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# QIBA SPECT BIOMARKER COMMITTEE: Quantitative / Image Analysis Task Force

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10 May 2016



# Agenda

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1. Profile Development/Writing  
(Section 3.10)

2. AOB

# 3.10 Image Analysis

## **3.10.1 DISCUSSION**

The Image Analyst using computer workstation analysis tools shall perform the specified measurements. The main quantitative data analysis task is to determine the Specific Binding Ratios (SBR) of Ioflupane DaTscan for the right and left caudate and putamen. The derived results are then compared to an age-normalized database to provide a reference for the SBR versus age-matched normals. The profile describes the data analysis methodology.

Quantitative Specific Binding Ratio (SBR) of Ioflupane DaTscan will be based upon patient SBR and compared to an age normalized database (or striatal phantom or digital reference object as the case may be). Qualified systems will be able to achieve a SBR within a certain range (e.g., **±5% of reference value** as prescribed by physical phantom measurement) for quantitative imaging of I-123 Ioflupane for the DaTscan phantom (described in this profile). **Further the coefficient of repeatability should be 20% for repeat studies.** The profile does not seek to make disease determination but to provide the methodology for data analysis and also for qualification of systems and processing for I-123 Ioflupane DaTscan data analysis.

# 3.10 Image Analysis

## Input Data:

The output images from Image Reconstruction are considered the input for Image Analysis. Once stored on the analysis workstation the image data will be processed for region of interest image analysis as described below. The original input data will be maintained as a separate file and will be stored along with the processed data for image analysis.

## Methods to be Used:

Uptake in the striatum (i.e., caudate, anterior putamen and posterior putamen) and background region (e.g., cerebellum or occipital region) is characterized by defining a region-of-interest (ROI). The measurand is the specific binding ratio and is determined from the following equation:

$$\frac{\textit{striatum}_{ROI}}{\textit{backgrnd}_{ROI}} - 1 \quad (\text{eq 1})$$

where the background (*backgrnd*)<sub>ROI</sub> counts are normalized to the same ROI volume as the striatal ROI (i.e., caudate or anterior putamen or posterior putamen).

Regions of interests will be drawn on preprocessed images as described below.

# 3.10 Image Analysis

Two volume of interest analysis strategies are described. The first method is referred to as the Small ROI approach. The second method is referred to as the Large ROI approach.

The small ROI approach is described as follows. On spatial normalized SPECT image volumes the transaxial slice with the highest striatal uptake is identified and the 8 hottest slices around it are averaged to generate a single slice image. Regions of interest (ROI) are then placed on the left and right caudate, the left and right putamen, and the occipital cortex (reference tissue), as shown in Figure 3.10.1. It should be clear which values belong to which striatal structures. This can be done by capturing DICOM coordinates along with ROI values or secondary screen capture of the ROI for identification. MRI anatomical images can be used for ROI drawing if they exist. ROIs maybe placed according to ROI template or using automated ROI placement tools. Count densities for each region are extracted and used to calculate specific binding ratios (SBRs) for each of the striatal regions. SBR is calculated as  $(\text{target region}/\text{reference region})-1$ , as described above in eq 1.

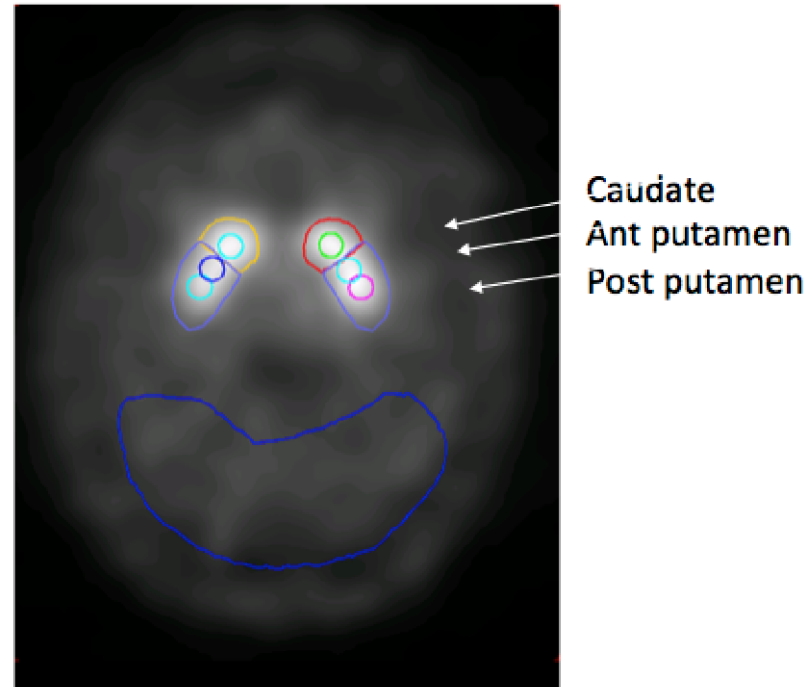


Figure 3.10.1. Illustration of Small VOI placement on summed slice image.

define axial extent of slices?  
... and the adjacent hottest slices occupying an axial extent of 2 cm or less are averaged ...

Need to define attributes of ROI?  
For example from FreeSurfer boundaries from co-registered MRI.  
What if no MRI available?

# 3.10 Image Analysis

The whole striatum ROI approach is similar to the Small ROI approach but uses larger volumes of interest (VOIs) and does not separate the putamen into two regions. The Large ROI approach is implemented in many commercial software packages (ref, JNuclMed-2013, Soderlund). The reconstructed image is spatially normalized to a SPECT template. Volumes of interest sampling most of the right and left caudate and putamen are drawn on the image as illustrated in Figure. 3.10.2. Background VOIs are drawn on the occipital cortex, as shown. VOIs can be systematically placed or automatically defined over the caudate nucleus and putamen to assess specific tracer binding and over the occipital cortex to assess non-specific binding [ref]. The striatal specific binding ratios are calculated using equation 1.

