AbstractID: 1369 Title: A Comparative Study of Rectal Dose Histograms in Prostate Brachytherapy: Some Analytic and Numerical Results

A cumulative dose histogram is the graph of an integral function integrated over a domain $V \subset R^3$ and is dubbed the dose-volume histogram (DVH), the dose-surface histogram (DSH) or the dose-wall histogram (DWH), depending on the dimension and structure of the region V. The first part of the paper presents a comparative study of the three rectal dose histograms for a cylindrical model of the rectum and also for sixty real patient data; in particular, the DSH and DVH for the cylindrical model with one point source are computed analytically in terms of elliptic integrals. The difference among the three relative dose histograms, averaged over the sixty patients, is less than 5%, whereas for the absolute counterparts -- which are actually more relevant for toxicity studies -- the difference can be as large as $3\sim12cm^3$ in the range 60~100Gy. The second part of the paper contains an error analysis of the computation of the dose histograms. Realistic seed distributions and two simple models of the rectum, for which the true DSH and DWH can be computed via numerical integration, are used to evaluate the effect of digitization. The digitized computation agrees quite well with the pre-digitization numerical integration, within 1% or $0.2cm^3$, because of the low dose-gradient effect near the rectum in prostate brachytherapy. The sampling and geometric errors are in some sense ``local'' over the range of dose, but the uncertainties in contouring the rectum could lead to large global errors, which nevertheless obey a scaling behavior under uniform deformations.