The Internet Journal of Nuclear Medicine
Volume 5 Number 2

Parameters Affecting on Intrinsic Uniformity Test For MEDISO

S Zobly, A Osman

Citation

S Zobly, A Osman. *Parameters Affecting on Intrinsic Uniformity Test For MEDISO*. The Internet Journal of Nuclear Medicine. 2009 Volume 5 Number 2.

Abstract

The most basic and sensitive routine quality control (QC) of gamma camera is that of intrinsic uniformity. Intrinsic uniformity must be assessed daily and after each repair, it must be critically evaluated and any necessary action must be undertaken before using the gamma camera for patient imaging. The main objective of this work is to determine the best parameters for daily quality control testing of intrinsic uniformity for the single-head gamma camera from MEDISO Company installed at Institute of Nuclear Medicine - University of Gezira. Intrinsic uniformity test was done by placing a point source $^{99m}TcO^{-}$ (^{99m}Tc) in front of the detector with removed collimator to measure the effect of correction matrix, source-to-camera distance, a count rate and activity volume on intrinsic uniformity.The result shows that the best intrinsic uniformity image obtained at distance of 100 cm, with correction matrix, activity volume in range of 0.1 - 0.4 ml in 3 ml syringe and a count rate in between 25 - 30 kcps which takes less than 14 min to get uniform image.

INTRODUCTION

Uniformity test is the most common practice in present gamma camera quality control procedures, suggested by NEMA (National Electrical Manufacture Association), IAEA (International Atomic Energy Agency) and IEC (International Electrotechnical Commission) [1-3]. Uniformity is a measure of camera's response to uniform irradiation of the detector surface. The ideal response is a perfectly uniform image [4].

Earlier cameras used thicker light guides and large-diameter photomultiplier tubes (PMTs), in part to achieve satisfactory uniformity, at the expense of somewhat degraded spatial resolution. Because of effective uniformity corrections, newer cameras can use thinner light guides and smaller PMTs, both of which contribute to more accurate event localization and improve intrinsic special resolution [5].

Field uniformity test can be done intrinsic or extrinsic. Intrinsic without collimator to monitor the condition of sodium iodide crystal and electronics and extrinsic with collimator to monitor the camera as it is used clinically [6]. We prefer intrinsic uniformity testing because a ^{99m}Tc point source is readily available at institute.

Intrinsic uniformity test was done with a point source (typically 11.1 MBq (300 µCi) of ^{99m}Tc) positioned in front of the uncollimated camera. The source was placed into the lead box with copper filtration of 2 mm. The uniformity of the camera is a sensitive indicator of camera performance and should perform daily for homogeneity before patient imaging. The flood uniformity image can be evaluated numerically or graphically [7]. The NEMA protocol for intrinsic flood field uniformity analyzes both differential uniformity and integral uniformity. Differential uniformity is a measure of maximum rate of change over a short distance and integral uniformity is a measure of maximum deviation. The integral uniformity represents the maximum pixel count rate change over the indicated field of view expressed as percent. The differential uniformity is the maximum change over a five pixel distance in the X or Y direction thereby representing the maximum rate of change of regional count rate [8].

MATERIAL AND METHODS

The following procedure was used to measure the system intrinsic uniformity and determined the parameters affect image uniformity. Gamma source activity, source holder, copper plat, source-to-camera distance, account per second, uniformity with & without correction matrix and source volume were evaluated to determine the ideal parameters for our daily quality control in our department (Department of Medical Physic and Instrumentation).

1. The collimator was removed from the camera and the detector was set with it face toward the ground.
2. 3 ml syringe was used as a point source, laid in the middle of the source holder; the volume was varied between 0.1 - 1.0 ml.
3. Source holder seated on the gantry arm facing the centre of detector with varied distance.
4. Camera surface and the room were cleaned to insure there in no contamination then the room background was measured by NaI crystal gamma camera it was 140 cps after removing all available sources from the room. The contamination affects the gamma camera performance, unless measurements of uniformity are performed with a medium or high energy collimator [9].
5. The point source was carefully aligned in the centre of the camera. The distance between the point source and the camera detector was varied between 85 cm- 120 cm (maximum distance) to determine the effect of the source distance on intrinsic uniformity.
6. NEMA (2001) and IAEA (1991) approach for the measurement of intrinsic uniformity was followed.
7. The intrinsic uniformity of the camera (Differential uniformity & Integral uniformity) was determined using InterView and DIAG software provided by the manufacture (Mediso Medical Imaging System) where the maximum and minimum pixel values determined.
8. A 20% energy window set symmetrically over the 99mTc photopeak is equivalent to 140 ± 10 % keV or a window spanning 126 - 154 keV.
9. We initially followed the manufacture's instruction for the tests.

