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Calibration seed sampling for iodine-125 prostate brachytherapy

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Aims & objectives

Implanted iodine-125 seeds can be effectively used for low dose rate brachytherapy treatments for localised adenocarcinoma of the prostate. This technique requires that the air-kerma strength of the seeds be checked against the vendor-supplied calibration certificate.

Checks of multiple sources are difficult to achieve when seeds are packaged in a sterile cartridge, as test seeds must be extracted at the beginning of the surgical procedure. For these assemblies, AAPM report 98 recommends testing of 5% of the seeds or 5 seeds, whichever number is smaller.

Detailed statistical studies of source strength homogeneity, assaying methods and clinical impact of source strength inhomogeneity have been presented by various authors, though AAPM report 98 specifically recommends against the use of these approaches, in lieu of distribution characterisation.

Aims & objectives

In an effort to comply with the AAPM's published recommendations while producing results efficiently enough to avoid surgical delays, the Nucletron Seed-Selectron afterloader contains and array of diodes that assay all seeds as the implant is delivered, as a backup system, allowing the manufacturer to claim that only one seed from each batch needs to be assayed before the implantation procedure commences.

This study used experimental (rather than statistical) measurements to investigate the consistency of the strength of all seeds in three small batches of 10, 20 and 30 ^{125}I seeds, with the aim of identifying the optimal assay sizes required to achieve the AAPM recommended tolerance of 3% uncertainty and exemplifying the uncertainty that may be introduced if only one seed is assayed.

Materials and methods

Three cartridges of 10, 19 & 30 seeds from three different batches of ^{125}I seeds were obtained from the vendor. The seeds were manually extracted from the cartridges, and their air-kerma strengths were measured using a calibrated PTW SourceCheck ionisation chamber mounted in a PMMA block, using a method similar to that described by Perez-Calatayud et al.

Results were analysed by calculating

- the difference between the measured air-kerma strength for each seed and the decay corrected air kerma strength calibration certificate value for the batch,
- the difference between the measured air-kerma strength for each seed and the mean of all values for the batch,
- the mean of these differences, calculated over each batch and all batches combined.

Materials and methods

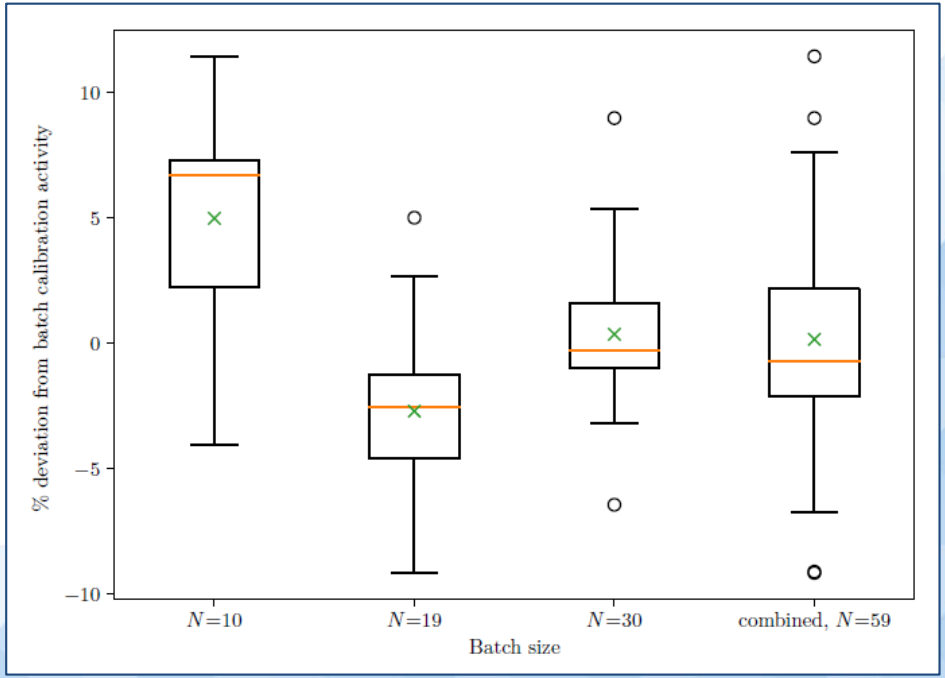
For each set of measurements, statistical sampling methods were used to characterise the 2σ standard deviation in the mean deviation between two values: the mean of air-kerma strength measurements for assays of size *n* and the mean of air-kerma strength measurements for the batch.

