DATA MINING OF HISTORICAL HUMAN DATA TO ASSESS THE RISK OF INJURY DUE TO DYNAMIC LOADS

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INTRODUCTION: The NASA Occupant Protection Group is charged with ensuring crewmembers are protected during all dynamic phases of spaceflight. Previous work with outside experts has led to the development of a definition of acceptable risk (DAR) for space capsule vehicles. The DAR defines allowable probability rates for various categories of injuries. An important question is how to validate these probabilities for a given vehicle. One approach is to impact test human volunteers under projected nominal landing loads. The main drawback is the large number of subject tests required to attain a reasonable level of confidence that the injury probability rates would meet those outlined in the DAR. An alternative is to mine existing databases containing human responses to impact. Testing an anthropomorphic test device (ATD) at the same human-exposure levels could yield a range of ATD responses that would meet DAR. As one aspect of future vehicle validation, the ATD could be tested in the vehicle's seat and suit configuration at nominal landing loads and compared with the ATD responses supported by the human data set. This approach could reduce the number of human-volunteer tests NASA would need to conduct to validate that a vehicle meets occupant protection standards.

METHODS: The U.S. Air Force has recorded hundreds of human responses to frontal, lateral, and spinal impacts at many acceleration levels and pulse durations. All of this data are stored on the Collaborative Biomechanics Data Network (CBDN), which is maintained by the Wright Patterson Air Force Base (WPAFB). The test device for human occupant restraint (THOR) ATD was impact tested on WPAFB's horizontal impulse accelerator (HIA) matching human-volunteer exposures on the HIA to 5 frontal and 3 spinal loading conditions. No human injuries occurred as a result of these impact conditions. Peak THOR response variables for neck axial tension and compression, and thoracic-spine axial compression were collected. Maximal chest deflection was determined from motion capture video of the impact test. HIC-15 and BRIC were calculated from head acceleration responses. Given the number of human subjects for each test condition a confidence interval of injury probability will be obtained.

RESULTS: Results will be discussed in terms of injury-risk probability estimates based on the human data set evaluated. Also, gaps in the data set will be identified. These gaps could be one of two types. One is areas where additional THOR testing would increase the comparable human data set, thereby improving confidence in the injury probability rate. The other is where additional human testing would assist in obtaining information on other acceleration levels or directions.

DISCUSSION: The historical human data showed validity of the THOR ATD for supplemental testing. The historical human data are limited in scope, however. Further data are needed to characterize the effects of sex, age, anthropometry, and deconditioning due to spaceflight on risk of injury.