Assessment of molybdenum breakthrough levels in molybdenum-99/technetium-99m generators: One year experience at NIMRA Jamshoro Pakistan

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ABSTRACT

Background: Technetium-99m radioisotope is the backbone of any nuclear medicine institute. This radioisotope is acquired by the elution of Molybdenum-99/Technetium-99m generator which emits 141 keV gamma ray and having 6.04 hour half-life. Occasionally the contents of Molybdenum-99 may mix up with elute, which may affect image quality and patients may receive higher doses than recommended. This study was initiated to check and evaluate the contamination of Molybdenum-99 in Molybdenum-99/ Technetium-99m generators used at Nuclear Institute of Medicine and Radiotherapy (NIMRA) Jamshoro Pakistan before its administration to patients for diagnostic procedures. ***Materials and Methods***: The Molybdenum-99 impurity in Technetium-99m elute for 50 generators was studied during the year 2012. The measurements were made using dose calibrator and a standard canister at the time of first elution of the generators. The dose calibrator displays result after executing various steps in a sequence. Due to some production process error or any mechanical fault high activity of Molybdenum-99 was recorded and removed with decrease in Technetium-99m yield. ***Results***: The most of eluted generators (90%) contained 10% of molybdenum breakthrough of the permissible limit ($P < 0.05$). The high activity of Molybdenum-99 was recorded in only 6% of the generator and removed by using standard methods with some reduced Technetium-99m activity. ***Conclusion***: The molybdenum breakthrough was according to recommended standards in most of the generators. The removal of high contents of Molybdenum-99 enabled the institute to continue routine imaging services by improved image quality and reduction in radiation dose to the patients.

Keywords: *Dose calibrator, ^{99}Mo-^{99m}Tc generator, ^{99}Mo, molybdenum breakthrough, ^{99m}Tc.*

INTRODUCTION

Technetium-99m (^{99m}Tc) is a favorite radionuclide which is mostly used for diagnostic purposes in nuclear medicine institutes throughout the world due to its unmatched physical & imaging properties for gamma camera, its low cost and ease in availability [1-6]. This radioisotope is obtained by the process of elution (milking the cow) of a Molybdenum-99/ Technetium-99m (^{99}Mo-^{99m}Tc) generator. Mainly Molybdenum-99 (^{99}Mo) having half-life of 66 hours decays to ^{99m}Tc (87%) by beta emission followed by one of major gamma ray of 141 keV (kilo electron Volt) with half-life of 6.04 hours [2,7]. Due to one of reasons like error or flaw in production process, any mechanical fault, rough handling during transportation, ^{99}Mo impurity

may also be extracted and mixed up with ^{99m}Tc during the process of elution [1,2,8].

This contamination of ^{99}Mo is being studied by molybdenum breakthrough (MBT) assay [2,6] which may prevent the proper labeling of isotope which results the decrease in labeling yield, reduction in image quality and the patients may receive unnecessary 50 times higher dose compared with the dose of ^{99m}Tc [1,8,9]. The present allowable limit of MBT is 0.15 kBq of ^{99}Mo/MBq of ^{99m}Tc which is recommended by National and International organizations [10-12].

The objective of the current study was to measure and evaluate ^{99}Mo contamination in ^{99m}Tc isotope from the generators manufactured by Isotope production division, Pakistan Institute of Nuclear Science and Technology (PINSTECH) Islamabad Pakistan during 1 year course (January-December 2012).

MATERIALS AND METHODS

The elution of 50 ^{99}Mo-^{99m}Tc generators was performed on consecutive weekdays in the morning from Monday to Saturday. The CRC-15R (CAPINTEC, Inc. USA.) dose calibrator was used to measure the activity [6]. It is recommended that the MBT test must be performed to assess the amount of ^{99}Mo contamination with standard lead canister and insertion holder [2,6,13-15]. The higher levels of ^{99}Mo contamination in the eluted ^{99m}Tc were reduced to acceptable level of 0.15 kBq of ^{99}Mo/MBq of ^{99m}Tc by passing the contaminated elute through an old generator as described by Fatima N *et al.,* Shah AS *et al.,* Reese IC and Mishkin FS [1,6,16].

For the statistical analysis of the data, independent t-test on SPSS 17 statistical software (SPSS Inc. USA) was used and significant value of $P < 0.05$ was considered.

RESULTS

It was observed that only 6% (n = 3) of 50 ^{99}Mo-^{99m}Tc generators contained high activity of ^{99}Mo which was brought down by the standard methods[1,6,16], the rest of them have less contamination than the recommended limits as set by [10-12] which is graphically represented in figure 1. Most of eluted generators 90% (n = 45) contained 10% of MBT ($P < 0.05$) as indicated in figure 2.

