AbstractID: 5759 Title: Effect of action level and uncertainties in daily imaging and re-positioning on the distribution of inter-fraction setup uncertainty

Purpose: To predict the post-correction probability distribution functions (PDFs) for inter-fraction setup uncertainty of individual patients who will undergo daily localization with an action level for setup correction.

Method and Materials: An analytical method was developed to derive the PDF at a given action level assuming 1) a Gaussian distribution for the pre-correction setup uncertainty, and including, 2) uncertainty in online localization, and also 3) the uncertainty with which patients can be re-positioned. An interactive spreadsheet was developed to evaluate and graph the PDF, as well as its mean and variance. Plots of the mean and variance of the PDFs predicted at different action thresholds for user specified (or patient-derived) levels of the three input uncertainties above were used to develop practical action level rules.

Results: When the variance of the localization uncertainty is the smallest of the three sources of uncertainty, there is an optimal action level that minimizes post-correction setup uncertainty. There is quantitative (and graphically demonstrated) improvement when σ_g^2, the sum of the variances of the localization uncertainty and re-positioning uncertainty, is less than σ_s^2, the variance of the pre-correction setup uncertainty. A practical rule is to set the action level to $\sigma_g(\sigma_s/\sigma_g)^{0.3}$ in these situations. The overlap of a resulting PDF with a Gaussian distribution with the same mean and variance is typically well over 90% when the action level is set according to this rule.

Conclusion: The analytical method developed here is a useful tool to estimate the post-correction setup uncertainty at different action levels, and to set rules for clinical specification of the action level in cases where the precisions of localization and setup correction allow an improvement. It also permits evaluation of potential improvements in post-correction setup uncertainty associated with improved precision in daily localization and/or patient repositioning.