OPTIMAL ASSAY SIZES FOR INTRAOPERATIVELY PLANNED $^{125}$I BRACHYTHERAPY

Scott Crowe, Tanya Kairn
Cancer Care Services, Royal Brisbane & Women’s Hospital, Herston, 4029, Australia
Science and Engineering Faculty, Queensland University of Technology, Brisbane, 4000, Australia
Contact: sb.crowe@gmail.com

BACKGROUND
- Implanted $^{125}$I seeds can be effectively used for LDR treatments for localised adenocarcinoma of the prostate.
- Technique requires that the air-kerma strength of seeds be checked against the vendor calibration certificate.
- Checks of multiple sources are difficult to achieve when seeds are packaged in a sterile cartridge; seeds must be extracted at the beginning of the surgical procedure.
- AAPM report 98 recommends testing of 5% of the seeds or 5 seeds, whichever number is smaller; and specifically recommends against the use of statistical methods described elsewhere in the literature.
- The Nucletron Seed-Selectron system contains an array of diodes that assay all seeds as the implant is delivered.
- Nucletron claim that only one seed from each batch needs to be assayed before the implantation procedure commences; but the literature suggests that this is not sufficiently precise to meet AAPM recommendations.

METHOD
- Study investigated 3 small batches of N=10, 19 and 30, to identify the optimal assay size, $n$, required to achieve the AAPM recommended tolerance of 3% uncertainty.
- Seeds were extracted from cartridges, and air kerma ($S_K$) measured using calibrated PTW SourceCheck chamber.
- The differences between measured $S_K$ for each seed and corrected certificate $S_K$ were calculated.
- Statistical sampling methods were used to characterise $2\sigma$ standard deviations in mean differences between the mean $S_K$ of assays of size $n$, (1<$n$<N-1), and the mean $S_K$ of the batch (N=10,19,30 or 59), of all combinations $S$:

$$\delta(n) = \frac{\sum_{i=1}^{n}(S_{Ki} - \bar{S}_K)^2}{n-1} \times 2$$

- Three 60 s readings were used for each measurement, which were adjusted for decay.

OBJECTIVE
- The aim of this study was to identify optimal assay sizes to achieve the 3% tolerance recommended by the AAPM, by experimental measurements to investigate the consistency of the strength of $^{125}$I seeds.

FINDINGS
- For three batches, N=10,19,30; 80%, 53% and 17% of seeds disagreed with vendor calibration certificate by >3%, respectively.
- $S_K$ within 3% of batch mean was achieved with random assays of 5 seeds. $S_K$ within 1% of batch mean was achieved with random assays of 7-9 seeds. See figures.
- >30% chance of random single seed $S_K$ differing from batch mean by >3%.
- Findings support recommendations of the AAPM, and agree with observations in the literature concerning distribution of $S_K$.
- Findings don’t support practice of single seed assay in surgical setting.

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For more information, see S. B. Crowe, T. Kairn, "Calibration seed sampling for iodine-125 prostate brachytherapy", IFMBE Proceedings 68(3): 459-462, 2019