A Physiological Modeling Analysis of Rapid Decompressions to 40,000 and 45,000 Feet.

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In 2006, the Federal Aviation Administration issued an interim policy that changed the procedure for certifying new airliners, potentially increasing the maximum cabin pressure altitude ceiling from 40,000 ft to 45,000 ft. The new policy allows aircraft a total of 3 minutes to descend below 25,000 ft in the event of a rapid decompression (RD), with 1 minute above 40,000 ft. We have constructed a computational model that provides a second-by-second prediction of physiological responses and O_2 fluxes occurring between passengers and the environment during RDs of 40,000 and 45,000 ft and the subsequent descents. **Methods.** We used established cardiovascular and respiratory parameters for a 70 kg healthy adult. Gaseous diffusion modeling was based on a one-dimensional monoexponential solution to the diffusion equation. Taking induced changes in ventilation and cardiac output established in previous work into account, we assumed P_{AO2} would fall monoexponentially, with a time constant of 6.2 sec until P_{AO2} calculated from the alveolar gas equation became greater than zero during the descent phase. Total body exchangeable oxygen reserves for a 70 kg human was set at 1150 ml. **Results:** For the 40,000 ft RD profile, the individual will use 1068 ml of the 1150 ml exchangeable O_2 reserves. For the 45,000 ft profile, at 31,219 ft (RD+131 sec), the individual will have used all of the 1150 ml exchangeable O_2 reserves, and will experience a total anoxic time of 35 sec, with a partial anoxic time of 19 sec. **Discussion.** The model predicts that the 45,000 ft RD profile will be inherently more dangerous, as passengers will experience a brief period of total anoxia. Although our results compare favorably to historical decompression research findings, the effect of anoxia-induced unconsciousness on ventilation is uncertain. As PA_{CO2} and RQ are dependent on ventilation in the model, validation work will be required.