

**PhD Thesis Title:** Dosimetric evaluation and characterization of Cobalt-60 source for brachytherapy and comparison with Iridium-192 source

**Author:** Rajni Verma

**Email:** 1989vermarajni@gmail.com

**Institution:** SMS Medical College and Hospital, Jaipur-302004 India

**Supervisor:** Prof. Arun Chougule

**Graduation Date:** 02May 2024

**Available Online:** NA

#### **ABSTRACT:**

Brachytherapy is one of the leading modalities for treatment of cancer due to its ability of high dose delivery to tumor with sharp dose gradient. The primary aim of the thesis work is to experimentally measure reference parameters significant for brachytherapy with Cobalt-60 source and its comparison with Iridium-192 source. It is well known that the primary standard for dose calculations in brachytherapy treatment planning is reported in AAPM TG-43 report. In this thesis work, in-phantom dose measurements were designed for experimental validation of AAPM TG-43 consensus data.

The present work of in-phantom dose measurement was designed to experimentally analyze or verify the brachytherapy dose calculation methodology recommended by the AAPM TG-43 report. This can also be considered as an experimental validation of TG-43 consensus data. At first, the radial profiles with respect to radial distance were obtained in water by the ionization chambers and solid-state detectors under AAPM TG-43 reference conditions. Secondly, these experimentally obtained radial dose profiles were used to calculate radial dose function as per the AAPM TG-43 formulation and compared with AAPM-TG 43 consensus data. In the present work, it was observed that due to a very sharp gradient of dose rate along radial distances the AAPM TG-43 reference point i.e., 1 cm from the source axis was very sensitive to radial distances and cannot be considered very suitable for analyzing the data. So, to rule out any chance of error or misinterpretation, for this study, the data was analyzed for two reference points i.e., 1 cm and 4 cm. Present work also explored the applicability of various detectors for experimental high-dose-rate (HDR) brachytherapy dosimetry and the role of Effective Point of Measurement (EPOM) and volume averaging in detector responses in HDR Co-60 dosimetry. It was observed that the individual properties or character of each detector was more crucial for accurate measurements instead of the type of detector. These results indicate that both the categories of the detector, solid-state and ionization chambers have several suitable detector options for HDR brachytherapy dosimetry, especially for Co-60 source. Micro diamond detector, solid-state detector and Semiflex chambers (small volume) in ionization chamber detector categories were found suitable for HDR brachytherapy experimental dosimetry.

In summary, the thesis work reported a reference design to perform experimental dosimetry in HDR brachytherapy for Cobalt-60 source and also verifies the AAPM TG-43 consensus data experimentally. Suitability of various dosimeters were tested for experimental brachytherapy dosimetry and found that the detectors with small volume and low energy dependence are detectors of choice for experimental dosimetry in HDR brachytherapy. As summarized in the present work, microDiamond and small volume Semiflex ionization chambers were found suitable for experimental dosimetry for the clinically relevant radial distances. Hence, the thesis work provided various dosimetric, radiobiological, clinical characteristics and safety aspects of Cobalt-60 and Iridium-192 radioactive sources used in HDR brachytherapy.

**References to author publications that relate specifically to the dissertation:**

1. **Verma R**, Jain GK, Chougule A. Implementation of safety and security standards for high dose rate brachytherapy sealed radioactive source used in a medical radiation facility. *Radiat Med Prot*. 2020;1(4):166-170. DOI: <https://doi.org/10.1016/j.radmp.2020.11.004>
2. **Verma R**, Jain GK, Chougule A. Dosimetric analysis of treatment planning optimization techniques for Co-60 and Ir-192 HDR brachytherapy sources in carcinoma cervix patients. *Libr Oncol*. 12 May 2022;50(1):3-9. DOI: [10.20471/LO.2022.50.01.02](https://doi.org/10.20471/LO.2022.50.01.02)
3. **Verma R**, Chougule A, Jain GK, Zakaria GA. Experimental validation of TG-43 brachytherapy dose calculation formalism for High Dose Rate Cobalt-60 brachytherapy source. *Proceedings of IRPA15 congress*. June 2022;1(2):1-8. Available from: <https://www.irpa.net/page.asp?id=54839>