Abstract

The patient is the primary source of occupational scatter radiation in diagnostic radiology, necessitating characterization of site-specific scatter dose to guide accurate implementation of protection measures. The study assessed the levels and spatial distribution of scatter doses by recreating a full-scale 3D Geant4 Monte Carlo code of the diagnostic X-ray room at Kitui County Level V Hospital. Simulations were performed at 120 kVp exposures, and the spatial scatter absorbed dose was scored at designated operator positions P_0–P_7 ranging from 0.25 m to 2.0 m at a height of 1.0 m for ambient dose equivalent H(10) calculations. The model was validated using a calibrated NT6102 survey meter under matched beam conditions. Agreement between experimental and simulated dose rates was within ±10 %, suggesting the model can be used reliably in dose estimations. Following validation, the model was applied to evaluate the effects of varying tube potential, field size, operator source distance, a mobile lead glass barrier, and protective gear during exposure. The combined practical optimization strategies reduced the scatter dose significantly by over 90 %. Increasing distance from 0.25 m to 2.0 m reduced scatter dose by over 97 %. The results demonstrate that the use of lead aprons and increased operator distance are quantitatively effective in reducing occupational dose, consistent with ALARA principles.