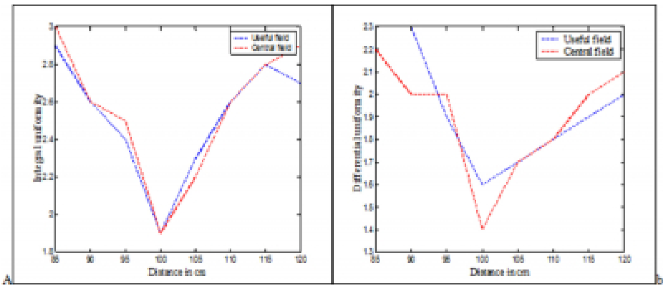
RESULTS

INTRINSIC UNIFORMITY VERSUS SOURCE-TO-CAMERA DISTANCE

Figure (1) shows the differential uniformity and integral uniformity of the machine versus the source-to-camera distance where the count rate increased with decreasing the distance and decrease with increasing the distance. Figure (1) shows that both differential and integral uniformity improved in source-to-camera distance in between 95 - 105 cm, the best result obtund at distance of 100 cm.

Figure 1

FIGURE 1.intrinsic uniformity versus source-to-camera distance, (a) distance versus integral uniformity (b) distance versus differential uniformity. The best values of intrinsic uniformity were at distance of 100 cm.

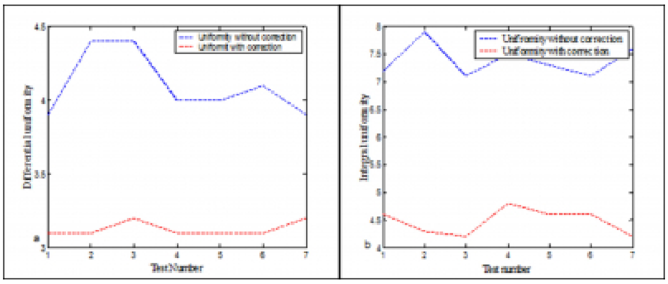


INTRINSIC UNIFORMITY WITH & WITHOUT CORRECTION

The intrinsic uniformity has been repeated several times with and without correction matrix. The result from figure (2) shows that the best values for differential & integral uniformity with correction matrix.

Figure 2

FIGURE2. Intrinsic uniformity test with and without correction matrix. (a) Differential uniformity, (b) Integral uniformity. The intrinsic uniformity for both differential and integral were within the range (acceptable) with correction but out of range without correction (not acceptable).

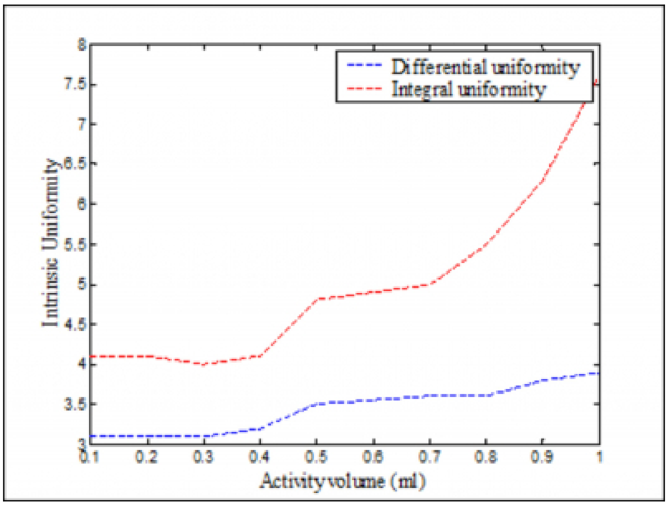


INTRINSIC UNIFORMITY VERSUS ACTIVITY VOLUME

Figure (3) shows the experimental intrinsic uniformity (Differential & Integral) of the camera at different source volumes. The ^{99m}Tc activity was 11.1 MBq (300 µCi), a count of 25 kcps and distance of 100 cm. Figure (3) shows constant intrinsic uniformity for the volume between 0.1 - 0.4 ml, then change when volume increased.

Figure 3

Intrinsic uniformity versus activity volume. The intrinsic uniformity was constant for source volume up to 0.4 ml.



