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24 Modelling human exposure to altered pressure environments

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During a reduction in environmental pressure inert gas forms in some tissues and if the pressure drop is too large or rapid a critical excess quantity of undissolved gas will develop in a particular tissue, resulting in decompression sickness. Hence it is necessary to predict the uptake and elimination of both dissolved and undissolved inert gas in these tissues throughout an exposure to altered environmental pressure. There are severe difficulties in developing a suitable model because the current endpoint in determining the outcome of a decompression trial still depends on the bends incidence and the aviator/diver - doctor interaction which is subjective and imprecise, even when recompression therapy appears to confirm a diagnosis. There is no reliable independent method of inferring the dissolved and undissolved content of a particular tissue or the safe maximum limits relative to the environmental pressure.

Any tissue can be divided into an aqueous and a lipid component, each with a distribution of vascularity such that both diffusion and blood perfusion contribute to the exchange of metabolic gases. The simplest linear model (A), consists of four compartments -two diffusion-limited aqueous and lipid compartments and another two which are perfusion-limited. All four compartments are interconnected and interacting such that the overall tissue response is a quadruple-exponential function.

It can be shown that this four-compartmental model requires at least 14 parameters to describe the overall response to a change in the environmental inert gas pressure. If this tissue contains undissolved gas as well, then it may reasonably be simplified to a two compartment model **(E),** requiring another 4 parameters.

Assuming that just one compound tissue is involved in the avoidance of an excess of undissolved gas then the results of an experimental series will provide an estimate of the dissolved gas content of only one of the four compartments in model A. The estimate will depend on any undissolved content in one of the compartments in model **B.** It is known that only two compartments can be determined from data arising in one compartment and thus the 14 + 4 parameters cannot be solved unless data can be extracted independently from another compartment or by using another gas such as helium or neon on a different experiment.

it can be concluded that until some other independent endpoint becomes available, it will not be possible to develop a physiologically-based model of decompression. There is no justification for choosing a multi-parameter or multi-tissue model until new experimental data demands it. **It** is proposed that a best-fit double compartmental model be used for dissolved gas and a single compartment for undissolved gas (4 + 2 parameters). These are the simplest models consistent with the available data. These reduced models do not establish the method of converting a nitrogen response to that of helium or visa-versa.

Because of these limitations an experimental series must be carefully designed to reveal the tolerance of the above models and parameters as well as accumulating statistics.