Purpose:To develop an empirical method for estimation of doses to critical structures of children undergoing kV-CBCT imaging for image-guided radiotherapy.

Methods:Forty pediatric patients were retrospectively assorted into four groups by gender and scanned sites with approval of IRB. Critical structures in CT images were delineated on Eclipse treatment planning system and were subsequently packaged into patient CT phantoms for Monte Carlo simulations. A benchmarked EGS4 Monte Carlo code was used to calculate 3D dose distributions produced by High-quality head and Pelvic protocols that were pre-defined by manufacturer. The ratios of irradiated volume over longitudinal length (V/L) and the equivalent sphere diameters (ESDs) were calculated by Eclipse. In accordance with the scanned region, either occipital-frontal circumferences (OFCs) or hip circumferences (HIPs) were calculated by DICOMan software. Regression was performed with SigmaPlot software suite where average standard errors of estimate (SEEs) were compared to evaluate the accuracy of regression and reliability of various parameters.

Results:For both sexes, mean doses of all critical structures were observed to decrease linearly with the increase of all physical parameters including age, weight, V/L, ESD, OFC, and HIP. As suggested by smaller standard errors of estimates, OFC and weight are recommended for head dose estimation while ESD and weight are more appropriate for pelvic/abdominal dose regression. Unique empirical functions for the estimation of doses to critical organs for male or female patients are presented which make a personalized dose assessment readily feasible.

Conclusions:Using Monte Carlo simulations in a population of 40 selected children, kV-CBCT doses were found highly correlated with body sizes of children. Considering uneven body development levels among children of same age, OFC and weight are recommended primarily for dose estimation in head, while weight and ESD are preferred for pelvic dose assessment.

Funding Support, Disclosures, and Conflict of Interest:

This work was partially supported by National Basic Research Subject (973) of China (No.2011CB707701), China Scholarship Council (No. 2010601107), and Joint Research Foundation of Beijing Education Committee, China (No. JD100010607)