COMPARISONS OF ^{99}Mo BREAK THROUGH LEVELS IN ^{99}Mo/^{99M}TC GENERATOR ELUATES FROM TWO MANUFACTURERS AND ITS PURIFICATION FOR NUCLEAR MEDICINE IMAGING.

Abdul Saeed Shah, Hameedullah, Ayub Khan, Sami U Khan, Safoora Shahid

Institute of Radiotherapy & Nuclear Medicine (IRNUM), Peshawar, Pakistan.

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ABSTRACT

OBJECTIVES: The molybdenum breakthrough assay is a common quality control test carried out to the check contamination due to ^{99}Mo in the ^{99m}Tc eluates from ^{99}Mo/^{99m}Tc generators. The regulatory authority recommends a limit of 0.15KBq ^{99}Mo/MBq of ^{99m}Tc. The licensees are required to comply with it. The present work describes the comparison of the molybdenum breakthrough levels in generators from two different manufacturers and purification of the eluates with elevated levels of molybdenum breakthrough before its application in nuclear medicine imaging procedures. **METHODS:** The Molybdenum breakthrough assay was performed by canister method with activity meter which is a semiautomatic system that displays result after performing steps in series. The step involved background estimation, 99Mo activity determination in canister and ^{99m}Tc radioactivity assay without canister. **RESULTS:** It was observed that 5 % of indigenously manufactured ^{99}Mo/^{99m}Tc generators had elevated levels of molybdenum breakthrough whereas all the imported generators had molybdenum breakthrough within permissible levels. The ^{99m}Tc eluates showing higher levels of ^{99}Mo were purified before using it for routine radiolabelling. It was observed that in the purification process on the average 26% of initial ^{99m}Tc radioactivity was lost. **CONCLUSIONS:** The purification method employed enabled the department to continue the routine imaging services besides revenue generation and use of available resources which otherwise could not be utilized due to regulatory constraints.

Keywords: Nuclear Medicine; Quality control; Molybdenum Breakthrough; Regulatory limit

Background

Radiopharmaceuticals labeled with ^{99m}Tc are widely used in imaging nuclear medicine departments throughout the world due to its ideal physical properties for imaging with gamma camera, low cost and easy availability. The cold kits are prepared by the manufacturers and released for sale after all prescribed quality control tests are completed. Therefore the composition, chemical purity, apyrogenecity, sterility and particle size, where applicable, are guaranteed by the producer. The 99mTc used in these formulations is obtained from ^{99}Mo/^{99m}Tc generators marketed by various manufacturers.[1-3] The chromatographic generator containing ^{99}Mo adsorbed on alumina is the most common source of ^{99m}Tc for labeling radiopharma ceuticals in nuclear medicine departments through out the world. The radionuclide quality control of eluates from these generators is important for the subsequent quality imaging outcome. The radionuclide contaminants include ^{60}Co, ^{86}Rb, ^{92}Nb, ^{103}Ru, ^{105}Rh, ^{110}Rg, ^{131}I, ^{134}Cs, ^{198}Au and ^{99}Mo.[4-6] The most common radionuclide impurity in the 99mTc eluates is ^{99}Mo. The ^{99}Mo (t1/2 66.7h) emits gamma rays of 740 and 780 keV energies. These ^{99}Mo gamma emissions cause a significant undesirable radiation dose to the patients undergoing investigations besides image degradations. The estimation of ^{99}Mo breakthrough (MBT) is carried out by various methods.[7-13] The current national and international regulations pose a limit of 0.15KBq ^{99}Mo/MBq of ^{99m}Tc at the time of administration of labeled radiopharmaceutical to the

Correspondence : Mr. Abdul Saeed Shah
Institute of Radiotherapy &
Nuclear Medicine (IRNUM)
Peshawar, Pakistan.
Cell: 0302-5523116
E-mail: shahsaeed2002@yahoo.com

patient.[14-15] The Institute of radiotherapy and nuclear medicine (IRNUM) procures 15GBq ^{99}Mo/^{99m}Tc generator weekly for nuclear medicine imaging procedures and is one of the busiest hospital in the north west of Pakistan. The present work describes our experience of MBT estimation on ^{99m}Tc eluates from ^{99}Mo/^{99m}Tc generators supplied by two manufacturers and its purification before subsequent use in nuclear medicine department for imaging.

