Automated organ dose calculation for thousands of computed tomography scans

Currently available CT dosimetry tools such as CT-Expo or CTDosimetry are based on simplified human anatomy and are difficult to use for a large scale dose reconstruction. We developed more accurate and automated method to assess organ and effective doses by using previously-published dose database\(^1\)\(^2\) and tested it for about 4,000 CT scans. The following equation was designed to calculate patient- or scan-specific dose by using the pre-calculated doses normalized by $\text{CTDI}_{\text{vol}}$ of the reference scanner and user input (body part scanned, age, scan length, gender, $\text{CTDI}_{\text{vol}}$, kVp, and mAs). A batch computing routine was developed to import the abstracted patient/scan parameters and perform automatic dose calculation.

$$D(\text{mGy}) = \frac{\sum_{z=\text{SS}}^{\text{SE}} d(\text{organ, age, sex, v, z})}{\text{CTDI}_{\text{vol, Reference}}(v)} \cdot \text{CTDI}_{\text{vol}}(v) \cdot t \cdot I$$

where

- $D$ (organ, age, sex, $v$, $z$) is the organ dose per 1 cm axial slice at longitudinal position $z$ on the phantom and normalized to 100 mAs;
- $z$ is the slice number ranging from the top of the head to the bottom of the patient’s feet;
- SS designates the slice number where scan starts;
- SE designates the slice number where scan ends;
- $v$ is the tube potential (kVp) of the particular CT scan;
- $\text{CTDI}_{\text{vol, Reference}}(v)$ is the CTDIvol measured on the reference scanner;
- $\text{CTDI}_{\text{vol}}(v)$ is for the particular scanner for which organ doses are sought;
- $t$ is the single rotation time (sec); and
- $I$ is the tube current (mA) for that particular CT scan.

Organ and effective doses for 3,982 scans were successfully calculated by using the batch routine where the abstracted parameters were imported. Illustrative analysis of the relationship between brain dose and age (left) and scan length (right) for 100-150 mAs boundary. Subset of the scans was selected for comparison with CT-Expo which showed that the realistic anatomy and higher age resolution are crucial for accurate CT dosimetry.

Reference