Purpose: The aim of this study is to verify the calculation of rectal equivalent uniform dose (EUD) using the Gaussian error function (GEF), which can reduce the dose-volume database to enhance the computing efficiency.

Methods: For a group of 20 prostate patients, cumulative dose-volume histograms (cDVHs) for the rectum, shifted in the anterior–posterior directions based on a 7-beam IMRT plan, were calculated and modeled using the Pinnacle3 treatment planning system (TPS) and GEF, respectively. The range of rectal shift for each patient was measured by daily electronic portal imaging with fiducial gold markers in the prostate. The shape of cDVH curve was fitted into the GEF model, and then the cDVHs were converted to corresponding differential DVHs to calculate the rectal EUDs in each interfraction organ motion.

Results: Rectal EUD was calculated per fraction to determine the equivalent dose at each movement step. Our results showed that rectal EUDs increased as the rectum shifted to anterior direction and decreased in the posterior direction. Moreover, it is found that rectal EUDs have a negative linear relationship with respect to the organ displacement. Based on the results, the patient with the smallest prostate (volume = 40 cc) in the group received the highest rectal EUD when the rectum shifted 8 mm anterior. Percentage difference of rectal EUD using the TPS and GEF has been calculated for each movement. Since the results are less than 0.5%, the GEF model is considered a good potential alternative of the TPS.

Conclusions: We concluded that the calculation of rectal EUD using the GEF model was validated with error less than 0.5%.