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Study on detection efficiency response of standing whole-body counter based on multi-size voxel phantoms

[Background] The standing whole-body counters are widely used for in-vivo measurements, such as ORTEC-StandFAST, CANBERRA-FASTSCAN, CIRP-StandWBC. They are mainly designed to quickly and accurately measure internal contamination of radionuclides with medium and high photon energy. The physical phantoms such as BOMAB, IGOR, sBCAM have been used for whole-body counting calibrations. However, these simplified phantoms cannot fully represent all the characteristics of the human body, furthermore, the phantom parameters are based on the reference human body, which cannot represent workers with different body shapes and sizes. To date, there is a lack of understanding about the detection efficiency response as a function of phantom sizes and photon energy.
[Methods] The Monte Carlo method was used to simulate and analyze the detection efficiency response of standing whole-body counter to multi-size voxel phantoms. The whole-body counter is ORTEC-StandFAST II. The multi-size voxel phantoms are Chinese adult male individualized voxel phantoms, with a height range of 155cm~185cm and a weight range of 42kg~103kg; The photon energy range is 80kev~1836kev. In this paper, the body build index (BBI,) is introduced to analyze the influence of human body size on the detection efficiency response of whole-body counter.
[Results] Compared with the detection efficiency of the calibration phantom, the relative deviation range of the detection efficiency response of the whole-body counter to other sized voxel phantoms is -20.15%~33.03%. A function was also found that related detection efficiency to BBI and photon energy. Based on this function, The deviation of detection efficiency between the calculated value based on this function and the simulated value is within -4.41%~8.15%.
[Conclusion] This paper presents a study on the detection efficiency of standing whole-body counter obtained from Monte Carlo simulations of multi-size voxel phantoms. The results show that the detection efficiency of whole-body counter largely depends on the phantom size, and the function can be used to modify the efficiency calibration results for a given individual, which can effectively improve the measurement accuracy of the whole-body counter.

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