Assessment of the Performance of the Siemens E-Cam Dual Head Gamma Camera during Load Shedding Period.

Mpumelelo Nyathi, Department of Medical Physics, Sefako Makgatho Health Sciences University, South Africa.
Mpho Enoch Sithole, Department of Physics, Sefako Makgatho Health Sciences University, South Africa.

Abstract-- INTRODUCTION: Intrinsic uniformity test provides the quickest sensitive quality control test for determining slight changes in the performance of the gamma camera. It is performed daily before patient imaging to detect defects. A defective system acquires patient images of poor quality characterised by ring artefacts giving rise to false positive and false negative patient results.

An irregular power supply affects the operational functions of the system particularly the photomultiplier tubes resulting in performance changes. Introduction of load shedding in South Africa raised questions and concerns among nuclear medicine physicians about the performance of the gamma camera and its ability to acquire patient images of good quality that can be used to fulfil diagnostic outcomes. This study was conducted to determine the performance of the Siemens E-Cam dual head gamma camera during load shedding period.

Methods: A point source soaked into technetium-99m of activity 0.55 MBq was placed into a vial. The vial was then placed in a source holder drawn such that it remained centrally between two detectors positioned at 0° and 180° with their collimators removed. With all conditions set, a static acquisition of 30 million counts was performed on a matrix size of 512 × 512 pixels with zoom fixed at one (1)

Results:

The integral uniformity (IU) values for central field of view (CFOV) for detector head 1 and 2 ranged from 2.15-4.50% and 2.00-5.30% respectively. For uniform field of view (UFOV) the values ranged from 2.60-5.18% and 2.32-5.70% respectively. The Differential Uniformity (DU) values for CFOV for detector heads 1 and 2 ranged from 1.12-2.5% and 1.03-2.41% respectively. For UFOV, they ranged from 1.15-2.75% and 1.18-3.15 % respectively. These values were within fell within the limits of acceptance tests, thus they gave the assurance that the gamma camera despite load shedding successfully acquired quality patient images.

Conclusion: Load shedding did not affect the performance of the Siemens E-Cam dual gamma camera during the study period. It continued to acquire reliable good quality images.

Index Term-- quality control, intrinsic uniformity test, load shedding, performance.

INTRODUCTION

South African power utility company commonly known as Eskom, recently introduced load shedding that affected the entire community. Departments such as the nuclear medicine at Dr George Mukhari Academic Hospital (DGMAH) have not been spared. Load shedding has brought about concerns on the gamma camera performance and particularly the quality of images it acquires. In the event of load shedding, the gamma camera runs on a generator, however there have been situations where it is shut down. Returning the gamma camera to use its normal clinical use is done following the manufacture’s recommendations. Further guidelines on returning the it to clinical use are also stipulated in the International Atomic Energy Agency (IAEA) report on quality control protocols. These guidelines recommends a 24 hour waiting period before acquisition of clinical images. However, due to work load and demand it is impossible to stick to the 24 hour waiting period at DGMAH. Failure by nuclear medicine technologist to adhere to the stipulated waiting period leads to the following question. Does load shedding affect the performance of the Siemens E-Cam dual head gamma camera?

Performance failure by the gamma camera leads to image artefacts. Poor quality of images contribute to a high rate of false negative and false positive patient results, ultimately failing the whole diagnostic process. This study sought to determine the impact of load shedding on the performance by the gamma camera during the period of study ranging from 7 June 2014 to 31 August 2014.

In order to study the performance of the gamma camera system and the quality of images acquired, the National Electrical and Manufactures Association (NEMA) recommends several performance quality control (QC) tests. However, the Finish Radiation and Nuclear Safety Authority (STUK) advises that gamma camera performance tests do not necessary need to be the same as those stipulated by NEMA. Nonetheless whichever test is done it should be capable of showing changes in the performance of the system. In this study, the intrinsic uniformity test was chosen to evaluate any possible slight changes in the performance of the Siemens E-Cam dual head gamma camera. This test provides the quickest means of performing a daily quality control (QC) tests taking between 10 and 11 minutes to acquire a flood image of 30 million counts on a matrix size of 512 × 512 pixels.

The intrinsic uniformity test measures the response to the camera’s response to a uniform flux of irradiation in the absence of collimators. The response to irradiation as measured by the uniformity test constitute the most basic sensitive test of the gamma camera performance. This QC test can be conducted on a daily basis before patient imaging even when the imaging schedule is tight.
The intrinsic uniformity is most sensitive to changes in the photomultiplier tubes (PMTs) performance and photopeak location changes. A photopeak energy that is incorrectly set may lead to degradation of the uniformity as well as reduction in the sensitivity of the imaging system. Furthermore, it may increase scatter thus contribution to the image degradation.\[^3,7\] The PMTs and allied electronics have a tendency of losing stability with time. Loss of stability of the PMTs together with other magnetic fields effects of the gamma camera introduces changes on the system's uniformity.\[^8\] Changes of this nature can be detected quickly before patient imaging using the intrinsic uniformity test. Another advantage of the intrinsic uniformity test is that it requires uses of technetium-99m which is readily available in all nuclear medicine departments.

