

Computed tomography (CT) is the only current clinical modality which is fundamentally quantitative. While other modalities can in many cases be calibrated to deliver a linear response, the normalization with respect to water of the Hounsfield Unit is the standard in clinical CT imaging. Furthermore, gray scale in CT is linearly related to the concentration of injected iodine contrast agent, which is useful for CT-based organ function assessment. In addition to a quantitative gray scale, CT is a robust quantitative tool in regards to distances in three dimensions. Because of the straight-line assumption used in x-ray imaging including CT, in the absence of patient motion, distances, areas, and volumes can in principle be measured with accuracy. Modern multi-slice CT scanners allow thin section imaging, and thus the volume data sets produce near-isotropic spatial resolution. These properties of CT have led to a number of quantitative applications: CT has been used to quantify bone mineral density for almost 30 years, and this tool has proven useful in quantitative risk assessment in patients with osteoporosis. Researchers in pulmonary function have used CT to measure changes in the lung parenchyma over time. Organ perfusion measurements are commonly performed in the head for the evaluation in patients suspected of stroke or vasospasm, and abdominal organ perfusion measurements have also been studied in cancer patients. Computed tomography remains a primary tool for the assessment of tumor size, in monitoring the response to chemotherapy in cancer patients. While linear dimension assessment is a RECIST criterion, there has been a recent move towards tumor volume assessment to better capture tumor response. After a brief review of the fundamental properties of CT pertinent to its quantitative performance, a number of clinically used quantitative CT applications will be discussed. Issues of accuracy and precision will also be addressed. A discussion of the expansion of CT as a quantitative tool in other clinical applications will conclude this presentation.

Learning Objectives:

The physical basis for quantitative CT will be described

Current applications of quantitative CT will be outlined

The precision and accuracy of volume and HU metrics will be described

A list of potential future applications in quantitative CT will be presented.