Low Radiation Dose Handling of a Technetium-99m Stock Solution

B.L. Wemmenhove, W.H. Bakker, and A.M. Ruis

University Hospital, Rotterdam, Netherlands

We have developed an inexpensive system to reduce the hand dose received by nuclear medicine technologists responsible for the daily preparation of [^{99m}Tc] pertechnetate syringes. Compared with a commonly used method, an overall hand dose reduction of about 90% was achieved. We also report a significant decrease in single syringe preparation time.

In a nuclear medicine laboratory the technologist concerned with the daily preparation of radioactive doses is at risk of receiving irradiation, especially to the hands. In order to minimize the radiation dose, we developed a low radiation stock solution handling system, which results in a substantial decrease in radiation during manipulation.

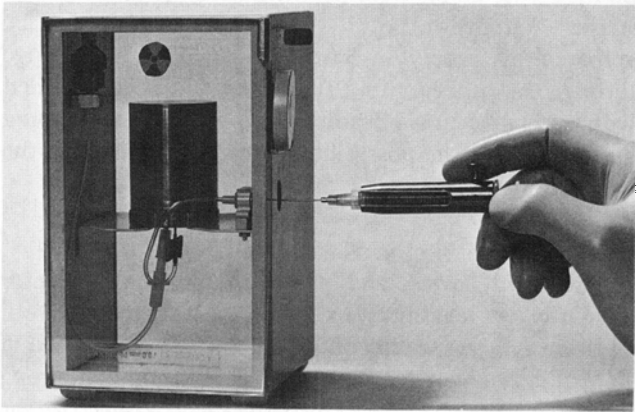

FIG. 1. Withdrawal procedure of [^{99m}Tc] pertechnetate from new system. Note that front and rear panel are made of lead glass.

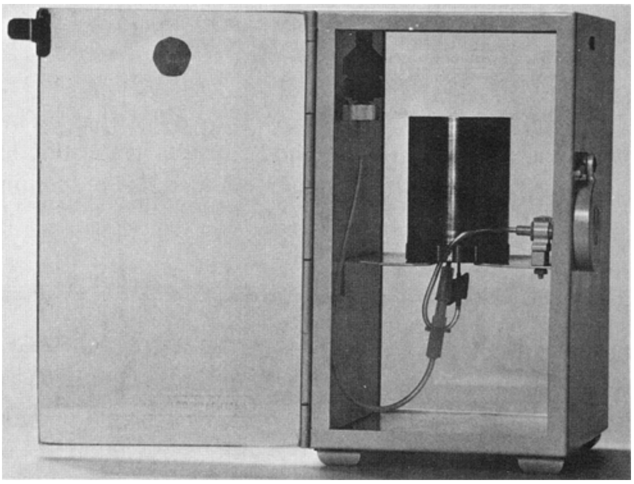

FIG. 2. System's interior. Note slide that shields activity when system is not in use.

Methods and Materials

The method routinely used in many hospitals (including ours until two years ago) consists of withdrawing the desired amount of [^{99m}Tc] pertechnetate directly from the stock solution and placing it in a vial shield (method 1). The technologist preparing these doses daily from a freshly eluted stock receives radiation from the stock solution and from the syringe during the preparation procedure. Our new system was designed to fulfill the following requirements: improve radiation protection, permit a simple vial installation procedure, and provide for ease of use and aseptic conditions. Our system (method 2) (Fig. 1) uses a lead-mounted box (110 × 120 × 180 mm; Pb-wall thickness: 5 mm) in which the stock solution, encircled by a vial shield, is placed.

The [^{99m}Tc] pertechnetate is collected by means of a butterfly infusion system. The rubber stop that forms the injection site is placed in a hole in one side of the box and the needle tip is inserted into the vial; this procedure has to be done with forceps.

In order to prevent creation of a vacuum in the stock solution when a syringe is filled, a plastic tube with an open end is connected to a needle in the stock solution via a sterile Swinnex 0.22μm micropore filter. To guarantee

For reprints contact: B.L. Wemmenhove, Dept. of Nuclear Medicine, University Hospital Rotterdam, Dr. Molewaterplein 40, 3015 GD Rotterdam, Netherlands.

TABLE 1. Data, Results, and TLD Badge Values during Preparation of Seven Syringes of 370 MBq (10 mCi) [^{99m}Tc] Pertechnetate from a 3.7 GBq (100 mCi) Stock Solution

	Average syringe preparation time (sec)	Radiation level 10 cm from withdrawal point (Coulomb/kg)	Radiation level in syringe during preparation (at finger level) (Coulomb/kg)	Calculated hand dose (Gy)	TLD badge value (Gy)
Method 1	15	5.2×10^{-5}	6.5×10^{-7}	5.9×10^{-5}	5.8×10^{-5}
Method 2	10	1.0×10^{-6}	6.5×10^{-7}	1.3×10^{-6}	9.3×10^{-7}

aseptic conditions we replace the plastic tube and micropore filter every week; we replace the needle as well as the butterfly daily. We perform regular sterility tests on the eluate handled in this way and it has proven to be sterile. Withdrawal of [^{99m}Tc] pertechnetate can be achieved by simply inserting the needle of a syringe through the rubber stop. Prior to this, the needle is filled with a 154 mM/L NaCl solution to prevent air trapping and to prevent the possibility of air leaking around the needle hub.

Comparison of Methods 1 and 2

Radiation levels and thermoluminiscent detector (TLD) badge readings were obtained during withdrawal of seven syringes, each containing 370 MBq (10 mCi) of [^{99m}Tc] pertechnetate, from a stock solution containing 3.7 GBq (100 mCi). The TLD badges were applied on the thumb, index, and middle fingers of the right hand during the experiment. Throughout our use of methods 1 and 2, we used a clean bench, lead glass body protection, syringe shielding, and lead-lined syringe carriers.

Results

Data and calculated results are shown in Table 1. The data clearly indicate that method 2 results in a distinctly decreased hand dose. Using our method, a 30% reduction in preparation time of a single Tc-99m syringe is achieved, since it is no longer necessary to remove air bubbles (because of previous filling of the needle with a NaCl solution). Prefilling also leads to a high correlation between calculated and measured dose especially in the case of high specific activity of the stock solution.

Furthermore, method 2 results in a 98% reduction in the radiation level from the stock solution. The overall decrease in hand dose is about 90% under the conditions tested. The reduction increases substantially when stock solutions containing larger amounts of [^{99m}Tc] pertechnetate are used, which is normally the case in nuclear medicine. Taking into account the yearly preparation of several thousands of syringes, our method leads to a considerable hand dose reduction. Since introduction of this method, the registered dose on the dosimeter worn on a technologist's forearm stayed below 5.1×10^{-3} Gy/yr.

We have now used this system for two years in our laboratory and it has proven to be effective, efficient, and satisfactory.

Acknowledgment

The authors express their gratitude to Mr. R.G. Jansen, Interuniversity Reactor Institute Delft, for the donation and processing of the TLD badges.