For the 10 seed and 19 seed measurement data, these values were calculated by iterative evaluation of all possible assay combinations. For the 30 seed and combined measurement data, random sampling methods were used to simulate the selection of random assays of random size.

A 2σ standard deviation was selected for evaluation because it would correspond to a confidence interval of approximately 95%, if the seed strengths were normally distributed, or a confidence interval of at least 75% if not.

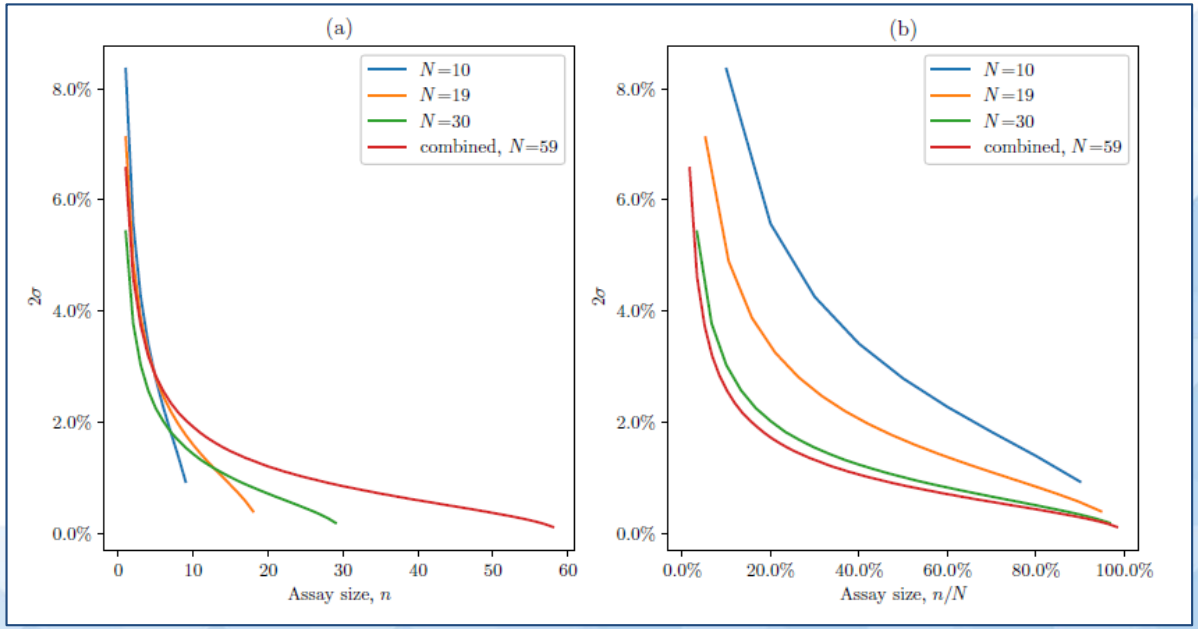
Results & discussion

Percent deviation between activity measurements and decay-corrected calibration activity values are presented.



Results & discussion

2σ for relative deviation between mean assay source strength (of assay size *n*) and mean cartridge source strength (of batch size *N*).



Results & discussion

For the cartridges containing 10, 19 and 30 seeds, the mean differences (±1σ) between seed and calibration air-kerma strengths were respectively 5.0%±4.4%, −2.7%±3.7%, and 0.4%±2.8%; with 80%, 53% and 17% of seeds disagreeing with calibration by more than 3%.

When *n*=5 seeds are assayed, the resulting air-kerma strength can be expected to be within 3% of the batch, supporting the AAPM recommendations.

Results were consistent with those reported by Perez-Calatayud et al., using the same dosimetry system and sources from the same vendor.

Conclusion

The results of this study support the AAPM recommendation that when checking the air kerma strength of LDR brachytherapy sources prior to implantation, an assay size of at least 5 seeds is needed to reduce uncertainty to within 3%.

An assay size of 7-9 seeds may be advisable, to reduce uncertainty due to assay size (and source strength variation) to within 1%, given the numerous other uncertainties affecting measurements of air kerma strength in a surgical setting.

The results produced in this study suggest that there may be a greater than 30% chance of one randomly selected seed having an activity that differs by more than 3% from the mean strength of all seeds in the cartridge.

References

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Conflict of interest

The authors declare that they have no conflict of interest.

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