Purpose: AccuBoost® applicators are designed to deliver boost dose after whole breast irradiation in substitution for electron boost. By augmenting the current design through adding a wedge inside the applicator and a tungsten window above the skin surface, the AccuBoost applicators can be used to treat skin cancer. This study aimed to design a skin applicator that could deliver brachytherapy in a conformal and homogeneous manner to the skin while minimizing OAR dose.

Methods: The 6 cm round AccuBoost applicator served as the foundation for variations of an internal cone, internal wedge, and external window. Monte Carlo (MC) methods (MCNP5) were used for dose characterization and design optimization of these tungsten-alloy components. Specifically, the cone, wedge, and window dimensions were iteratively varied in MC simulations based on HDR Ir-192 dose distributions having (0.5 mm)^2 voxels in a soft tissue phantom. The design goal was an applicator that can protect tissue > 5 mm while providing lateral dose conformity and a homogeneous dose distribution for tissue < 3 mm.

Results: The internal wedge angle governed field size to be irradiated, limiting depth-dose spread into the phantom. Dose conformity was enhanced by the internal cone and collimating window. Window thickness increased required treatment time, where 3 mm was determined to be optimal when considering tradeoff between depth dose and dose rate. With a lesion thickness of 3 mm and setup uncertainty of 1 mm, the optimal design provided better lateral coverage at d = 5mm. Here, the dose was less than 30% of that within the treatment aperture.

Conclusion: Standardized criteria were established for dose optimization of a skin applicator. Using these criteria and MC methods, an optimized design was obtained. Optimization is underway for other applicator diameters. Clinical evaluation within a 3D treatment planning system and comparison with other brachytherapy skin applicators is ongoing.

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Prof. Rivard is a stakeholder of Advanced Radiation Therapy, LLC.