
J.H. WESSELL1, III, J. CONKIN2,
1Wyle Laboratories, 2Universities Space Research Association, Houston, TX.

INTRODUCTION

• In 1982, NASA started its decompression sickness research with BENDS I to provide a safe and efficient prebreath for altitude Extravehicular Activities (EVA). At that time, all study data were kept in the form of logbooks and bulky paper spreadsheets, from which analysis and results were derived.
• In 1985, the then head of the JSC Environmental Physiology Laboratory IEPL, Dr. John Gilbert, used the lab’s first computer and started digitizing BENDS data into RHAB, a rudimentary database software package. This allowed the entry of test subject and study data into the original tabular format that still serves as the backbone of the current database today.
• In 1988, Dr. Varunshu Karné decided that his data, and all the rest of the lab’s data, would be better served in MS Access and started converting it all into that format.
• In the timeframe of 1988-1994, the database became “carnival” in both data integrity and structure due to the many people inputting data.
• Two EPLs later in the processes of Mr. Koonta Aoscope (1995) and Dr. Karl Linoff (1996) provided the EPL with new data entry expertise and accuracy control and rectified many of the accumulated errors.

METHODS

• The NASA Decompression Sickness Database is in a MS Access 2005 format and currently consists of 28 tables and 458,791 cells.
• There were 584 viable test exposures from 238 test subjects, in 11 major studies, under 31 unique testing procedures.
• For details about each of the major tests, the reader is referred to the notebook in the immediate vicinity of this point, labeled “Testing Regimes”.
• The studies below were tabulated with ambulatory subjects, had long prebreathe prebreathe or overnight stays at 10.2 psia and utilized 26.5% oxygen.
- Evaluation of 3.5 - 4.0 hour prebreathe testing (BENDS 2, 4, 6)
- 10.2 psia Staged Decompression Protocol (BENDS 3, 4, 5, 9)
- Evaluation of 6.5 psia EVA tests (BENDS 6)
- Evaluation of high exercise rate during EVA (BENDS 7)
- Evaluation of pre-EVA exercise and role of DCS and VGE (BENDS 8)
- Evaluation of Flying after Diving (BENDS 10)

• The studies below were specifically done to understand the benefits of adynamia prior to and during the altitude exposure:
- Evaluation of adynamia (BENDS 9 and 11)
- JSC standard operating procedures require a modified Air Force Class III Physical, so that data is included in the database.
• Subjects were recruited to approximately match the physical characteristics of the astronaut corps.
• About half the testing data were collected under test termination rules that allowed the test to continue until the ability to perform EVA-simulation exercise was hindered, as the subject wished to terminate the exposure. This was later amended through the Institutional Review Board to a more conservative approach to ensure greater safety for the pool of test subjects.

RESULTS

Figure 1 shows the various pressure regimes used throughout the history of DCS research conducted at JSC. Readers are encouraged to follow individual lines from left to right to better understand the 31 conducted testing protocols. Divergence points at the right end of a subsection of grey line illustrate marked differences between protocols with similar prior pressures, while divergence points show a shared feature of multiple protocols.

Figure 5 shows the age and gender distributions in 548 exposures. A criterion we used to evaluate our testing is how closely the test subject age matches that of the astronaut. Unfortunately, the overall test subject recruitment over the years has not perfectly mimicked the age at the time. The average age of astronauts is about 43 years, while that of our test subjects is about 31 years. The subset of female test subjects are decidedly younger on average, in comparison.

Figure 3 shows that initial DCS research at JSC (1982-84) used male test subjects. The test subject pool was later expanded to include females in 1985. All subsequent testing has attempted to have a ratio of males to females that closely mimics the gender composition of the astronaut corps, while allowing for the difficulties of test subject recruitment.

Figure 6 shows the maximum VGE grades assigned during the majority our testing protocols. When VGE are present, they rapidly manifest themselves in the higher classifications of Grades III and IV. Nearly a third of all our possible VGE scores fall into those two combined categories.

DISCUSSION

Figure 8 shows the onset of DCS symptoms often occur later than the onset of VGE detected in the pulmonary artery using a Doppler bubble detector. The graph shows points that are from a subset of subjects where both VGE were detected and DCS symptoms were reported. In general, the presence of VGE in the pulmonary artery is a necessary but not sufficient condition for DCS. VGE first detected later in an altitude exposure correspond closely to the onset of DCS symptoms than VGE first detected earlier at the altitude exposure.

Future Direction of Work: The next major step in the evolution of the NASA Hypobaric Decompression Sickness Database is to merge it with the NASA Prebreathe Reduction Protocol Database into a common format (MS Access).