Determination of Crossover Counts From Tc99m in an In111 Window

Assertion:

That counts from a Tc99m source were spilling into a higher energy In111 window on a dual-isotope gastric emptying scan.

Hypothesis:

Despite the theoretical possibility of combined counts from multiple Tc99m photons being in the In111 windows, our hypothesis was that such counts would not be significant.

Methodology:

The windows for the dual-isotope study were examined. The Tc99m window is centered on 140keV with a 9% +/- variance. The lower In111 window was centered on 171keV with a 10% +/- variance. The In111 window centered on 245keV was not considered due to its lack of proximity to the Tc99m window. Mathematically, the upper bound of the Tc99m window is 152.6keV and the lower bound of the In111 window is 153.9keV.

Two Tc99m sources were obtained, 0.151mCi and 7.5mCi. These sources were placed under the LEHR collimators on the Infinia camera and the MEGP collimators on the Hawkeye camera. Spectra were observed and captured in the images in appendix A.

An image taken earlier with an unknown quantity of Tc99m with the MEGP collimators was examined. This image was taken with an 128x128 matrix for 120 seconds. 231959 counts were observed in the Tc99m window and 7490 counts were observed in the In111 window. This image is in appendix B, below.

The first image from a dual-isotope gastric emptying study was also examined. For this image, approximately 1mCi of Tc99m and 100uCi of In111 was visualized in vivo in a 128x128 matrix image acquired for 120 seconds. 132048 counts were observed in the Tc99m window and 27811 counts were observed in the In111 window. This image is in appendix C, below.

Discussion:

The initial impression from viewing the peaks leads on to believe that the "spill up" effect is insignificant. The physical windows do not overlap, and while some amount of the 140keV peak is in the lower In111 window, it does not appear to be qualitatively significant. The percentage of the Tc99m peak in the In111 window qualitatively appears to be a smaller percentage; due to the nature of qualitative data this cannot be assessed quantitatively with the information at hand.

The quantitative data presents a different picture. The earlier image with a Tc99m source presents 7490 counts in the upper window. That is 3.22% of the counts in the lower window, or 3.13% of the total counts collected during the acquisition. While worrisome enough, this becomes more worrisome when compared to an actual study.

The Tc99m counts for the actual study (appendix C) are 56.93% of the counts from the source image (appendix B). It is reasonable to extrapolate that the "spillup" counts are proportional. This implies that 4264 counts (7490 * 0.5693) in the In111 window or 15.33% of the total counts in the indium window are suspect as coming from the Tc99m instead of the In111.

Ultimately, we have failed to prove the hypothesis that crossover counts from a Tc99m source into an In111 window are not significant.

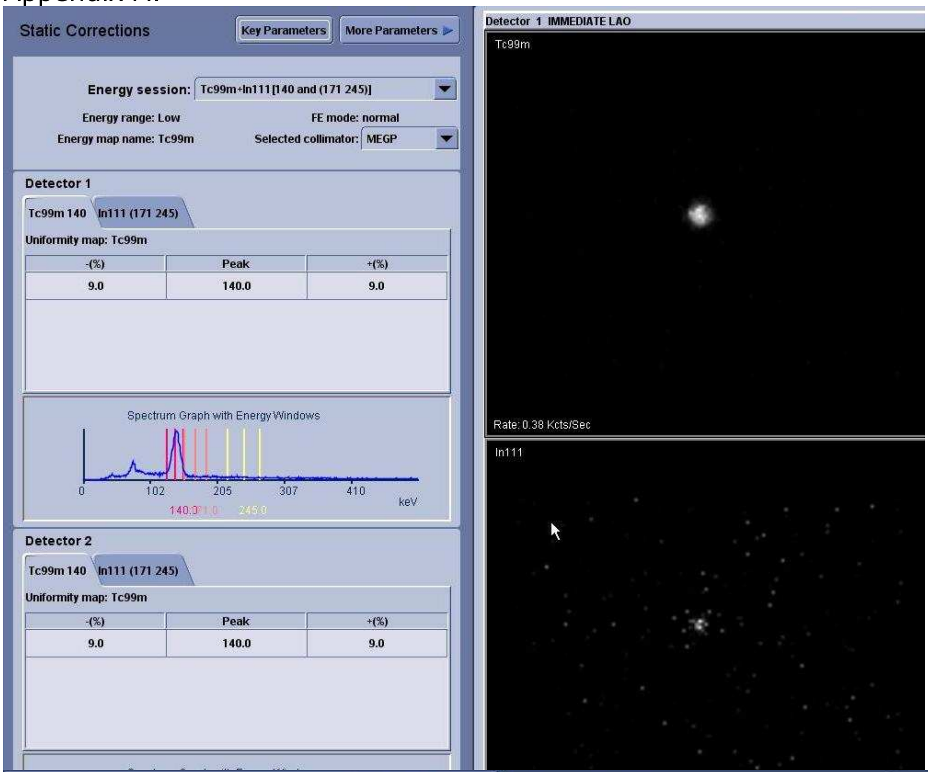
Further Research:

