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Dosimetric Feasibility of Applying the Fast Forward Trial Protocol for Breast Radiotherapy Using a Co-60 Machine in Resource-Limited Settings

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In a significant development for global radiation oncology, a study conducted at the Teaching Hospital, Badulla, Sri Lanka has demonstrated the potential of delivering the Fast Forward breast radiotherapy protocol using cobalt-60 (Co-60) machines. Originally designed for advanced linear accelerators, the Fast Forward protocol's successful adaptation to Co-60 systems could provide a breakthrough in cancer treatment for low-resource countries.

This research, presented at **ICARO-4 (International Conference on Advances in Radiation Oncology)**, evaluates the dosimetric feasibility of implementing the 26 Gy in 5 fractions Fast Forward regimen on Co-60 equipment and compares it with the conventional 40 Gy in 15 fractions regimen in right-sided breast cancer patients. The study was led by Oncologist **Dr. P.K.D.P. Alahakoon (MD)** and Medical Physicists **Buddhika Srimal Sesath (MSc)** and **J.H.J.K. De Silva (MSc)**.

The Fast Forward trial, developed for modern linear accelerators (LINACs), demonstrated clinical safety and efficacy in reducing treatment time for breast cancer patients by using larger dose fractions over a shorter schedule. However, applying this regimen on Co-60 teletherapy machines, still widely used in many low- and middle-income countries, presents unique challenges due to their physical limitations, such as lower photon energy and broader penumbra.

Hypofractionated radiotherapy offers significant advantages: shorter treatment duration, increased patient throughput, and potentially improved patient compliance—critical benefits for overloaded public health systems.

This study explored whether these modern protocols could be adapted for legacy equipment without compromising treatment quality or patient safety. The primary objective of this study was to assess the dosimetric feasibility of delivering the Fast Forward breast radiotherapy protocol—administering 26 Gy in 5 fractions—using a cobalt-60 (Co-60) machine, which is more commonly available in resource-limited settings. A secondary goal was to compare the outcomes of this hypofractionated regimen with the

conventional 40 Gy in 15 fractions treatment. The study focused on evaluating critical treatment planning parameters such as planning target volume (PTV) coverage, radiation doses to the heart and lungs, and dose homogeneity. Special attention was given to analyzing differences in dosimetric outcomes between patients who underwent mastectomy (MA) and those who received wide local excision (WLE), in order to determine the protocol's suitability across diverse clinical scenarios.

The study included a total of 74 patients diagnosed with right-sided breast cancer, comprising 39 individuals who underwent Modified Radical MA and 35 who received WLE All patients were planned using the PCRT-30 protocol for 3D-Conformal Radiotherapy (3D-CRT) delivered with a cobalt-60 (Co-60) unit. In accordance with the Fast Forward protocol guidelines, the CTV, PTV, and OARs were carefully delineated. Treatment planning involved the use of two tangential glancing beams with wedges, a widely accepted technique to effectively cover the breast or chest wall. Particular attention was given to ensuring uniform PTV coverage and optimizing dose homogeneity, while simultaneously minimizing radiation exposure to critical organs such as the heart and lungs.

DOSE PER FRACTION (GY)	KEEP 30% OF DOSE TO < 15% OF IPSILATERAL LUNG VOLUME	KEEP 25% OF DOSE TO < 5% OF HEART VOLUME	KEEP 5% OF DOSE TO < 30% OF HEART VOLUME
2.67	12.0 Gy	10.0 Gy	2.0 Gy
5.2	8.0 Gy	7.0 Gy	1.5 Gy

Table 1: Dose Constraints for OARs

The use of Co-60 presented several technical challenges in the context of breast radiotherapy. One of the primary limitations was its lower photon energy compared to LINACs, which reduced beam penetration and increased scatter, thereby affecting overall dose distribution. Additionally, Co-60 systems produce a larger penumbra, resulting in less precise dose conformity at the field edges and making it more difficult to spare adjacent OARs, such as the heart and lungs. These factors necessitated increased planning efforts to reduce hot spots and ensure a consistent and uniform distribution across the PTV, while still maintaining treatment effectiveness and safety.

The results of the study highlighted several key findings related to dose homogeneity and OAR sparing. In terms of dose homogeneity, WLE plans demonstrated superior performance, with a lower average HI of 0.51 compared to 0.68 in modified radical MA plans, indicating more uniform dose distribution in WLE cases. Regarding heart dose, MA plans consistently resulted in lower mean heart doses across both the 26 Gy and 40 Gy regimens. However, in both MA and WLE plans, a relatively higher percentage of heart volume received 5% of the prescribed dose, although less than 5% of the heart volume received 25% of the total dose in either treatment regimen, remaining within acceptable constraints. Lung dose metrics also showed promising results, with the volumes of lung receiving 30% of the dose being similar in both dose schedules. The differences in lung dose between MA and WLE groups were minimal, underscoring the ability of Co-60 systems to adequately spare lung tissue with careful treatment planning.

The study demonstrates that WLE plans provide superior dose homogeneity, which may contribute to better long-term cosmetic outcomes and a reduced risk of radiation-induced complications. Conversely, modified radical MA plans, although less homogeneous, consistently result in lower mean heart doses—likely due to the increased distance between the heart and chest wall in post-mastectomy patients. Importantly, both MA and WLE plans successfully met established dose constraints for the heart and lungs under both the Fast

Forward protocol and the standard regimen. These results strongly support the clinical feasibility of delivering the Fast Forward protocol using Co-60 machines for breast radiotherapy, making it a viable treatment option in resource-limited settings.

The study was inspired by the outcomes of the UK FAST and FAST- Forward trials and demonstrates how global radiotherapy guidelines can be adapted for low-resource environments. It paves the way for more equitable access to evidence-based cancer care worldwide. The research team acknowledges the foundational work of the UK Standardization of Breast Radiotherapy (START) trials.