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abstract

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Validation of the Siemens Biograph MCT 64S 3R PET/CT Simulation Model Using the NEMA Standards Approach

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Introduction: Medical imaging plays a crucial role in diagnosing cancer and other diseases, where the accuracy and reliability of diagnostic information from medical images are essential for effective treatment. Therefore, this study applies internationally accepted NEMA standards to validate GATE – based Monte Carlo simulations of the Siemens Biograph mCT 64S 3R PET/CT scanner, aiming to enhance imaging accuracy and optimize protocols for local clinical use.

Methodology: The Siemens Biograph mCT 64S 3R PET/CT scanner was modeled in GATE and validated per NEMA standards for Noise Equivalent Count Rate (NECR), Scatter Fraction (SF), and sensitivity. Forty-five F-18 activity levels, ranging from 852.71 MBq to 3.3 MBq, were simulated at 15-minute intervals during radioactive decay to assess NECR and SF. Sensitivity was measured at 0 cm and 10 cm offsets from the central axis, beginning with 5.4 MBq of F-18. Five aluminum sleeves from the sensitivity phantom were sequentially removed, with 5.4 MBq of F-18. Five aluminum sleeves from the sensitivity phantom were sequentially removed, with each scan acquiring at least 10,000 true counts per slice to determine effective sensitivity.

Results: Simulated peak NECR of 102.6 ± 0.05 kcps and SF of 34.2 ± 0.08% were observed at 662.42 MBq. The NECR differs by 4.7% from the clinical value of 107.6 kcps, while the SF differs by 7.5% from the clinical value of 36.98%. Usually, deviations under 10% are generally acceptable for simulation validation. Sensitivity at 0 cm and 10 cm offsets showed strong agreement, with simulated values of 6.93 kcps and 7.03 kcps closely matching clinical values of 6.48 kcps and 6.53 kcps.

Conclusion: The validated GATE - based simulation of the Siemens Biograph mCT 64S 3R PET/CT scanner showed strong agreement with clinical data, confirming its reliability for optimizing imaging protocols and enhancing diagnostic accuracy in local clinical settings.

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