Denitrogenation and Protection from Hypobaric Decompression Sickness

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❶General overview of NASA prebreathe protocols: resting in-suit, 10.2 psia staged, and exercise during prebreathe.
❷Variables that contribute to the risk of DCS.
❸Introduction to 360-minute half-time tissue compartment to account for N2 washout / washing.

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❶Shuttle and ISS EVA prebreathe protocols.
❷Operational aspects of conducting EVAs in the EMU.

3. Henninger D. NASA Exploration Atmospheres Working Group (2010) Recommendations for exploration spacecraft internal atmospheres: The final report of the NASA Exploration Atmospheres Working Group. NASA Technical Publication NASA/TP-2010-216134.

❶Outline of trade process to identify 8.2 psia / 34% O2 staged denitrogenation prebreathe.

4. Waligora JM, DJ Horrigan, Jr., J Conkin, AT Hadley, III. Verification of an altitude decompression sickness protocol for Shuttle operations utilizing a 10.2 psi pressure stage. NASA Technical Memorandum 58259, Johnson Space Center, Houston, TX, June 1984.

❶Description of 10.2 psia / 26.5% O2 staged decompression prebreathe for Shuttle.

5. Conkin J, KV Kumar, MR Powell, PP Foster, JM Waligora. A probability model of hypobaric decompression sickness based on 66 chamber tests. Aviat Space Environ Med 1996; 67:176-83.

❶Example of literature and NASA data combined in a survival analysis to estimate the P(DCS).

6. Conkin J, Powell MR. Lower body adynamia as a factor to reduce the risk of hypobaric decompression sickness. Aviat Space Environ Med 2001; 72:202-14.

❶Importance of ambulation as a contributor to the risk of DCS.

7. Conkin J, Pollock NW, Natoli MJ, Martina SD, Wessel JH, III, Gernhardt ML. Venous gas emboli and ambulation at 4.3 psia. Aerosp Med Hum Perform 2017; 88:370-76.

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❶Importance of exercise intensity as a contributor to the risk of DCS

9. Abercromby AFJ, Conkin J, Gernhardt ML. Modeling a 15-min extravehicular activity prebreathe protocol using NASA's exploration atmosphere (56.5 kPa / 34% O_2). Acta Astronautica 2015; 109:76-87.

❶Application of NASA data and Bubble Growth Index in a logistic regression to estimate the P(DCS).

10. Conkin J, Abercromby AFJ, Dervay JP, Feiveson AH, Gernhardt ML, Norcross JR, Ploutz-Snyder R, Wessel JH, III. Hypobaric decompression sickness treatment model. Aerosp Med Hum Perform 2015; 86:508-17.

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❶List of all DCS case descriptions from NASA research.
❷Description of the Tissue Bubble Dynamics Model and its application in quantifying DCS treatment success.

12. Conkin J. Evidence-based approach to the analysis of serious decompression sickness with application to EVA astronauts. NASA Technical Publication 2001-210196, Houston: Johnson Space Center, January 2001.

❶Example of literature data used to estimate the P(serious DCS)

13. Conkin J, Gernhardt ML, Powell MR, Pollock NW. A probability model of decompression sickness at 4.3 psia after exercise prebreathe. NASA Technical Publication NASA/TP-2004-213158 Houston: Johnson Space Center, December 2004.

❶Method on how to quantify denitrogenation during prebreathe with exercise.

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vacuum chamber testing decompression sickness tiger team report. Houston, TX: NASA Johnson Space Center; July 2019. NASA Technical Publication NASA/TP-2019-220343.

❶One source for several useful P(DCS) regressions.
❷Example of how a potential prebreathe protocol is evaluated.

15. Conkin J. Probability of decompression sickness and venous gas emboli from 49 NASA hypobaric chamber tests with reference to Exploration Atmosphere. Houston, TX: NASA Johnson Space Center; April 2020. NASA Technical Publication NASA/TP-2020-220529.

❶Last best survival models for all of NASA data.
❷Comparison of TR360 and BGI360 as decompression dose in all NASA data.
❸Examples of quantifying (modeling) N2 washout in complex prebreathes.
❹Variables that contribute to the risk of DCS, such as age, gender, BMI, ambulation, etc.