers who have not fielded questions about providing treatment for Covid-19 patients.

There is little doubt that hypoxia in a critically ill Covid-19 patient could be improved during HBOT. However, this would only last for the duration of the treatment, and it is unknown whether any other benefit would accrue. HBOT is not known to have specific antiviral effects. Nevertheless, as practitioners in this field are aware, there are potentially beneficial immune-modulatory and anti-inflammatory actions elucidated and reported in other indications.[1] Their net effect on the natural history of Covid-19 is unknown.

There are predictable logistic difficulties in providing HBOT to Covid-19 patients, including patient transfer and access, staff protection, infection control, and (depending on patient selection) the challenges of caring for very sick patients in a hyperbaric environment. There are also potential risks. Any hyperbaric dose of oxygen will promote pulmonary oxygen toxicity. Some patients may have existing pulmonary oxygen toxicity due to prolonged high-fraction normobaric oxygen administration, and their vulnerability to exacerbation by HBOT is unknown. There is also the likelihood that Covid-19 may enhance risk of pulmonary barotrauma. In a series of 202 Covid-19 patients intubated for ventilatory support 5.9% developed pneumothorax;[2] an unusually high number (even in pulmonary pathology) suggesting that the disease promotes gas trapping (substantially confirmed by computed tomography scans)[3] or structural lung damage or both. There is also the distressing potential for patients to become 'oxygen-trapped' toward the end of HBOT sessions if developing worse oxygenation than pre-treatment levels during decompression to surface pressure.

The crucial balance between these potential benefits and risks is simply not informed by adequate evidence at this point. The Undersea and Hyperbaric Medical Society is taking an appropriately cautious position on this matter. They state that "*there is insufficient evidence to endorse the use of routine adjunctive HBO_2 for COVID-19 patients outside the context of an IRB-approved clinical trial*".[4] It is gratifying that multiple groups have taken up the implied challenge of answering the relevant questions with controlled studies.[5–8] Study primary end points include: incidence of intubation,[5] mortality,[6] effect on oxygen requirement,[7] and PO_2/FiO_2 ratios and immunological responses.[8]

One consequence of the pandemic for all clinical hyperbaric units is the challenge of maintaining a service for patients with the usual indications for HBOT amidst lock-downs, patient reluctance to interface with medical services for fear of infection, and inevitable uncertainties around patient Covid-19 status even in the absence of symptoms. Many patients at high risk of poor outcomes if infected (elderly or co-morbid patients) are treated at hyperbaric units, and it follows that high levels of attention to social distancing, staff and patient personal protective equipment, and equipment and environmental hygiene must be maintained. These matters can be particularly challenging in practices utilising multi-place chambers and an attempt to provide relevant guidance has been promulgated by the European Committee for Hyperbaric Medicine.[9]

For those more focused on the diving medicine side of practice the effects of this pandemic may reverberate for longer. In particular, there are obvious but (at this point) poorly understood implications for future fitness for diving after Covid-19 infection.

Experience with persisting lung changes following the original SARS-CoV-1 epidemic in 2003 have raised fears that the risk of pulmonary barotrauma may be heightened in Covid-19 survivors. The mid to long-term natural history of lung changes caused by Covid-19 are not yet characterised, and this uncertainty has encouraged conservatism, at least for the time being. For example, a guideline on diving after Covid-19 pulmonary infection released by the Belgian Society for Diving and Hyperbaric Medicine states that "*a diver who has been hospitalised with or because of pulmonary symptoms in relation to COVID-19, should, after a three-month waiting period (with no diving), undergo complete pulmonary function testing as well as a high resolution CT scan of the lungs*".[10] It further states that the "*CT scan should show a return to normal before resuming diving*". Another thoughtful and highly structured guideline has been promulgated by the University of California San Diego group.[11]

Advocacy for considering detailed radiological investigation of Covid-19 affected divers or diving candidates before diving seems reasonable in the present uncertain circumstances, but in the likely absence of a baseline CT scan, interpreting "*normal*" may be problematic. For example, Covid-19 infection seems to promote gas trapping detectable by CT,[3] but gas trapping can also be seen on CT in subjects who are in perfect health with normal lung function.[12] This is likely to become a challenging issue for our field.

The prospect of mid to long-term pulmonary effects also signals other possible problems for diving fitness. Damaged lungs may become less efficient at filtering the venous gas emboli (VGE) that are commonly formed after surfacing from compressed gas dives, raising concerns about an increased risk of those forms of decompression sickness associated with arterialisation of VGE. There is also concern that Covid-19 (like SARS-CoV-1 in 2003) may leave survivors with significantly reduced exercise capacity. This was seen in patients whose lungs appeared largely recovered, and may be multifactorial in origin.[13]

These considerations, along with other potential complications, suggest that it would be wise for any diver or diving candidate who has suffered Covid-19, but particularly cases with obvious pulmonary, cardiac or neurological symptoms to be reviewed by a diving physician, investigated appropriately and counselled about risk prior to diving, or advised against diving if risk is considered excessive. With time, experience and more research, consensus on an evidence-informed pathway for pragmatic management of these consultations will emerge.

