Integrating Biological Dosimetry into Planned Medical Radiation Exposure

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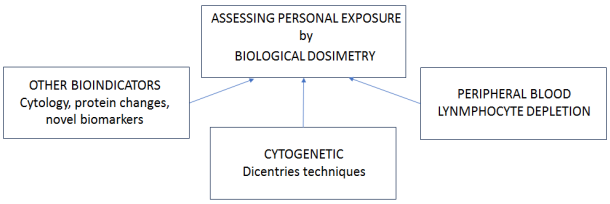
Riassunto

Biological dosimetry is a critical tool in radiation protection and that relies on the quantification biological markers, such as chromosomal aberrations, gene expression, or protein biomarkers, to estimate the absorbed dose. It is particularly valuable in scenarios where physical dosimetry is not feasible or when individual monitoring is required. It is most commonly employed in the aftermath of radiation accidents**,** such as nuclear plant incidents, radiological terrorism, or accidental exposure in medical or industrial settings. In these cases, biological dosimetry can be used to rapidly assess the radiation exposure of affected individuals, enabling the appropriate medical intervention, monitoring, and risk assessment.



Biological dosimetry methods for assessing individual exposure dose

While peripheral blood lymphocyte depletion is already used in radiotherapy for monitoring patients undergoing treatment, other techniques—particularly cytogenetic dicentric chromosome analysis which is standardized according to ISO 21243:2008—are not commonly employed despite scientific research supporting their effectiveness. For many years, these techniques remained limited to niche applications due to the complexity of their implementation: they are time-consuming, labor-intensive, and require expert interpretation, which restricts their scalability in mass-casualty situations and their use in non-emergency settings. However, with recent advances in scientific understanding and technological development, these techniques are beginning to be applied in other exposure scenarios, including both existing and planned exposures, making their use more feasible.

Biological dosimetry can be utilized in radiation therapy to assess the radiation dose received by patients under atypical clinical conditions. For example, it can be employed to evaluate different radiotherapy modalities, assess the impact of concurrent chemotherapy, and estimate exposure in cases of partial-body irradiation. In diagnostic radiology, particularly during high-dose procedures such as computed tomography (CT) scans, angiographic studies, and fluoroscopically guided interventional surgeries, patients may undergo multiple exposures over time, leading to significant cumulative radiation doses. In nuclear medicine, dicentric chromosome analysis can be used to assess individual radiation doses, thus offering an advantage over standardized procedures. This study aims to focus on planned medical exposures by reviewing the existing literature.