Pathway to a Paradigm: The Linear Nonthreshold Dose-response Model in Historical Context: The American Academy of Health Physics 1995 Radiology Centennial Hartman Oration

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This paper traces the evolution of the linear non-threshold dose-response model and its acceptance as a paradigm in radiation protection practice and risk analysis. Deterministic effects such as skin burns and even deep tissue trauma were associated with excessive exposure to x rays shortly after their discovery and carcinogenicity was observed as early as 1902. Still, it was not until 1925 that the first protective limits were suggested. For three decades these limits were based on the concept of a tolerance dose which, if not exceeded, would result in no demonstrable harm to the individual and implicitly assumed a threshold dose below which radiation effects would be absent. After World War II, largely because of genetic concerns related to atmospheric weapons testing, radiation protection dose limits were expressed in terms of a risk based maximum permissible dose which clearly implied no threshold. /The 1927 discovery by Muller of x-ray induced genetic mutations in fruit flies, linerar with dose and with no apparent threshold, was an important underpinning of the standards. The linerar nonthreshold dose-response model was originally used to provide an upper limit estimate of the risk, with zero being the lower limit of low-level irradiation since the dose-response curve could not be determined at low dose levels. Evidence to the contrary such as hormesis and the classic studies of the radium dial painters notwithstanding, the linear nonthreshold model gained greater acceptance and in the centennial year of the discovery of x-rays stands as a paradigm although serious questions are beginning to be raised regarding its general applicability. The work includes a brief digression describing the work of x-ray protection pioneer William Rollins and concludes with a recommendation for application of a de minimis dose level in radiation protection.

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