These are challenging times for our discipline. Many hyperbaric practitioners in large centres are also qualified in front-line hospital-based disciplines like anaesthesiology or emergency medicine where they will have been distracted from hyperbaric practice, but will have made significant contributions to caring for patients under trying and hazardous conditions. Indeed, thanks and respect are due to front-line medical staff world-wide for a response that has engendered a profound appreciation of the medical profession. Back in the world of hyperbaric medicine the quiet, professional and ethical initiatives currently underway to scientifically define the role (if any) for HBOT in treating Covid-19 are also deeply appreciated. An answer may not come until the current pandemic is in decline, but there will still be patients to treat, and we can be sure that it will happen again.

References

1 Moon RE, editor. Hyperbaric oxygen therapy indications, 14th ed. North Palm Beach (FL): Best Publishing Company; 2019.

2 Yao W, Wang T, Jiang B, Gao F, Wang L, Zheng H, et al. Emergency tracheal intubation in 202 patients with COVID-19 in Wuhan, China: Lessons learnt and international expert recommendations. Br J Anaesth. 2020:In press. doi: 10.1016/j.bja.2020.03.026.

3 Li Y, Xia L. Coronavirus disease 2019 (COVID-19): Role of chest CT in diagnosis and management. AJR. 2020;215:1–7. doi: 10.2214/AJR.20.22954. PMID: 32130038.

4 UHMS Position Statement: Hyperbaric oxygen (HBO_2) for COVID-19 patients. Available from: https://www.uhms.org/images/Position-Statements/UHMS_Position_Statement_Hyperbaric_Oxygen_for_COVID-19_Patients_v13_Final_copy_edited.pdf. [cited 2020 April 24].

5 Hyperbaric oxygen therapy (HBOT) as a treatment for COVID-19 infection. Available from: https://clinicaltrials.gov/ct2/show/NCT04343183?term=Hyperbaric+oxygen&cond=COVID&draw=2&rank=1. [cited 2020 April 24].

6 Hyperbaric oxygen for COVID-19 patients. Available from: https://clinicaltrials.gov/ct2/show/NCT04332081?term=Hyperbaric+oxygen&cond=COVID&draw=2&rank=2. [cited 2020 April 24].

7 Management by hyperbaric oxygen therapy of patients with hypoxaemic pneumonia with SARS-CoV-2 (COVID-19). Available from: https://clinicaltrials.gov/ct2/show/NCT04344431?term=Hyperbaric+oxygen&cond=COVID&draw=2&rank=3. [cited 2020 April 24].

8 Safety and efficacy of hyperbaric oxygen for ARDS in patients with COVID-19 (COVID-19-HBO). Available from: https://clinicaltrials.gov/ct2/show/NCT04327505?term=Hyperbaric+oxygen&cond=COVID&draw=2. [cited 2020 April 24].

9 European Committee for Hyperbaric Medicine. ECHM position on hyperbaric oxygen therapy (HBOT) in multiplace chambers during coronavirus disease (COVID-19) outbreak. Available from: http://www.eubs.org/wp-content/uploads/2020/03/ECHM-position-on-HBOT-and-COVID-19-16th-March-2020.pdf. [cited 2020 April 24].

10 Position of the Belgian Society for Diving and Hyperbaric Medicine (SBMHS-BVOOG) on Diving after COVID-19 pulmonary infection. Available from: http://www.sbmhs.be/2020%200412%20Position%20of%20the%20BVOOG.pdf?fbclid=IwAR2gju6gVB1XtlKHi1gWYiqxVuNWgWk-crrYCuJh1cF4S7bKqCqlz_qE1RU. [cited 2020 April 24].

11 Sadler C, Alvarez Villela M, van Hoesen K, Grover I, Newman T, Lindholm P. UC San Diego guidelines for evaluation of diving during COVID-19 pandemic. Available from: https://health.ucsd.edu/coronavirus/Pages/health-professionals.aspx. [cited 2020 May 14].

12 Tanaka N, Matsumoto T, Miura G, Emoto T, Matsunaga N, Ueda K, et al. Air trapping at CT: High prevalence in aymptomatic subjects with normal pulmonary function. Radiology. 2003;227:776–85. doi: 10.1148/radiol.2273020352. PMID: 12702825.

13 Hui DSC, Chan PKS. Severe acute respiratory syndrome and coronavirus. Infect Dis Clin N Am. 2010;24:619–38. doi: 10.1016/j.idc.2010.04.009. PMID: 20674795. PMCID: PMC7127710.

doi: 10.28920/dhm50.2.90-91. PMID: 32557408.

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Front cover: Dr Craig Challen (left) and Dr Richard Harris (right) after emerging from the cave on one of the Thailand cave rescue days. Image taken by Australian Federal Police.