RADIOBIOLOGY PROGRAM
RESEARCH PROBLEMS
-Approach To Problem Oriented Research Strategy-

I - Life Sciences Requirements

A - Determination of Biological Effects and Acceptable Levels of Exposure

1 - Dose-Response Relationships

a - Particle Radiation

(1) - Early and intermediate effects of HZE

(2) - Long term delayed effects of low dose exposure to HZE. Of fractionated exposure.

(3) - Long term delayed effects of low dose exposure to protons.

(4) - Long term delayed effects of low dose exposure to neutrons.

(5) - Long term delayed effects of low dose exposure to mixed neutron, proton, & HZE (1-100 RAD range).

b - Bremstrahlung. Evaluation of the potential hazard of all forms of secondary radiation in anticipated shielding configurations for immediate, intermediate and delayed effects.

c - Flight Exposure Profiles. Effects of total anticipated radiation from ambient, secondaries, proximity to stored and instrumentation isotopes, and from medically administered isotopes.

(1) - Mathematical modeling

(2) - Simulation by sequential exposure of animals to total flight exposure profile for intermediate and delayed effects?

(3) - Solar flare effects, per se.

(4) - Influence of specific spaceflight physiological changes (decreased RCM, fluid & electrolyte, body composition, bone, muscle, circulatory, etc. changes), and contingency situations (acute & subacute illness, toxins, diminished

or altered life support provisions, microwave radiation, etc.).

(5) - Effects of proposed on-board medical techniques and instrumentation (neutron activation, total isotope administration, etc.).

2 - Mechanisms of Radiation Damage. Emphasis on HZE, protons and neutrons. Emphasis on non-renewing tissues and those especially subject to radiation damage (functional and malignant degeneration).

a - Physical Changes.

(1) - Intracellular molecular-chemical, genetic, and ultrastructural morphologic changes.

(2) - Tissue changes - vascular and lymphatic exchanges, immunology, tissue morphology.

b - Functional Changes. Finely discernable changes and rates of change for intercurrent assessment and prognosis of delayed effects. (See also, under Methodology Development).

c - Pathogenesis and significance of the "Light Flash" phenomenon. (Special problem.)

3 - Methodology Development.

a - Development of biological model examination systems (in vivo and in vitro) for dose-response relationships, especially for determination of long term functional alterations and losses.

b - Mathematical Modeling.

c - Development of sensitive physical and laboratory examination tests for slight, but significant, functional changes, especially of the brain stem.

d - Long term follow-up longitudinal studies of flight personnel.

e - Long term follow-up of exposed animals - facilities and standardized methods.

B - Dosimetry for Man and Other Living Systems

1 - Technique Development

a - Improved Capability. For particle radiation, the capability of accurately reading mass and charge.

b - Automated dosimetry for particle radiation.

c - Real time read out of particle dose.

d - Improved accuracy - all forms of radiation, including all secondaries.

e - Biological Dosimetry

(1) - Utilizing man, himself.

(2) - Utilizing small living systems.

2 - Improved Dose Expression - to reflect more accurately and uniformly a measurement of the actual radiological assault received by the living system as the stimulus or potential stimulus for its response. Objective, improved dose-response calculations and predictive equations.

3 - Dose Distribution Modeling

a - Man modeling.

b - HZE transport through thin shields. (See also, Part II).

c - Identification of other critical organs besides skin, eye, and bone marrow.

C - Medical Selection Criteria; Identification of Human Susceptibility Factors

(April AIBS Panel recommendation: "---- even if proved successful, would probably achieve no more than a 10% improvement and is a potentially expensive and low-yield activity.")

D - In-Flight (Real Time) Prognostication Techniques

---- Some possible approaches:

- From real time dosimetry and dose-response curves
- From on-board blood counts
- From blood cellular morphology changes
- From on-board karyotyping of lymphocytes, buccal mucosal cells or other cell sources
- From immunochemical changes in blood
- From other changes in blood chemistry (enzymes, amino acids?)
- From hair root changes (possible DDx by micro-staining and light microscopy?)
- From subtle changes in skin temperature or other more focal temperature changes?

E - Countermeasures

1 - Preventive

1 - Preventive Countermeasures (cont.)

a - Chemical Protection - - Internal; External
(April AIBS Panel recommendation: maintain cognizance of the work of other Agencies active in this area.)

b - Body Shielding - - Total; Partial

c - Prevention of excessive exposure through dose-response knowledge, dosimetry, and intermediate damage assessment methods.

2 - Therapeutic

a - Transfusion of stored autogenous marrow.

b - Standard Clinical Therapy - - (Maintain cognizance of research advancements by other Agencies.)

F - Preparation of Flight Experiments; Maximum exploitation of Shuttle, BESS, Space Station, and possibly SSPS to fulfill NASA radiobiological information needs.

(April AIBS Panel recommendations: Use of 3-6 month BESS flights in polar orbit for prolonged low dose HZE effects data; possible further evaluation of combined effects of radiation plus weightlessness aboard Shuttle and/or BESS.)

II - Data Required from the NASA Physical Sciences (has been formally requested)

A - Ambient Space Environment

For the Immediate Period: A restatement of the trapped radiation environment at geosynchronous altitude (19,600 nautical miles) within a $\pm$ 30° geographic latitude. Include data on the time course of fluctuations and ranges of magnitude, and information on correlations with the solar cycle.

Ultimately: A model with $\pm$ 20% accuracy of the energy spectrum and fluence of charged particles in any part of space in which we plan to operate for the planned operating period.

B - New data on the solar particle contribution to the radiation environment at geosynchronous altitudes. Need a model giving not only "worst case" situations, but time course variation of long term averages of particle fluences and energy distribution. Desire half year intervals in the solar cycle as method of presentation of these data.

Improved and reliable predictive indices for solar particle events also required.

C - New and sustained shielding research applicable to manned space flight. Emphasis on composite shielding with view toward reduction of weight and bremstrahlung. Need data on shielding effectiveness, and models of radiation transport for HZE through candidate shielding materials.

D - NASA support of the Radiation Shielding Information Center (RSIC).

E - Full and ready access to existing and developing microwave data in readily usable form for application to hazard evaluation in space as well as on the ground (SSPS). The need for additional NASA research on microwave effects to be determined.

F - Data on radiation degradation (particularly HZE) of bioinstrumentation, especially solid state microcircuits (a problem shared with other disciplines but nonetheless important to the Life Sciences).

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