INTRINSIC UNIFORMITY ACCOUNT RAT VERSUS UNIFORMITY TIME

Figure (4) shows the calculated time and the actual time for the intrinsic uniformity test. The time calculated by:

(1)

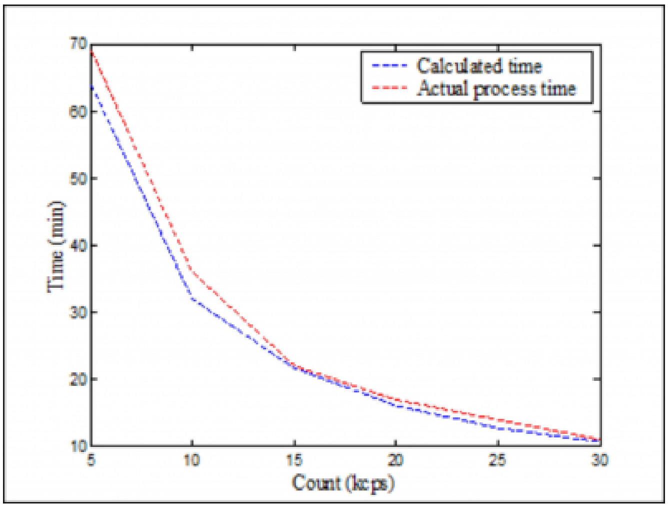
From figure (4).

1. There is a small difference between the calculated time and actual processing time; the difference was due to environmental changes.

2. The process time decreased when increasing the count per second, the suitable range was in between 25- 30 kcps to get a best uniform image and save time (11 - 14 min). To a chive this account rate, the source activity must be more than 10.36 MBq (280 µCi) and less than 11.84 MBq (320 µCi).

Figure 4

The relation between the time and a count rate. The different between calculated time and actual process time is very small



CONCLUSION

Various agencies, companies and authors (1 - 3, 9, 16 & 17) have suggested many protocols for gamma camera quality control, there is no significant difference between our parameters and the suggested protocols, the differences most probably was due to setting and environmental changes. We have used the above protocol (parameters) for our daily planar gamma camera quality control (QC) during last nine months. It takes 11 - 14 min, a count rate of 25 - 30 kcps, activity volume in between 0.1 - 0.4 ml and distance between 95 - 105 cm (at 100 cm was perfect). Above all intrinsic uniformity has to be done with matrix correction.

References

1. IAEA TECDOC-60. Quality Control of Nuclear Medicine Instruments. 1991.
2. NEMA Standard Publication NU 1-2001, Performance Measurements of Scintillation Cameras. USA, Rosslyn: National Electrical Manufacturers Association, 2001.
3. International Electrotechnical Commission. EC Standard 61675-2, Radionuclide Imaging Device – Characteristics and Test Condition. Part1. Single Photon Emission Computed Tomography. Switzerland, Geneva: International Electrotechnical Commission 1998.
4. J. Bushberg et al. Essential Physics of Medical Imaging. 2nd edition. USA 2002.
5. C. Simon, P. Michael, S. James. Physics in Nuclear Medicine. 3rd ed. Philadelphia: Saunders Co., 2003.
6. Scintillation Camera quality control. Scintillation Quality Control Lecture-3- Product Training Manual. htt://www.authorstream.com/presentation.
7. P. H. Murphy. Acceptance Testing and Quality Control of Gamma Camera's. Including SPECT. J Nucl Med.1987; 2: 1221 - 1227.
8. G. Muehllehner, R. Wake, R. Sano. Standard for Performance Measurement in Scintillation Cameras. J Nucl Med. 1981; 22: 72 - 77.

9. M. O'Connor, et al. Quality Control of Scintillation cameras (Planar and SPECT).
10. A. Elkamhawy et al. Intrinsic Uniformity and Relative Sensitivity Quality Control Tests for Single-Head Gamma Cameras. J Nucl Med. 2000; 28: 252 - 256.
11. Quality Control of Gamma Camera System. IPEM Report 86, Fairmount House, 230 Tadcaster Road York YO24 IES UK. 2003.
12. IAEA Quality Control Atlas for Scintillation Gamma Systems Vienna: International Atomic Energy Agency, 2003.
13. S. Baechler, et al. Feasibility of the Gamma Camera Acceptance Testing Procedure Introduced by the Swiss Federal Office of Public Health Swiss: Swiss Federal of Public Health, 2005.
14. Peter F. Sharp, Howard G. Gemmell, Alison D. Murray. Practical Nuclear Medicine. 3rd ed. London: Springer – Verlag, 2005.
15. C. Chiesa. Quality issues with nuclear medicine equipment: gamma cameras. Annual Congress of the European Association of Nuclear Medicine. Istanbul 2005.
16. American Association of Physicists in Medicine - Nuclear Medicine Committee. Scintillation Camera Acceptance Testing and Performance Evaluation. AAPM Report No. 6. American Institute of Physics. 1980.
17. Mediso Medical Imaging System. Product Document for Single-Head Gamma Camera, Revision 1.02. Mediso, Budapest.

Author Information

Sulieman M. S. Zobly
Dep. of Medical physic & Instrumentation, National Cancer Institute, University of Gezira

Abd Elbagi O. Osman
2- Dep. of Nuclear Medicine, National Cancer Institute, University of Gezira