AbstractID: 3814 Title: Statistical reconstruction of X-ray CT images from energy-integrated signals: a simulation study.

Purpose: Statistical reconstruction (SR) algorithms have the potential to significantly reduce X-ray CT image artifacts due to a more realistic model of the detector signal acquisition process. Most SR algorithms assume that the CT detectors are photon-counting devices and generate Poisson-distributed signals. However, actual CT detectors integrate energy and exhibit compound Poisson distributed signal statistics. The goal of this study is to assess the impact on image quality of the resultant mismatch between the detector and signal statistics models assumed by the sinogram and the reconstruction algorithm. **Method and Materials:** A 2D CT projection simulator software was created to generate synthetic polyenergetic transmission data assuming i) photon-count signals with simple Poisson distribution and ii) energy-weighted compound Poisson distributed signals. An Alternating Minimization (AM) algorithm was used to reconstruct images from the data models i) and ii) for a typical abdominal scan protocol and for incident particle fluence levels ranging from 10^5 to 1.6×10^6 photons/detector. The phantoms simulated included normal soft tissue, bone, and metal inserts. The images reconstructed from data models i) and ii) were compared by visual inspection and quantitative image-quality measures. **Results:** Substantial streaking artifacts appear in images formed from energy-integrated data when the AM algorithm assumes a particle-fluence spectrum $\overline{\Phi}_0(E)$. Once AM's spectrum is replaced by the energy-fluence spectrum $E \cdot \overline{\Phi}_0(E)$, AM correctly predicts the data means and eliminates the artifacts. With the energy-weighted spectrum, the reconstructed image quality from data models i) and ii) does not differ significantly even when SNR is very low. **Conclusion:** Mismatch between the actual and assumed CT detector signal statistics does not significantly degrade image quality once systematic data means mismatches are corrected. Within the context of statistical image reconstruction, there appears to be no benefit to develop more complex statistical reconstruction algorithms based upon energy-integrating detector signal statistics models.