Saha,\[^9\] reported that any changes in the PMTs will cause decline in gamma camera uniformity. However this only occurs as a result of instabilities affecting the PMTs which are caused by erratic power supply to the gamma camera.\[^8,10\] The NEMA protocol stipulates that the gamma camera should be kept running on at all times to avoid instabilities affecting the PMTs.\[^3\] However, in the times of load shedding the gamma camera system cannot be kept running throughout. The study aimed at determining the assessing the performance of the Siemens E-Cam dual head gamma camera during load shedding period.

MATERIALS AND METHODS

A Technitium-99m (\(^{99m}\)Tc) point source of activity of 0.55 MBq was used to perform the intrinsic uniformity test. \(^{99m}\)Tc drops were soaked into a small cotton wool ball of a radius of approximately 0.5 mm which was later placed into the vial. The collimators of the Siemens E-Cam dual head gamma camera were removed from both detectors to allow maximum uniform irradiation to reach each detector's crystal. The two detectors were rotated such that one detector was positioned at 0\(^\circ\) and the other at 180\(^\circ\) as shown in figure 1. The source holder was pulled from its storage position and extended such that it was centred between the two detectors.

The vial containing the cotton ball soaked with \(^{99m}\)Tc (point source) was placed into the source holder. Care was taken to ensure that the point source in the vial remained centred between the two detectors. The gantry was raised up and down until an equal count rate was registered on both detectors. A static acquisition of 30 million counts was performed on a matrix size of 512 \(\times\) 512 pixels with zoom fixed at one (1). The Siemens E-Cam dual head gamma camera automatically performed the uniformity verification.

![Siemens E-Cam dual head gamma camera set up for intrinsic uniformity tests.](image-url)
RESULTS

Fig. 2. Integral uniformity for central field of view for detector heads #1 and #2.

Fig. 3. Integral uniformity for useful field of view for detector heads #1 and #2.
DISCUSSION
Good quality images are crucial in nuclear medicine in order to arrive at informed diagnostic decisions. They eliminate the false positives and false negative results. Acquisition of good quality images can only be guaranteed if the performance of the gamma camera is good or falls within the margins prescribed by NEMA protocol, and manufacture’s acceptance tests. Intrinsic uniformity test conducted during the period stretching from 7 June 2014 to 31 August 2014 showed that the Siemens E-Cam dual head gamma camera performed well despite load shedding. These results created confidence among the nuclear medicine physicians at DGMAH who had been worried about the implications of load shedding on their diagnostic studies.

The intrinsic uniformity was quantified in terms of the integral uniformity (IU) and differential uniformity (DU). IU is the variation of the count density over the entire field-of-view whilst the DU is a measure of the maximum rate at which the count density changes over a specified distance. The values of the parameters IU and DU were found to be within the limits of a good performing gamma camera. IU values for CFOV for detector head #1 ranged from 2.15% to 4.50% whilst those of detector head #2 ranged from 2.00% to 5.30%. The acceptance tests results were 2.16% and 2.7% for detector heads 1 and 2 respectively. The IU values for the UFOV for detector head #1
ranged from 2.60% to 5.18% whilst those of detector head #2 ranged from 2.32% to 5.70%. The acceptance tests results were 2.47% and 2.70% for detector heads #1 and #2 respectively.

The DU values for CFOV for detector head #1 ranged from 1.12% to 2.5%. The acceptance tests value was 1.61%. For detector head #2, the DU values for CFOV ranged from 1.03% to 2.41%. The acceptance test value for detector head #2 was 1.90%. The DU values for UFOV for detector head #1 ranged from 1.15% to 2.75%. The acceptance test value was 1.61%. The DU values for UFOV for detector head #2 ranged from 1.18% to 3.15% compared to its acceptance test value of 1.91%.

The fact that IU and DU values coincided with the acceptance tests further proved that the gamma Siemens E-Cam dual head gamma camera functioned well despite power outages. The power outages therefore did not affect the operational functions of the PMTs and the Siemens E-Cam dual head gamma camera.

**CONCLUSION**

The daily intrinsic uniformity test provided the quickest economically affordable means to check the performance of the Siemens E-Cam dual gamma camera during the load shedding period. Results of the study showed that the performance of the Siemens E-Cam dual gamma camera remained within the acceptable norms during the load shedding period. The images acquired during that period could therefore be confidently used to arrive at desired diagnostic outcomes. Physicians in developing countries in which load shedding is common should therefore not bother much about load shedding as the performance of the Siemens E-Cam dual gamma camera is not adversely affected.

**REFERENCES**


