AbstractID: 9843 Title: Advances and Quality Assurance in Gamma Camera & SPECT Systems

Single crystal gamma cameras, now in use for 40 years, have evolved slowly over time. Their size and shape may have changed, but the principal components remain the same: a NaI(Tl) crystal, array of photomultiplier tubes, and collimator. The greatest improvements in performance and stability have been through introduction of digitization and computer processing within the detector heads. The "digital" gamma camera of today consists of the same three major components, but with digitization occurring at the output of each photomultiplier tube. Digitization has added new quality assurance procedures, such as uniformity correction. Due to improved stability, the frequency of all quality assurance procedures may be re-evaluated.

Recently, "solid-state" gamma cameras with pixelated arrays of CsI and cadmium zinc telluride (CZT) have been introduced. The CsI has been coupled with position sensitive photomultiplier tubes or an array of solid-state photodetectors. Solid-state CZT detectors offer direct capture of the gamma energy to electrical energy signals, avoiding use of photodetectors, providing for improvement in energy resolution of 5-6%. These systems are much smaller in size and have been developed for special purpose imaging such as scintimammagraphy and sentinel node localization.

SPECT systems have evolved to include multiple gamma camera heads; two or three are most common. Overall system performance remains dependent of choice of collimator, imaging distance, and proper application of uniformity and center-of-rotation corrections. The use of non-circular detector orbits has reduced the imaging distance and thus improved image resolution. As an option, transmission imaging has been incorporated to provide data for applying attenuation correction on the reconstructed images. There are several available methods for transmission imaging, including the use of an incorporated CT system with rotating x-ray tube.

Of all the improvements added to SPECT systems, the most significant is the introduction of iterative reconstruction algorithms incorporating maximum likelihood methods of estimation. They have become the standard method for reconstruction of SPECT images. Accelerated methods using ordered sets are employed to reduce the overall reconstruction times. Requirements for low noise reconstructions, and filter methods for reducing the noise in the reconstructed images will also be presented.

Educational Objectives:

1. Learn the history of the development of the digital gamma camera used today and how digital improvements have changed quality assurance procedures.
2. Understand the process of uniformity correction applied to gamma camera images, and to evaluate the results of such corrections.
3. Understand the operation and use of various solid-state gamma camera systems.
4. Be able to perform routine SPECT system calibrations for uniformity and center-of-rotation corrections.
5. Be able to compare the methods of transmission imaging for performing attenuation correction on reconstructed SPECT images.
6. Become familiar with the ordered-set maximum likelihood iterative algorithms used for SPECT image reconstruction.
7. Understand the requirements for low noise reconstructions of SPECT images.