Obtaining an Unbiased Estimate of Intake in Routine Monitoring When the Time of Intake is Unknown

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A common problem in internal dosimetry occurs in routine monitoring, when it is required to estimate an intake from a measurement made at the end of a monitoring interval, and the time of intake is unknown. ICRP suggests that, in these cases, it should be assumed that the intake occurred in the middle of the monitoring period. However, it has been shown that this will, in the long term, lead to biased estimates of a worker's intake and dose. In order to overcome this biasing, the United States Department of Energy (USDOE) recommends a different method based on calculating the intakes for all possible intake-times in the interval, and then taking an arithmetic average. In this paper, it is shown that both the ICRP and USDOE methods are biased. An alternative method is suggested, which assumes a constant chronic intake throughout the monitoring interval. Monte Carlo simulations are used to estimate the magnitude of bias for two realistic monitoring programmes using all three methods. It is shown that the proposed method is unbiased and also yields estimates of intake that are generally closer to the actual intake, than the other two. The Monte Carlo conclusions are backed up by a theoretical analysis of bias. Finally, the source of bias in the apparently intuitive approach of the USDOE method is revealed by viewing the problem from a Bayesian perspective.

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