PhD Thesis Title: Impact of Pinhole Collimation on SPECT Image Quality Metrics, and Methods for Patient-Specific Assessment of Noise and Standardization of Imaging Protocols

Author: Sarah Grace Cuddy-Walsh
Email: sarah.cuddy-walsh@canada.ca
Institution: Carleton University
Supervisor: R Glenn Wells
Graduation Date: February 15, 2019
Available Online: https://curve.carleton.ca/1abe0fb1-75a0-4893-9743-9e336a63dc62

ABSTRACT:

Dedicated cardiac pinhole single photon emission computed tomography (SPECT) camera designs offer improvements in overall sensitivity, thereby enabling the use of lower injected radiotracer activity and shorter imaging times than parallel-hole designs. The effect of these novel camera designs on image noise on a voxel-by-voxel level has not previously been investigated. This work identifies the position and orientation-dependent variability of the spatial resolution in the field-of-view (FOV) of pinhole cameras. It also identifies a 1.7-fold gradient in the magnitude of image noise across the length of the heart which leads to a 1.3-fold gradient in the standard deviation values for a normal database for the attenuation corrected images acquired with a commercially available cardiac pinhole camera. This pattern of noise varies with different patients and with different positioning of the heart within the FOV. Thus, to assist with clinical interpretation, a new 1-minute post-processing technique is developed to provide a patient-specific image of the noise distribution which may augment normal database information. Changes in the attenuation result in varying levels of noise between patients of different body habitus, administered the same radiotracer activity. A method for creating weight-based protocols is developed that standardizes the average noise in cardiac perfusion images by tailoring the radiotracer activity and the acquisition time to the body mass of each patient. Methods developed in this thesis allow for more patient-specific imaging protocols, thereby standardizing the image noise level and providing physicians with more information about the noise and spatial-resolution distribution to aid in image interpretation.

References to author publications that relate specifically to the dissertation:

1. **Cuddy-Walsh, S.G**., Clackdoyle, D.C., Renaud, J.M., and Wells, R.G. (2021), "Patient-specific SPECT imaging protocols to standardize image noise." J. Nucl. Cardiol., 28: 225-233. https://doi.org/10.1007/s12350-019-01664-5
2. **Cuddy-Walsh, S.G**. and Wells, R.G. (2019), "Noise heterogeneity in attenuation-corrected cardiac SPECT images increases perfusion value uncertainty near the base of the heart." J. Nucl. Cardiol. https://doi.org/10.1007/s12350-019-01821-w
3. **Cuddy-Walsh, S.G**. and Wells, R.G. (2018), "Patient-specific estimation of spatially variant image noise for a pinhole cardiac SPECT camera." Med. Phys., 45: 2033-2047. https://doi.org/10.1002/mp.12883
4. **Cuddy-Walsh, S.G**., Clackdoyle, R., and Wells, R.G. (2014), "Directional resolution of limited-angle multi-pinhole SPECT cameras." *2014 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC)*: 1-4. https://doi.org/10.1109/NSSMIC.2014.7430996