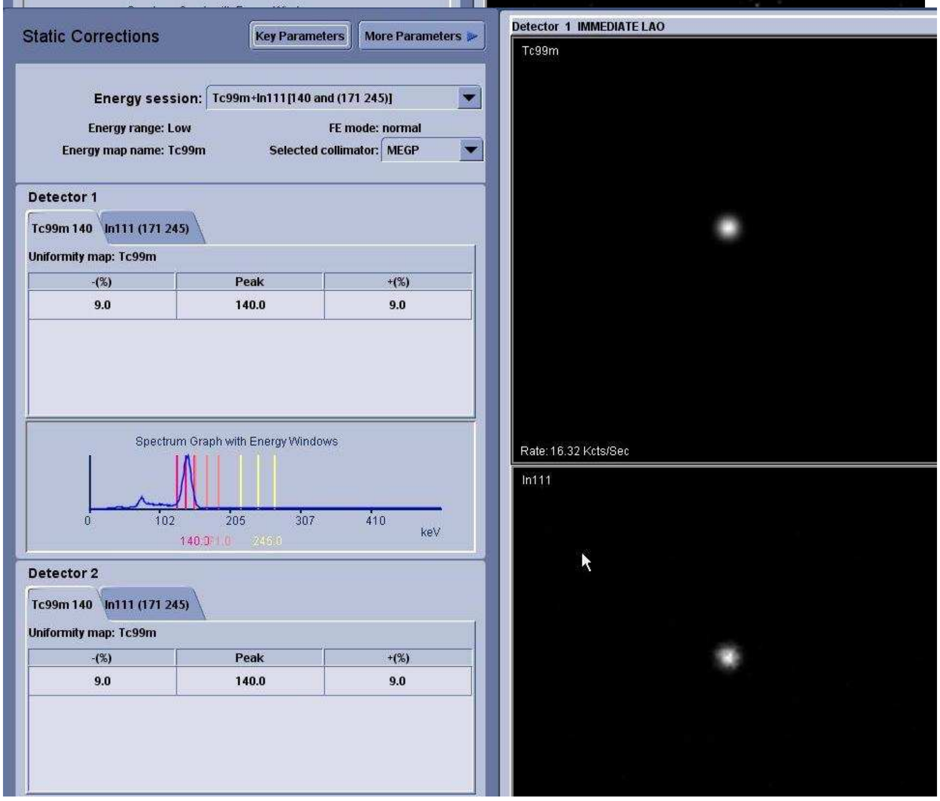
An immediate resolution to this problem is the cessation of dual-isotope gastric emptying studies. This is not a satisfactory long-term solution, however. The convenience factor of dual-isotope gastric emptying studies is a strong impetus to keep performing these studies. Further, other types of studies - TcSC bone marrow scans in conjunction with In111-labeled WBC studies, for example - will have to deal with these effects even if the scan times are not co-temporal.