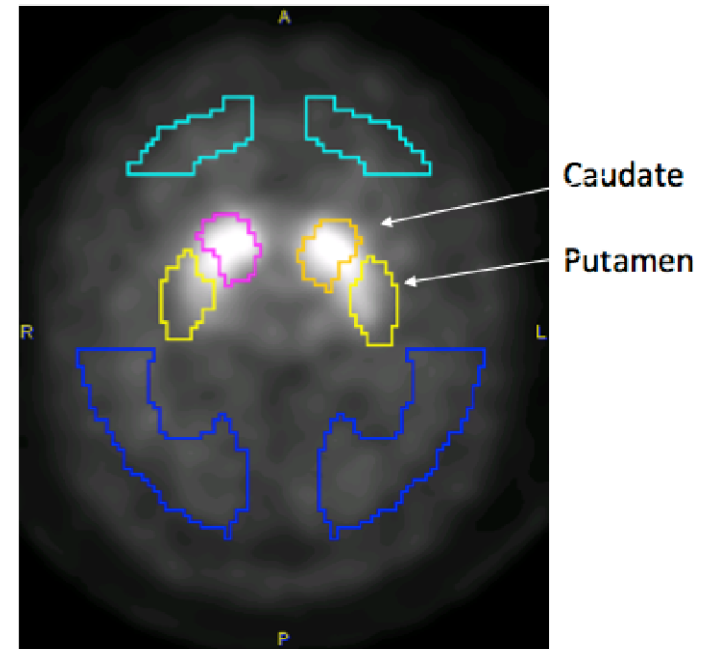


Figure. 3.10.2. Illustration of Large ROI placement on summed image.

Should we list names of commercial software packages?

Again if VOIs are hand drawn, we need to describe attributes to make them acceptable.

## 3.10 Image Analysis

Parameter	Actor	Requirement
Specific Binding Ratio	Image Analyst	<p><b>Analysis Workstation</b> Shall have a suitable monitor of appropriate size and pixel density for diagnostic viewing of medical images. Shall be placed in a room with in room lighting appropriate for image data analysis and interpretation (i.e., a radiology reading room). Shall have appropriate computation power and memory to carryout ROI or VOI data analysis.</p>
		<p><b>Post processed image for data analysis</b> Image for data analysis shall be reconstructed in accordance with parameters as described in Section 3.7. If using large ROI analysis technique, image shall be spatially normalized before VOI analysis. If using the Small ROI approach, the transaxial slice with the highest striatal uptake is identified and the hottest slices within a ?mm axial extent are averaged to generate a single slice image for ROI analysis.</p>
		<p><b>ROI software analysis tools</b> Using analysis workstation tools, regions of interest are placed on the left and right caudate, the left and right putamen, and the occipital cortex (reference tissue). ROIs shall be drawn either manually or automatically by image analysis software. Method of ROI drawing and placement must be consistent for all images analyzed. Count densities for each region are extracted to calculate SBRs.</p>

Might be better to define this by axial extent versus specific number of slices.

# 3.10 Image Analysis

Parameter	Actor	Requirement
Specific Binding Ratio	Image Analyst	<p><b>Analysis Workstation</b>            Shall have a suitable monitor of appropriate size and pixel density for diagnostic viewing of medical images. Shall be placed in a room with in room lighting appropriate for image data analysis and interpretation (i.e., a radiology reading room). Shall have appropriate computation power and memory to carryout ROI or VOI data analysis.</p>
		<p><b>Post processed image for data analysis</b>            Image for data analysis shall be reconstructed in accordance with parameters as described in Section 3.7. If using large ROI analysis technique, image shall be spatially normalized before VOI analysis. If using the Small ROI approach, the transaxial slice with the highest striatal uptake is identified and the hottest slices within a 7mm axial extent are averaged to generate a single slice image for ROI analysis.</p>
		<p><b>ROI software analysis tools</b>            Using analysis workstation tools, regions of interest are placed on the left and right caudate, the left and right putamen, and the occipital cortex (reference tissue). ROIs shall be drawn either manually or automatically by image analysis software. Method of ROI drawing and placement must be consistent for all images analyzed. Count densities for each region are extracted to calculate SBRs.</p>
Certify VOI	Qualified professional	<p>Shall either (1) agree with region boundaries, (2) reject boundaries and return for reprocessing, or (3) make revisions “on the fly” as indicated.</p>

Note: “Large ROI analysis” is being renamed to “whole striatum VOI analysis”.

Do we want to include a specification where a physician or other actor certifies placement of the VOI’s on the image?



# Profile section assignments (first draft/next iteration/last check before public review)

- Executive Summary: Mozley/Seibyl/whole committee
- 3.1-3.2 (Pre-delivery, Installation) Device manufacturers/Cella
- 3.3 (Periodic QA) Dickson/Zimmerman, et al.
- 3.4 -3.5 (Subject selection, Subject Handling) Mozley/Seibyl
- 3.6 (Acquisition) Dewaraja
- 3.7 (Reconstruction) Frey/Dewaraja
- 3.8 (Image QA) Dickson/Zimmerman
- 3.9 (Image Distribution) ?Klein/Pierre
- **3.10 (Image Analysis) Miyaoka/Seibyl**
- 3.11 (Image Interpretation) Seibyl, et al.
- 4 Assessment procedures – assignments?

# Wrap-up

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Review action Items

Any other business