VALIDATION OF PLANNED RADIATION ABSORBED DOSE FOR BREAST CANCER TREATMENT USING RADIOMETRIC FILM DOSIMETER

T.B. Dery

Department of Physics – University of Cape Coast

Abstract— **Background:** GLOBOCAN estimates indicate that 4645 new cases were diagnosed and 1871 death occurred due to breast cancer in Ghana in 2018; making it the commonest female cancer and a major public health problem. According to the World Health Organization report, 40% of the cancer cure results from radiation therapy that uses high-energy particles to destroy cancer cells. The essential role of radiotherapy is to ensure the detection and treatment of breast cancers using appropriate doses. The unintended detriments in the treatment and the risk of secondary cancers are mostly associated with delivering much higher doses than the planned dose. To ensure the facilities in Ghana implement quality control measures, this study focused on using phantoms for the determination, and comparison of planned doses with actual doses delivered to the breast, during radiation treatment. To achieve this, the major limitation of the non-availability of phantoms was addressed by the construction of phantoms. **Methods:** Based on scanned images, two phantoms namely Adelaide phantoms "A" and "B" were constructed using perspex and locally procured materials to mimic the surrounding tissues of the human female thoracic cavity. Balloons, mango seed, cassava stick, and candle were radiologically assessed and used as surrogates for the lung, heart, spinal cord and glandular tissue of the breast respectively. Radiochromic EBT3 film dosimeter was used with the standard (anthropomorphic) and Adelaide phantoms to measure doses absorbed by the breast and non-target organs; the doses were delivered from cobalt-60 (^{60}Co) and linear accelerator (LINAC) systems of energies 1.25 MeV and 6 MV respectively. Monte Carlo N-Particle (MCNP) transport code was also used on a virtual phantom to compute the dose distribution from the cobalt machine. and validated with experimental measurement. **Results:** The deviations of delivered doses from planned doses when the standard anthropomorphic phantom, constructed phantoms "A" and "B" were used, ranged as follows, -0.05 – 0.03 Gy; -0.08 – 0.01 Gy; -0.14 – 0.01 Gy respectively, when the radiation was delivered by a Cobolt-60 machine. When the radiation was delivered by a linear accelerator system, the deviations were -0.05 – 0.03 Gy; -006 – 0.07 Gy; -0.06 – 0.04 Gy respectively. The spinal cord absorbed the lowest dose of 0.03±0.02 Gy and 0.05±0.01 Gy, while the left lung received the highest doses of 0.74±0.04 Gy and 0.78±0.01 Gy for Co-60 and linear accelerator system respectively.

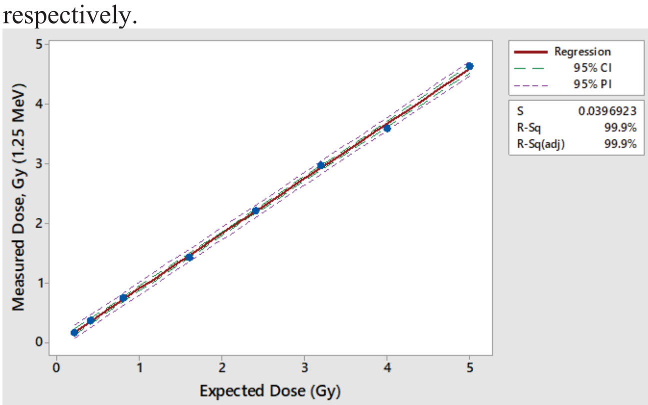

Fig. 1. Measured Dose versus Expected Dose for 1.25 MeV

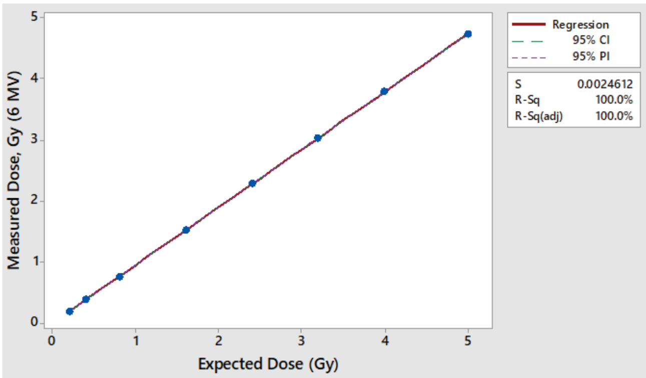

Fig. 2. Measured Dose versus Expected Dose for 6 MV

Based on the findings, it was clearly determined that the target organ received the expected dose within the acceptable tolerance level of 5%. Additionally, the non-target organs equally received a minimum radiation dose according to required standards and within dose constraints.

The MCNP generated a more fitting model for the relationship between dose and depth, and the absorbed doses simulated at many points were greater at the entrance surface, compared with the doses deeper within the phantom. The Monte Carlo simulation estimated for absorbed dose was below 5% of the acceptable tolerance.

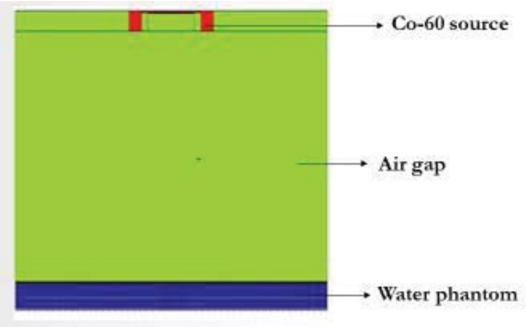

Fig. 3. Geometric view of MCNP simulation.

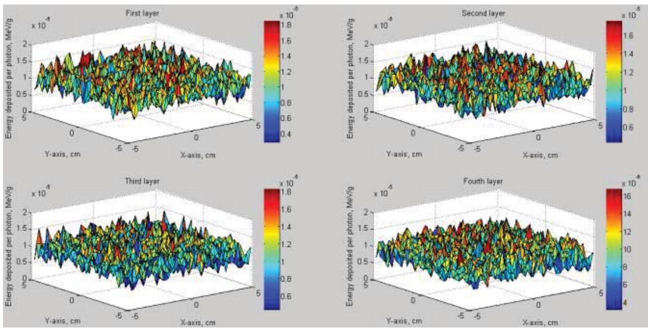

Fig. 4: Energy deposition at the depth within the virtual phantom.

The model computed the dose in each voxel in each layer by transporting several millions of particles based upon probability theory of interaction with the virtual phantom mimicking the patient. This is because radiotherapy involves finding the precise location of a tumour and optimizing the intensity of the radiation and the orientations of the beams shaped to match the plan delineation of the tumour.

Conclusion: A non-clinical significance differences of planned and delivered doses were achievable following appropriate quality control both with anthropomorphic and constructed phantoms. The study has demonstrated that local materials are potentially useful for the construction of phantoms, which can be good substitutes for standard commercial phantoms in ensuring the safety of patients under-going radiation treatment for breast cancer.

Keywords — Dosimetry. Cobalt-60. Monte Carlo. Phantom. Radiochromic film. Radiotherapy.