Methods

All the ^{99}Mo/^{99m}Tc generators included in the present study were eluted in the morning on consecutive week days starting from Monday. The CAPINTEC, CRC-15R activity meter (CAPINTEC, INC. USA.) used for dose calibrations is a semiautomatic system. The daily quality control tests are performed regularly on the activity meter. The results of these tests are within the acceptable range. The MBT assay is performed by canister method described in owner's manual of CAPINTEC, CRC-15R activity meter.[15] The ^{99m}Tc eluates showing higher levels of ^{99}Mo were purified by passing it through previously used ^{99}Mo/^{99m}Tc generators alumina column after washing it with saline.

Results

The MBT levels were found within permissible limits in all the imported ^{99}Mo/^{99m}Tc generators. The 5 % of indigenously manufactured ^{99}Mo/^{99m}Tc generators had elevated levels of MBT (Fig. 1).

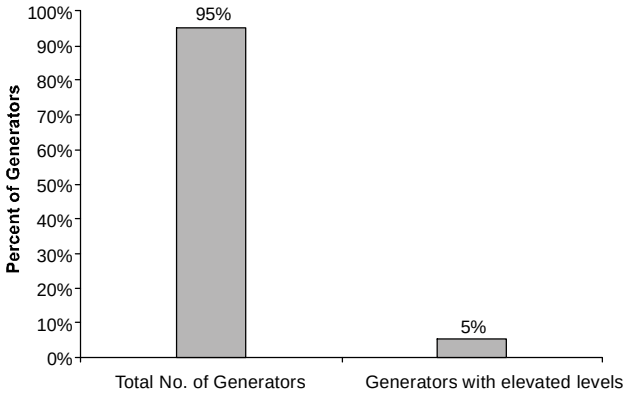

Figure 1: MBT Levels in Indigenous Generators

In terms of number of elutions, 24% elutions showed elevated levels of MBT with range of 1.43 -1.63 KBq ^{99}Mo/ MBq ^{99m}Tc (Fig. 2).

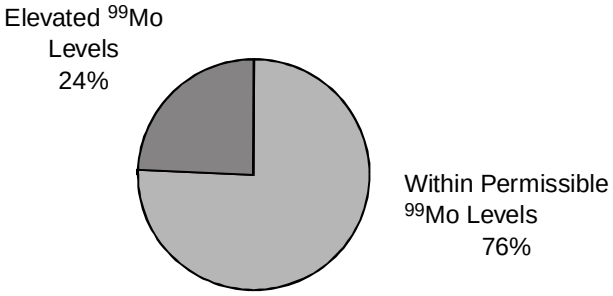

Figure 2: Percent Elutions Showing ^{99}Mo Breakthrough Levels

The elutions from generators having MBT levels above the permissible level were purified (Fig. 3a).

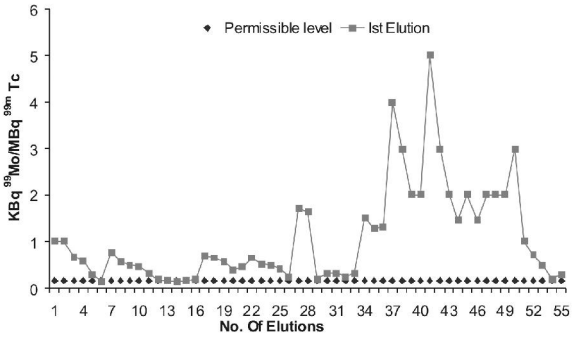

Figure 3a: ^{99}Mo Breakthrough Level Before Purification

After purification the MBT levels were found within the permissible levels (Fig. 3b).