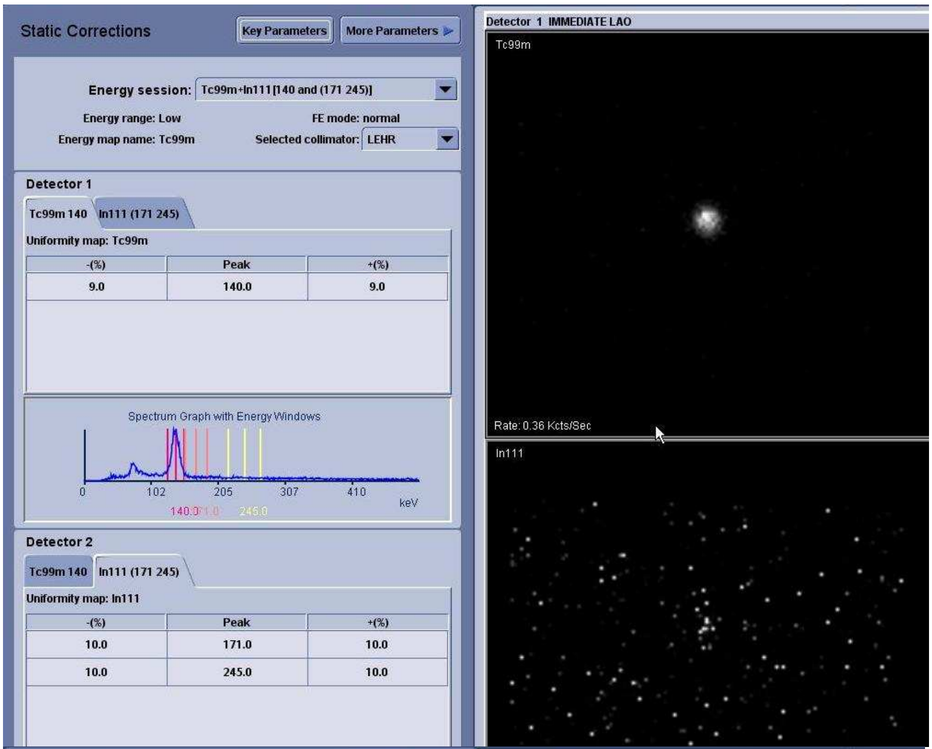
This troubling effect may be lessened by utilizing amounts of both isotopes that are closer to parity in absolute terms. That is, the if the ten-fold difference in activity was lessened, proportionately fewer Tc99m counts would be found in the In111 window. Likewise, if the In111 activity was increased, any crossover would be less significant.

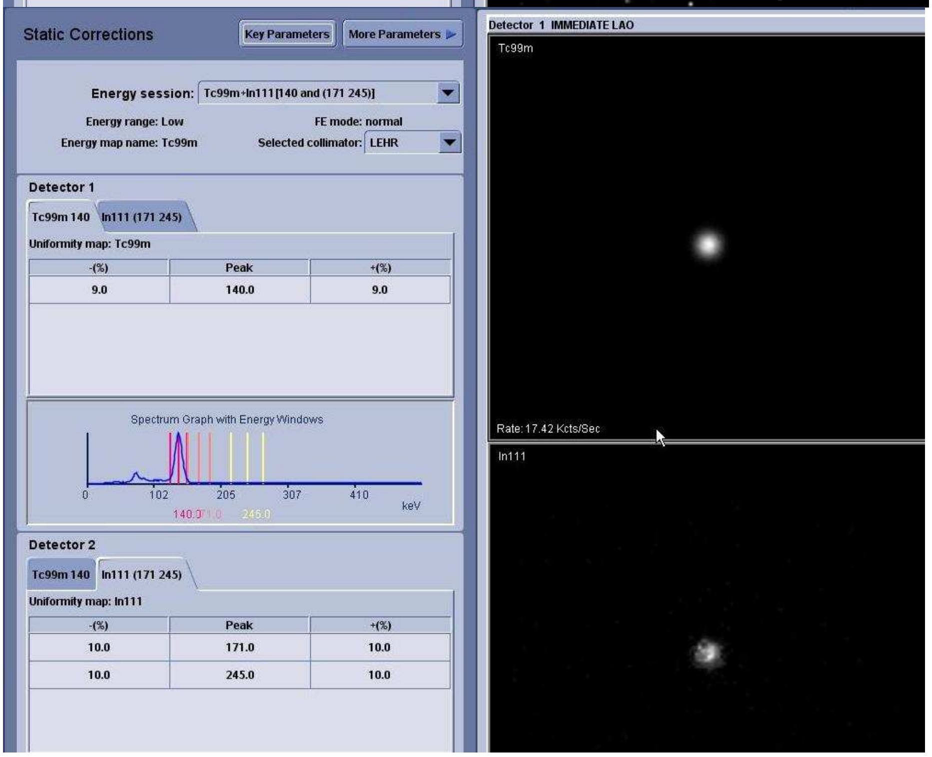
Further examination of a smaller window on both count rate and crossover effects would be extremely useful. The qualitative spectra images suggest that any crossover effects are localized around the 150-155keV range. Quantifying this effect will provide a great deal of useful data in guiding further patient imaging.

