

Laboratory Automation for Cytogenetic Biodosimetry and Inter-Laboratory Comparison of the Dicentric Assay

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The dicentric chromosome assay (DCA) is the "gold standard" biodosimetry method for radiation dose assessment. The DCA can be used for quickly assessing dose to individuals in the early period aftermath of a radiological or nuclear incident for optimum medical aid. DCA's application in radiation mass casualties necessitates greater sample processing and chromosome aberration analysis capacity. Therefore, automated sample processing, chromosome aberration analysis, and establishment of a co-operative network of cytogenetic laboratories are essential. Recent efforts at the Armed Forces Radiobiology Research Institute (AFRRI) focussed on increasing sample processing via automation, technology integration, and implementation of a laboratory information management system (LIMS) for resources and data. We developed a high-throughput, flexible, modular, and scalable robotic blood handling system, which represents a "beta" version for automated blood handling aiding increased throughput. Other components of the automated cytogenetic biodosimetry laboratory include sample and reagent bar-code tracking, metaphase harvesters and a spreader, slide stainer, a high-throughput metaphase finder, and multiple satellite chromosome-aberration analysis systems all integrated with LIMS.

Because use of a cooperative network for chromosome aberration analysis and dose assessment by DCA requires routine quality control exercises among partner laboratories, the National Institute for Allergies and Infectious Diseases (NIAID) and AFRRI sponsored an interlaboratory comparison study to determine DCA's validity and accuracy among five laboratories following the guidelines of International Organization for Standardization. Blood samples irradiated at the AFRRI were shipped to all laboratories, which constructed individual calibration curves in the 0.0- to 5.0-Gy range for 60-Co gamma-rays and assessed the dose to dose-blinded samples. For all laboratories, the estimated coefficients of the fitted curves were within the 99.7% confidence intervals (CIs); but the observed dicentric yields differed. When each laboratory assessed radiation doses to four dose-blinded blood samples by comparing the observed dicentric yield with the laboratory's own calibration curve, the actual doses were within 99.75% CI for the assessed dose. Across the dose range, the error in the estimated doses, compared to the physical doses, was from 15% underestimation to 15% overestimation.

Our efforts to improve diagnostic biodosimetry response by the DCA aiding optimum medical treatment for radiation exposed individuals in mass casualties.

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