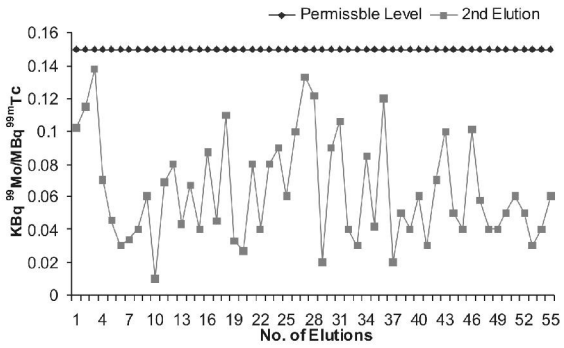

Figure 3b: ^{99}Mo Breakthrough Level After Purification

After purification the MBT levels were found within the permissible levels (Fig. 4).

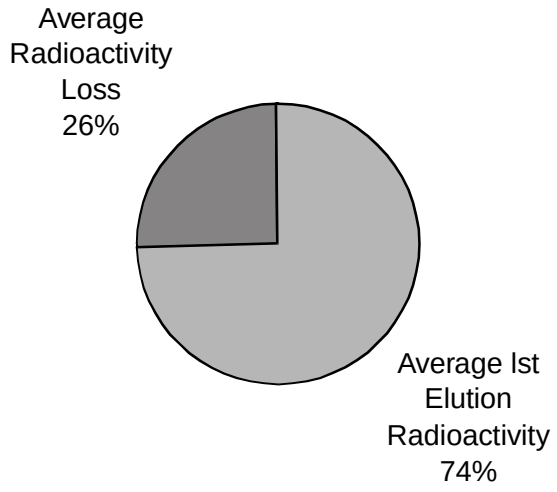

Figure 4: Average ^{99m}Tc Radioactivity Loss

Discussion

The nuclear medicine department of the institute exclusively depends on the weekly supply of the ^{99}Mo/^{99m}Tc generators for in vivo imaging procedures. The elutions from these generators with elevated levels of MBT cannot be used for radiolabelling diagnostic nuclear medicine kits as per existing regulations. The dose coefficient for ^{99}Mo is about 50 times higher than that of ^{99m}Tc due to the beta particle and gamma rays emitted by ^{99}Mo. Moreover, depending on the activity of the ^{99}Mo, the quality of the image acquired is also affected. The results of MBT assay indicate that 5 % of the indigenously manufactured generators had MBT level above the permissible levels (Fig. 1). Generally elevated levels of MBT are associated with defective alumina column packing, filter damage and disruptions in the alumina column during transportation or channel formations in the column due to daily elutions. But in the present work elevated MBT levels were observed in the very first elution and then all the subsequent daily elutions down the week, suggestive of defective alumina column packing or disruptions in the column during transportation. The detection of higher MBT levels in the early elutions from ^{99}Mo/^{99m}Tc generators poses problems to the nuclear medicine department for continuation of imaging services as under the prevailing regulations eluate with MBT content above the permissible level can not be used for patient's diagnostic tests. Such situations also cause inconvenience to the patients waiting for the diagnostic investigation and revenue loss to the hospital. In order to offset the impact of these factors, the ^{99m}Tc elutions were purified from ^{99}Mo contamination. We used Issac & Freed method[10] which is simple, easy and does not involve additional cumbersome steps. However, in this purification process the final ^{99m}Tc activity recovered was less than the initial activity applied on the column. The decrease in the final ^{99m}Tc radioactivity appears due to ^{99m}Tc retention in the tubing and column of the generator system used for purification. The purification method employed enabled the department to continue the routine imaging procedures, revenue generation from these procedures and use of available resources.

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