

# The Impact of Daily Flood Uniformity Test on Quality of Images: A Case Report

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## Abstract

The Daily intrinsic flood uniformity test of a gamma camera is required to be performed before using the gamma camera to acquire patient images. It is meant to detect changes in the performance of a gamma camera system that may affect the interpretation of clinical studies adversely.

## Introduction

The Daily intrinsic flood uniformity test of a gamma camera is required to be performed before using the gamma camera to acquire patient images. It is meant to detect changes in the performance of a gamma camera system that may affect the interpretation of clinical studies adversely [1]. Before patients' testing, any non-uniformity must be eliminated so that artifacts, false-positive and false-negative patients' results will also be eliminated. Two different uniformity parameters that are usually measured during the test are: integral uniformity and differential uniformity. These are calculated for both the Central field of view (CFOV) and Useful field of view (UFOV) of the gamma camera respectively. The integral uniformity has typical values of 2% to 4% [2] or 4% to 7% [3] while those of differential uniformity are in the range 1.0% to 2.5%.

Image uniformity is affected by photo-peak location, PMT performance, energy correction and linearity correction; hence, it is probably the most important Q.C. test that can be performed on a gamma camera system on daily basis [3]. It can also be affected by yellowing of the camera crystal [4]. The photomultiplier tubes (PMTs), and the associated analog electronic components of the camera tend to become unstable with time and this affects uniformity of images greatly. If one or more PMTs "drift", hot or cold spots may appear in the flood image. The unstableness of the PMTs and other effects such as that of magnetic fields on the gamma camera can cause the uniformity to change [5]. When the uniformity of a camera exceeds the required value, the integrity of the clinical image becomes questionable; this can happen when there is a PMT failure. We recently experienced a failure of a PMT in our camera which did not show on our clinical images, hence, emphasizing the need for a daily uniformity test before acquisition of patient images. We report this case here.

## Case Report

A Siemens (Siemens Medical Solutions USA, Inc) e-cam signature series SPECT system with single head which was installed at our center in March, 2006 and has been in use, since then suddenly developed a problem of photo-multiplier Tube (PMT) failure. Images acquired during the period of the PMT failure (before the PMT was replaced) did not show any sign of such a problem on the camera. So it was during one of the daily uniformity test sessions that the problem was actually discovered. The flood uniformity image showed the PMT failure clearly and during the tuning of the PMTs, the camera reported a 'No count or low count' error thereby completing the tuning unsuccessfully. All these were signs that there was a problem with a PMT or with several PMTs.

Figure 1 shows a representative flood uniformity image and values

of the gamma camera before this problem occurred while Figures 2 shows image and values of the flood uniformity test when the problem has occurred. Figure 3 is an image of a patient acquired on the same day as figure 2 when the PMT has failed while Figure 4 shows the flood uniformity image and values when the faulty PMT had been replaced. There was no apparent indication on the patient skeletal image that something was wrong with the camera.

## Discussion

Quality control of equipments (such as the gamma camera) in a Nuclear Medicine Department is an important part of the overall Quality Assurance of the Department. The quality control of the gamma camera includes the daily evaluation of the intrinsic flood field uniformity. This evaluation makes it possible to correct many gamma camera problems as soon as they appear [4]. The daily flood uniformity test of a gamma camera is one of the primary tests carried out on the gamma camera [6] and it is also one of the indices of performance of the camera. Its importance in the day to day use of the camera cannot be overemphasized as demonstrated in this case report. The integrity of images acquired on a camera when the flood uniformity test is not carried out is questionable hence, the need for the test to be carried out on a daily basis (especially in a case that the camera is shut down daily due to power supply constraints).

From the images acquired which look normal, one could conclude that all is well with the camera. But this is not the case as the flood uniformity test revealed that the camera had a PMT problem. This case study also revealed that as sensitive as the gamma camera is, clinical images cannot reveal easily and with certainty, the problems encountered by the camera, which are best detected through quality control tests. Some of these problems could be as mundane as small statistical fluctuations in field uniformity and PMT 'drift'. Again, since it is not evident in patient images that the camera was faulty, the problem could have persisted and possibly degenerated if the flood field uniformity test had not revealed it. The PMT was thereafter replaced

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Received December 06, 2011; Accepted May 25, 2012; Published May 28, 2012

Citation: Ejeh JE, Adedapo KS (2012) The Impact of Daily Flood Uniformity Test on Quality of Images: A Case Report. J Nucl Med Radiat Ther 3:132. doi:10.4172/2155-9619.1000132

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and the camera became normal again as can be seen on the flood field uniformity image in figure 4.

## Conclusion

It is therefore, concluded that the daily flood uniformity test has a lot of impact on the daily use of the gamma camera and quality of patients' images acquired by the camera. Therefore, it should be performed on a daily basis before clinical studies commence.

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