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To: Barton L. Gledhill, Chairman
Institutional Review Board

From: Paul Meyer

Subject: Human Subjects Experiments with Air Tagged with Radioisotopes N-13 and Ar-41, IRB Approval No. 80R-109

This memo is in answer to your request of February 23, 1988 for more information on the subject matter. I will attempt to address the issues you raised point by point.

Why are experiments done? What is the Navy's Interest? Decompression sickness problems remain the most important limitations of present and proposed operational Navy diving. Central Navy tasking to the medical laboratories recognizes the problem. It provides general guidance, such as "produce an algorithm for special warfare divers to perform complex dives, outside the current decompression tables," and allocates stable funding of about $500K per year (Ref. 3). Much of that funding is consumed by computational work and trial and error human experiments in the large high pressure chambers at the Naval Medical Research Institute (NMRI) in Bethesda, Maryland. Both the P.I. (Ref. 9) and the Head of Diving Medicine (Ref. 1) believe that the proposed human experiments can provide a needed quantum increase in basic understanding to minimize future trial and error procedures.

Why at LLNL? Some years ago, on the urging of LLNL's Hazards Control Department, I developed a radioisotope facility at the LINAC to produce short-lived biological isotopes. In addition, a three-dimensional positron camera imaging system was implemented to study the effect of ozone on lung function of dogs and humans. This project was in cooperation with the University of Washington Medical School, funded by NIH and EPA, and approved by LLNL's Finance Committee. The capability and expertise gained was unique in the United States and lead to the current joint research program with the Navy. At this time, there exists, to our knowledge, no other laboratory where this scientific investigation could be conducted without a lengthy development period.

REPOSITORY LLNL B361 Rm. B940A
COLLECTION Institutional Review Board
BOX No. IRB Protocol File
FOLDER Meyer, P. IRB No. 80P-109
Decompression Sickness Studies
With Radioactive Gases

University of California
Lawrence Livermore National Laboratory

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Decompression sickness risks; what are they and how often do they materialize? The present decompression tables are known to result in dozens of cases of decompression sickness per year in the Navy. During 1971-1978, the number of dives is listed as approximately 16,200 for the Navy alone. Overall incidence rate was found to be 1.25%; the incidence rate for individual schedules, having more than 50 dives, ranged from 0-4.8% (Ref. 4). Several percent of these cases left permanent disabilities, such as central nervous system dysfunction, residual paralysis, sensory loss below the knee and impotence are some of the more common ones. Although systematic records are unavailable, it is said that civilian divers using Navy decompression tables under less controlled conditions, experienced an order of magnitude greater problems. Furthermore, a new Navy need is for a general decompression computer algorithm for SEAL teams to operate on complex dives not allowed by current decompression tables (Ref. 1,3,9). Their mission success depends on a good calculational approximation for gas exchange kinetics in humans.

Radiation exposure risk? The dose received by each subject is calculated using actual lung volume and time elapsed from isotope production to beginning and end of exposure. The maximum dose of 400mr is based on absolute specific activity measurements achievable under full accelerator beam power condition, extrapolated back to beam-off time. In practice, the actual dose is always less than the maximum, because of elapsed time to gas uptake and generally lower than maximum beam power. Due to the necessary gas preparation procedure, the time to uptake is at least one half-life of the N-13. Steve Homan (health physicist, LLNL Hazards Control) addresses the cancer risk (Ref. 2). His conservative estimates are based on 400mr to the lung and generally accepted international statistical methods. The expected number of cancer fatalities for a set of 20 subjects associated with this procedure os 0.0002, i.e. two in 10,000. This must be compared with a natural expected value of five cancer fatalities for the group, i.e., 20 x 0.25 fatalities per person.

Why use human subjects? Animal work with radioactive gas has been performed (Ref. 6) and the results have been partially implemented in new human decompression procedures (Ref. 7 and 8). However, the work done at LLNL with humans (Ref. 5) showed a striking qualitative difference in outcome, that perplexes diving physiologists and makes direct human studies imperative.

Paul Meyer

Paul Meyer

PM/pb-1424A

Attachments

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References enclosed

1) Letter from Dept. of the Navy by Capt. E. T. Flynn, Feb. 8, 1988.

2) Internal Memo from Steve Homan, LLNL Hazards Control Dept., Feb. 1, 1988.

References previously submitted

3) "Scientifically Based Decompression Tables for AIR and Mixed Gas Division," Research and Technology Work Unit Summary, DD-DR&E(AR)636.

4) "U. S. Navy Air Decompression Schedule Risk Analysis," NMRI 80-1, T. E. Berghage and D. Durman, Naval Medical Research Institute.

5) "Nitrogen Gas Exchange in the Human Knee," P. K. Weathersby et al., J. Appl. Physiol. 61(4); 1534-1545 (1986).

6) "Distribution of Xenon Gas Exchange Rates in Dogs," P. K. Weathersby et al., J. Appl. Physiol: Respirat. Environ. Exercise Physiol. 50(6); 1325-1336 (1981).

7) "Statistically Based Decompression Tables, 'I. Analysis of Standard Air Dives: 1950-1970,'" NMRI 85-16, Naval Medical Research Institute.

8) "Equal Risk Air Diving Decompression Schedules," NMRI 85-17 (1985), Naval Medical Research Institute, Bethesda, MD.

9) Letter from Dept. of the Navy by Cdr. P. K. Weathersby, Dec. 22, 1987.

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