

Overview of the Needs for Biodosimetry for Acute Events and the Role of Biodosimetry in Current Plans

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Radiation injury to different physiological systems and tissues may result from external exposure and/or the uptake of radioactive materials by inhalation, ingestion, skin absorption, or wound contamination. Radiation injury (with the exception of the injury caused by high and uniformly lethal doses) does not manifest immediately, while the severity of radiation injury expressed is generally a function of the dose received, after taking account of variables such as dose rate, heterogeneity of exposure, and quality of the causative radiation (e.g., high v. low LET). This latency and dose dependency afford an opportunity to administer appropriate mitigating and therapeutic agents early, prior to the full-blown expression of acute tissue injury, potentially resulting in better outcomes. Critical to such early mitigation and treatment is the accurate presymptomatic evaluation of exposure.

The recent emphasis the United States Government has placed on the development of radiation countermeasures for normal tissue injury reflects concerns about the potential use by terrorists of radiological or nuclear weapons. The scenarios of greatest concern would result in the exposure or potential exposure of large numbers of people and intense pressure on first responders to initiate appropriate treatment as soon as possible. The current diagnostic gold standard in the field of radiation biodosimetry, the cytogenetic analysis of radiation-induced chromosome aberrations, is labor-intensive and slow, and its use in mass casualty situations would be problematic.

The United States Government has therefore promoted the development of both enhanced operational capabilities in the area of radiation biodosimetry as well as improved, high-throughput approaches to the diagnosis of radiation injury. The enhancement of operational capabilities includes the augmentation of radionuclide bioassay capabilities at CDC as well as the development, in theory, of a network of coordinated laboratories capable of performing radiation biodosimetry. The development of improved, high-throughput approaches to the diagnosis of radiation injury includes the targeted evaluation of physical, functional, and biochemical indicators of radiation-induced physiological damage. The techniques under study include radiation-induced cytogenetic, genomic, proteomic, metabolomic, immunologic, and physico-chemical approaches predictive of radiation injury. A rational architecture of triage and definitive diagnosis using an array of physiologically informative techniques is envisioned as the ideal operational endstate and will be described briefly.