Importance of Toilet in Nuclear Medicine and Molecular Imaging Center

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Abstract
The practice of nuclear medicine imaging and radio-nuclide therapy involves administering a radioactive compound, which is labeled with a gamma ray or positron or beta minus emitting radionuclide into the body of patients resulting in radiation emissions from the patients until their radioactivity becomes negligible. These are used to provide diagnostic information in a wide range of disease states and they range from those with short half-lives such as 15O, 18F, 99mTc emitting photons whereas relatively long-lived ones such as 131I with both gamma ray and beta particle emitting for radio-nuclides therapy. Since the patients excrete much of the radiation via urination in the nuclear medicine facility, Special toilet (Hot or Active Toilet) for Nuclear Medicine patients is required. Because of the patients excrete much of the radiation via urination, Patient toilet should not use for general patients, patient visitors and hospital staff.

Keywords: Technetium 99m (99mTc), radiopharmaceuticals, nuclear medicine, radiation monitoring, Radiation protection, Active (Hot) toilet

Introduction
Lavatories play a vital role in the sanitation of your domestic and keep you hale and hearty. They effectively and hygienically remove waste away from the home, reducing the exposure your loved ones have to human waste and the diseases it can carry. These preventable diseases, such as diarrhea, can cause sickness and ill health which can lead to long-term problems. Using a toilet rather than other means, such as defecating outside, is an important step to raising sanitation levels and health quality across Nepal.

The importance of toilets in Nuclear Medicine facilities is totally difference than our domestic and public aspect such as to maintain hygiene. Nuclear Medicine services are now at growing stage in Nepal. Till now, there are three PET/CT centers are available in Nepal in which two centers are available in Kathmandu valley where as one center is available at Birtamod in Jhapa district (Eastern Nepal). Likewise, there are seven SPECT and Radio-Iodine Therapy centers are available in Nepal in which four of them available in Kathmandu valley and three are available outside the valley (two centers at Bharatpur in Chitwan district and one center is available at Biratnagar in Morang district).

The nuclear medicine practice imaging involves administering a radioactive material to patient, which is labeled with a radionuclide into the body of patients resulting in gamma ray or positron emissions from the patients until their activity becomes negligible. These are used to provide diagnostic information in a extensive range of disease states and they range from those with short half-lives such as ^{15}O (T1/2=123 sec) emitting photons of 511 keV to relatively long-lived ones such as ^{131}I (T1/2=8.04 days) with gamma ray energies of 636.9 keV (7.3%) and 364.5 keV (81.2%) and beta minus (β^-) energy of 606.3 keV (89.3%) [1] which is also used for therapeutic purposes. Technetium-99m (^{99m}Tc) with gamma ray energy of 140 keV and a half-life of 6.02 hours is today the most widely used radionuclide in nuclear

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medicine. [2, 3] When injected into patients, ^{99m}Tc is excreted mostly via the renal pathway primarily by glomerular filtration. It is said that in patients with normal renal function, 50% to 60% of the injected dose is excreted in the urine within 24 hours .3

The use of radionuclides in patients undergoing nuclear medicine procedures presents special concerns for evaluation of radiation dose and risk to the population [4] and the general public [5] including relatives, friends and others who come in contact with the patients. Based on the need to protect the general public from radiation exposure from the environment including that from patients administered with radionuclides, the International Commission on Radiological Protection (ICRP) and the Atomic Energy Regulatory Board (AERB) of India set the acceptable annual exposure dose for the general public to be 1mSv, while the European commission linked the constraint to age (children, including the unborn child - 1 mSv, adults up to 60 years old - 3 mSv, adults more than 60 years old - 15 mSv and general public - 0.3 mSv)[5]. The International Atomic Energy Agency (I.A.E.A) and the Nuclear Regulatory Commission (NRC) set the limit at 5 mSv.

The nuclear medicine patient, during staying or before leaving department, would have eliminated much of the radiation by both physical and biological decay of the radionuclide. The patients are usually encouraged to drink large amounts of water or fluid to aid the excretion of the radionuclide injected from the body and for the attenuation of the radiation dose to the bladder. Since the patients excrete much of the radiation via urination in the nuclear medicine facility, Special toilet (Hot or Active Toilet) for Nuclear Medicine patients is required. Because of the patients excrete much of the radiation via urination, patient toilet should not use for general patients, patient visitors and staff. The drainage of the active toilet should not be directly joined to main sewer of city. There should be two delay tanks for each active toilet and after radioactivity decayed till negligible level, open to main sewer of city [figure 1].

The radiation levels in the active toilets are little bit high and the radiation risk posed by the "radioactive urine" should be avoided by relative of patients (who accompany very sick patients to such toilets), the cleaners and other radiation personnel. There should be at least two types of toilets available in Nuclear Medicine facilities, one is active toilet and other is general toilet. The Active toilet should not be used by any other than the patients undergoing scintigraphy administered radiopharmaceuticals. Hot or active refers to an area where radiation may be present. For example, a "hot or active" toilet is reserved for patients who have been given a radioactive substance and who are considered radioactive themselves. A lot of researches concluded that the radiation levels from toilets used by patients injected with ^{99m}Tc-based radiopharmaceuticals were within reasonable and acceptable limits and do not pose significant radiation risk to others but still we should not let it go.

There is special attention should be focused in toilet available in radionuclides therapy isolation ward. Radionuclides are usually administered to the patient. The radionuclides concentrate in the patient's diseases. However, radionuclides will also be eliminated from the patient via the urine, perspiration and other body excreta. Radioactivity remaining in the body after 48 hours is located primarily in the patient's diseases organ. There should be two delay tanks for each active toilet and waste should be stored in delay tank. After radioactivity decayed to negligible level, it can be open to main sewer of city.

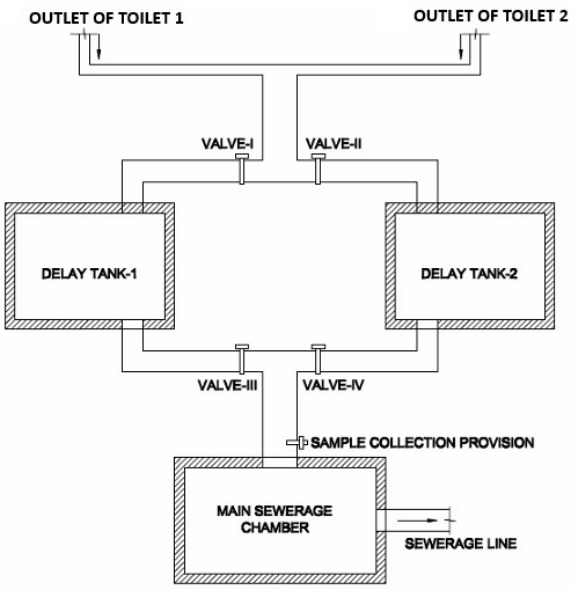

FIGURE 1: DUAL DELAY TANK SYSTEM FOR COLLECTION AND SAFE DISPOSAL OF RADIOACTIVE WASTE FROM NUCLEAR MEDICINE FACILITIES

Endnote

Here we concluded that there should be special separate toilet for both Nuclear Medicine Imaging facilities and Radio-nuclide therapy ward for only patients administered radio-nuclides for diagnosis or therapeutic purposes. The radiation levels can further be significantly reduced if radiation safety instructions are properly followed by the patients and usage of automatic toilet flushers, which will flush the toilets should the patient fail to follow the instruction to flush twice after use will be of great efficacy especially within the milieu of high illiteracy.

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