The 15th Leading Special Lecture

Prof. Harold M. Swartz

The Use of EPR Dosimetry to Establish the Risk of Acute Clinical Effects in the Event of a Large Scale Radiation Event

Prof. Ann Barry Flood

The Human Factors Involved in the Use of EPR Dosimetry in Large-Scale Nuclear Incidents

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Leading Graduate School
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ACADEMIC DEGREES:

1951-1953 University of Chicago
1953-1955 Loyola University of Chicago
1955-1959, M.D. University of Illinois College of Medicine
1959-1960 Michael Reese Hospital, Rotating Internship
1961-1962, M.S.P.H. (Radiation Biology) University of North Carolina (Chapel Hill)
1966-1969, Ph.D. Georgetown University Medical School, Department of Biochemistry

The Use of EPR Dosimetry to Establish the Risk of Acute Clinical Effects in the Event of a Large Scale Radiation Event

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The potential exposure of large numbers of individuals to levels of radiation that could lead to acute clinical effects is a major concern because of the possibility of radiation accidents, acts of terrorism, or nuclear warfare. In order to cope medically with such an event, it is essential to be able to identify those individuals who probably have had clinically significant exposures, so that they can be entered into the medical system, and to identify those who do not need medical intervention so that the response system is not overwhelmed by them. The capabilities of electron paramagnetic resonance (EPR or ESR) to measure radiation-induced paramagnetic species along with the persistence of such species in certain tissues (especially teeth and finger & toenails) has led to EPR becoming a prominent methods for making the measurements in potentially affected individuals. Recent results in the last few years further demonstrate the high potential of these techniques and progress towards practical devices that could be utilized in the field. With tooth dosimetry the device has now obtained excellent dose response curves in human subjects undergoing total body irradiation with clear delineation of appropriate thresholds for triage. Plans for regulatory approval have advanced through discussions with the FDA. We also have started planning on a variant of the tooth dosimeter that will enable measurement be made suitably for subjects with combined injury, with the patient in a recumbent position, no need to be able to cooperate, and improved dose resolution.

The nail techniques also have made significant new progress, which would allow improved assessment of heterogeneity in the exposure. Two approaches to the use of nails are being pursued, based on the use of nail clipping and on making the measurements directly on the finger and toes in vivo. The technique using clipped nails has had an important breakthrough, with elimination of much of the scatter in results with irradiated nail clippings; these results are being verified with clipped nails irradiated in vivo during TBI. The approach measuring nails in vivo without clipping has also had major advances, with data being obtained on nails irradiated in situ on isolated fingers. The use of nails also provides an excellent direct approach to determining whether the exposure was homogeneous or heterogeneous. This is very important for guiding therapy because if a significant portion of the body has been shielded from the radiation, the bone marrow in that part of the body can act as a source of new marrow cells, replacing the stem cells in the more highly irradiated parts of the body.

In summary, EPR biodosimetry for ionizing radiation appears to be an excellent tool for solving a previously unsolved problem: how to determine who needs acute medical treatment after a large scale radiation incident such as occurred in Fukushima and which would be the critical issue in the event of the detonation of an improvised nuclear device (nuclear bomb) by terrorists.

Ann Barry Flood

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ACADEMIC DEGREES:

1977–1979	NIMH Post Doctorate Fellowship, Research Training Program in Organizations and Mental Health, Stanford University
Ph.D. 1977	Sociology, Stanford University, Stanford, CA
M.A. 1968	Sociology, Stanford University, Stanford, CA
B.A. 1965	Mathematics and Sociology, University of Kansas, Lawrence, Kansas, with Highest Distinction and with honors in Sociology

The Human Factors Involved in the Use of EPR Dosimetry in Large-Scale Nuclear Incidents

Ann Barry Flood

In the event of large-scale radiation event, where thousands of people may have been exposed to clinically relevant levels of ionizing radiation, there is an urgent need to assess the impacted population in order to triage those with were exposed to significant radiation to receive healthcare. This disaster context introduces many important human factors that must be taken into account when developing effective methods for biodosimetry. These human factors include developing methods that can be used to assess dose quickly and efficiently in situations with severely compromised infrastructures, such as having little or no access to medical experts or to usual sources for power or water or communication services. The facilities available in which to gather samples or carry out the screening procedures may be unusual too, ranging from being in a tent open to ambient temperature and wind conditions to school gymnasiums or community meeting spaces with little opportunity for privacy, instead being nearby to devices that might potentially emit interfering signals or cause significant noise or vibrations. Providing services in a disaster also alters the goals and eligibility of who should receive care, for example, eligibility should be based on the need to help everyone regardless of their ability to pay or their ability to make decisions for themselves. In addition, some or all of the evaluations needed for triage may need to be carried out by non-expert technicians with minimal training. In sum, human factors represent special challenges in their intended end-use that need to be considered when designing and implementing effective methods to triage victims in a radiation disaster. These factors will be illustrated using EPR Dosimetry to evaluate the exposure of thousands of victims within days of a large-scale radiation disaster.