DESCRIBING DECOMPRESSION SICKNESS (DCS) OF THE BRAIN, SPINE, AND JOINTS BY MULTINOMIAL PROBABILITY

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BACKGROUND

- Vann et al. reviewed evidence suggesting that arterialized VGE initiate serious DCS (cerebral and spinal) at this meeting (Vann, Howle, Pollock, Moon. Poster F126, 2012 UHMS Meeting). This poster describes a multinomial probability model for mild (affecting limbs only) and serious DCS that postulates the possibility of AGE-initiated bubble formation if VGE cross the pulmonary filter.

METHODS

- Figure 1 represents the human body by two tissue types. Tissue 1 forms bubbles easily at low supersaturations and represents the limbs, a well-known source of VGE. Tissue 2 resists bubble formation except at high supersaturations (or on initiation by AGE) and represents the brain and spinal cord which appear bubble-free at physiological supersaturations (<4 atm) during human decompressions. Bubbles form in Tissue 1 upon decompression, and after reaching a threshold volume, VGE enter the venous circulation at a rate proportional to bubble volume (Vann. UHM 37, 298, 2010). VGE carried to the lungs are filtered if the VGE load (in *mL·min/kg*) does not exceed the pulmonary filtration threshold. Right-to-left shunt (e.g., PFO) is assumed absent.
- Figure 2 shows the sequence of events in which: (a) the VGE load exceeds the pulmonary filtration capacity; (b) AGE appear in the arterial blood; and (c) AGE initiate bubble formation in Tissue 2.
- The bubble volume in Tissue 1 is the instantaneous DCS risk which is integrated over time to compute the probability of mild DCS. The bubble volume in Tissue 2 is similarly integrated to find the probability of serious DCS. Model parameters might be calibrated with US Navy Experimental Diving Unit data from N_2 and He dive trials in which there were 13 serious (of 82 total) N_2 cases and 26 serious (of 62 total) He cases in 3,595 dives (1,529 on N_2; 2,066 on He).
- Figure 3 illustrates qualitative estimates of expected probabilities of mild and serious DCS as functions of bubble volume. As serious DCS is of greater concern than mild DCS, decompression procedures could be designed to have a lower target risk for serious DCS than for mild DCS.

DISCUSSION

- In computing decompression procedures, mild and serious DCS manifestations are: (a) traditionally considered equivalent; and (b) tacitly considered a consequence of the same pathophysiology. We suggest that by differentiating mild from serious manifestations according to operative pathophysiologies, safer and more efficient decompression procedures may be achieved.

ACKNOWLEDGMENT

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Figure 1. VGE originate in the limbs and are filtered by lungs.

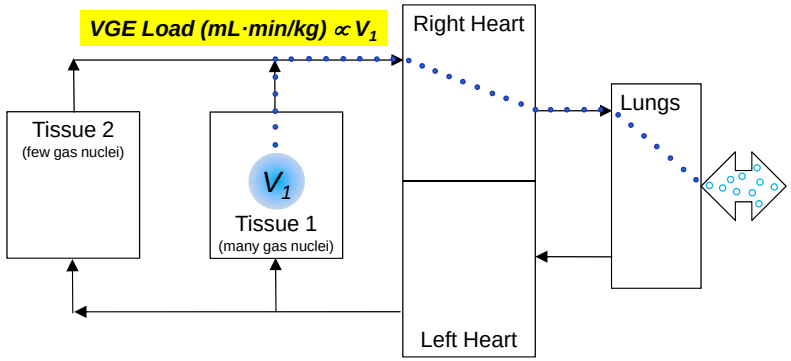

Figure 2. VGE exceed the pulmonary filtration capacity and initiate bubble formation in the brain and spinal cord.

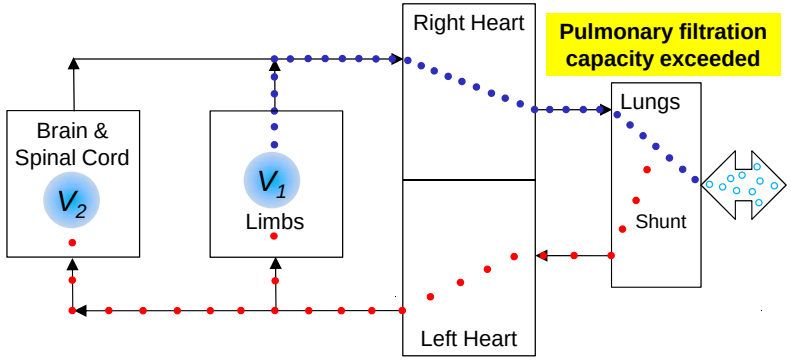

Figure 3. Probabilities of mild and serious DCS and selection of target DCS probabilities.