Appendix A:


Static Corrections
Key Parameters
More Parameters
Energy session: Tc99m+In111 [140 and (171 245)]
Energy range: Low
FE mode: normal
Energy map name: Tc99m
Selected collimator: MEGP
Detector 1
Tc99m 140
In111 (171 245)
Uniformity map: Tc99m
-(%) Peak +(%)
9.0 140.0 9.0
Spectrum Graph with Energy Windows
0 102 205 307 410
keV
Detector 2
Tc99m 140
In111 (171 245)
Uniformity map: Tc99m
-(%) Peak +(%)
9.0 140.0 9.0
Detector 1 IMMEDIATE LAO
Tc99m
Rate: 0.38 Kcts/Sec
In111


Static Corrections
Key Parameters
More Parameters
Energy session: Tc99m+In111 [140 and (171 245)]
Energy range: Low
FE mode: normal
Energy map name: Tc99m
Selected collimator: MEGP
Detector 1
Tc99m 140
In111 (171 245)
Uniformity map: Tc99m
-(%) Peak +(%)
9.0 140.0 9.0
Spectrum Graph with Energy Windows
0 102 205 307 410
keV
Detector 2
Tc99m 140
In111 (171 245)
Uniformity map: Tc99m
-(%) Peak +(%)
9.0 140.0 9.0
Detector 1 IMMEDIATE LAO
Tc99m
Rate: 16.32 Kcts/Sec
In111


Static Corrections
Key Parameters
More Parameters
Energy session: Tc99m+In111[140 and (171 245)]
Energy range: Low
FE mode: normal
Energy map name: Tc99m
Selected collimator: LEHR
Detector 1
Tc99m 140
In111 (171 245)
Uniformity map: Tc99m
-(%) Peak +(%)
9.0 140.0 9.0
Spectrum Graph with Energy Windows
0 102 205 307 410
keV
140.0
245.0
Detector 2
Tc99m 140
In111 (171 245)
Uniformity map: In111
-(%) Peak +(%)
10.0 171.0 10.0
10.0 245.0 10.0
Detector 1 IMMEDIATE LAO
Tc99m
Rate: 0.36 Kcts/Sec
In111


Static Corrections
Key Parameters
More Parameters
Energy session: Tc99m+In111[140 and (171 245)]
Energy range: Low
FE mode: normal
Energy map name: Tc99m
Selected collimator: LEHR
Detector 1
Tc99m 140
In111 (171 245)
Uniformity map: Tc99m
-(%) Peak +(%)
9.0 140.0 9.0
Spectrum Graph with Energy Windows
0 102 205 307 410
keV
140.0
245.0
Detector 2
Tc99m 140
In111 (171 245)
Uniformity map: In111
-(%) Peak +(%)
10.0 171.0 10.0
10.0 245.0 10.0
Detector 1 IMMEDIATE LAO
Tc99m
Rate: 17.42 Kcts/Sec
In111

Appendix B:


4/10/2008
128
x 128
18:10:55.0
Nuclide:Tc99m+In111[140 and (171 245)],
4.4182 mm/pixel
Total 231959 cts
120000 millisec
IMMEDIATE LAO_Tc99m
Zoom 1.0
1937 counts/sec
U: 5392
L: 0
4/10/2008
128
x 128
18:10:55.0
Nuclide:Tc99m+In111[140 and (171 245)],
4.4182 mm/pixel
Total 7490 cts
120000 millisec
IMMEDIATE LAO_In111
Zoom 1.0
1937 counts/sec
U: 73
L: 0

Appendix C:


4/10/2008
128
x 128
12:21:17.0
Nuclide:Tc99m+In111[140 and (171 245)],
4.4182 mm/pixel
Total 132048 cts
120000 millisec
Imm lao
Zoom 1.0
1040 counts/sec
U: 633
L: 0
4/10/2008
128
x 128
12:21:17.0
Nuclide:Tc99m+In111[140 and (171 245)],
4.4182 mm/pixel
Total 27811 cts
120000 millisec
Imm lao
Zoom 1.0
1040 counts/sec
U: 129
L: 0