

## Reply:

We thank Professor Moon for his interest in our series. The series highlighted that, whilst early use of hyperbaric oxygen (HBOT) is associated with the best neurological outcome, it is often difficult to achieve this aim.<sup>1</sup> Delays to treatment occurred even when the initiating event was in a hospital with a hyperbaric facility. Further delaying HBOT to obtain cerebral imaging is likely to significantly add to the time between the cerebral gas embolism (CGE) event and effective treatment. This compounds delays imposed by late recognition of CGE diagnosis, the need to complete the surgical procedure and/or the need to transfer patients to a HBOT facility.

In general, magnetic resonance imaging (MRI) or computerised tomography (CT) imaging may support a diagnosis but cannot make the diagnosis. A normal CT or MRI should not be reassuring that no significant neurological insult has occurred. In two cases of witnessed CGE during cardiac ablation surgery which resulted in major CNS dysfunction, initial imaging was reported as normal. In both cases imaging delayed effective treatment and despite treatment with a US Navy Treatment Table 6A only one had a favourable outcome.<sup>2</sup> In a similar incident, 15 ml of air was inadvertently injected into a subclavian artery. Basilar artery air was demonstrated angiographically and the patient showed signs of posterior circulation ischaemia but normal and diffusion weighted MRI did not detect an abnormality.<sup>3</sup>

If CGE occurs at a centre without a hyperbaric unit, imaging may be of benefit to triage patients but should not delay transfer. As you suggest, the presence of widespread gas on brain imaging may be associated with a poorer outcome. In our series, both patients in whom intravascular air was demonstrated on CT died. In both cases, intravascular air was seen in multiple sequences. Detection of intravascular gas by CT, however, mandates some attempt at treatment even if ultimately futile. We believe that delaying HBOT to obtain imaging may impact significantly on neurological outcome.<sup>4</sup> In a retrospective study, better outcomes were reported if the delay between the diagnosis of CGE and HBOT was less than six hours.<sup>5</sup> In a prospective study, a longer time interval between CGE and the first HBOT did not affect mortality but aggravated neurological sequelae at one-year follow-up.<sup>6</sup>

In our series, imaging was performed on 25 of the 36 patients prior to receiving HBOT, totalling 27 studies. 11 patients had no imaging studies prior to HBOT. The tests included 18 CT of the head, five MRI studies of the brain and two combined CT and MRI. Two CTs demonstrated gas in the cerebral circulation, and a normal CT scan and an abnormal MRI was reported in one other patient. Of the 25 exams that did not demonstrate gas, eight had secondary changes consistent with gas embolism (five CT brain, three MRI). Imaging was performed prior to HBOT in 13 patients despite gas entry being observed during the procedure (10 CT brain, three

MRI). In our opinion cerebral imaging is of limited value if CAGE is witnessed and usually delays effective treatment.

## References

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Associate Professor Geoff Frawley  
Department of Intensive Care and Hyperbaric Medicine, The Alfred Hospital, Prahran, Victoria, Australia  
E-mail: <g.frawley@alfred.org.au>

## Key words

Cerebral arterial gas embolism (CAGE); clinical audit; radiological imaging; outcome; letters (to the Editor)