DISCUSSION

The previous studies [6, 9, 17] carried by researchers on MBT are not enough so the comparison of the current study with other related studies become difficult.

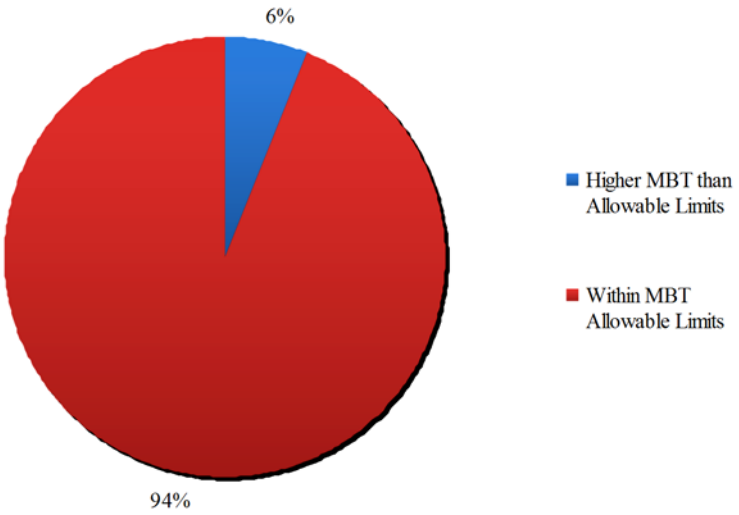

Figure 1. Percentage of Mo^{99}-Tc^{99m} generators within permissible and higher than allowable MBT levels.

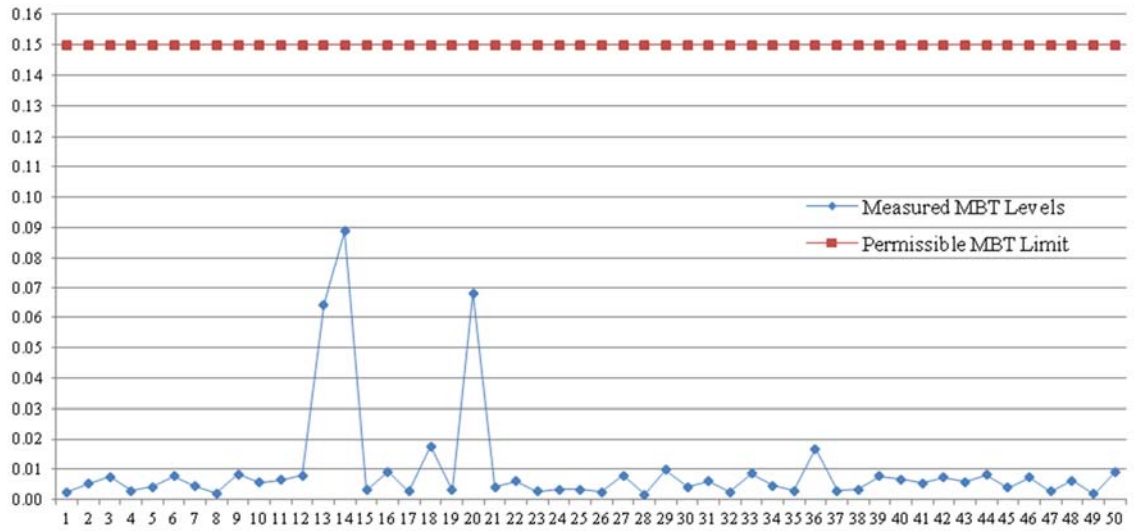

Figure 2. Comparison of NIMRA's MBT Level in Generators with Permissible Level.

^{99m}Tc is the foundation/ building block of nuclear medical centre on which all the diagnostic tests are uprighted. The high contaminated ^{99m}Tc radionuclide with ^{99}Mo was passed through an old generator as described by Fatima N *et al.,* Shah AS *et al.,* Reese IC and Mishkin FS [1, 6, 16] to reduce impurity to acceptable level of 0.15 kBq of ^{99}Mo/MBq of ^{99m}Tc.

The studies [6,17] including current showed the presence of higher levels of MBT which was reduced per standard methods [1,6,16] . The generator elution with higher level of MBT can not be used because the image produced would be of poor quality and the associated radiation doses to the patients would also be higher [1,8,9].

In conclusion this current study among others [6, 9, 17] pointed out the importance of MBT procedure to carry out on each generator [13-15], which is very helpful in getting better image and radiation protection of patients.

The authors suggested that more studies must be conducted on MBT for comparison and to boost up the importance of this vital procedure.

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Conflict of interest: *Declared none.*

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