J of Nuclear Medicine Technology, first published online December 23, 2014 as doi:10.2967/jnmt.114.147983

Assessment of technetium-99m succimer residual activity using inert non-reactive syringes

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ABSTRACT

It has been widely reported that technetium-99m (Tc99m) succimer adsorbs to plastic syringes significantly (up to 50%), often resulting in a lower administered dose than intended or inaccurate dosing. This is especially problematic in the pediatric population. To improve Tc99m succimer dosing, we compared the adsorption of Tc99m succimer to two types of syringes: silicone-coated syringes with non-latex rubber on the plunger, and inert non-reactive syringes with no silicone coating and no rubber on the plunger. Methods: Tc99m succimer kits were compounded according to manufacturer's instructions. A series of Tc99m succimer doses (37 – 185 MBq) were drawn into 3-mL (silicone-coated or inert non-reactive) syringes in 1 mL volume. Thirty min, 1hr, 2hr, and 4 hr later, the syringes were assayed in a dose calibrator, and assayed again after being emptied and rinsed with saline. In addition, we examined the data collected from 129 Tc99m succimer doses administered in a pediatric department, in which 52 were dispensed in silicone-coated syringes and 77 were dispensed in inert non-reactive syringes. The doses were assayed immediately before and after injection followed by flushing with saline. Results: The labeling efficiency of the Tc99m succimer kits was more than 95%. Residual activity left in the inert non-reactive syringes was 0.73% (SD ± 0.18%), which is significantly lower than the activity left in the

silicone-coated syringes (P<0.0001), which was 20.9% (SD ± 5.6%). The extent of adsorption did not change significantly between 30 min and 4 hours of incubation. The clinical data showed that the residual activity was 30.6% (SD±12.5%) from doses dispensed in silicone-coated syringes and 6.38 % (SD±2.95%) from doses dispensed in inert non-reactive syringes (P<0.001). Conclusion: The inert non-reactive syringes have significantly less residual of Tc99m succimer than silicone based syringes, making it possible to accurately administer calculated doses of Tc99m succimer to pediatric patients.

Key Words: technetium-99m dimercaptosuccinic acid; succimer; syringe residual; radiopharmaceutical; administered activity

INTRODUCTION

The adsorption or adhesion of radiopharmaceuticals to administration sets and syringes has been well documented. Table 1. In a previous study we found that ^{99m}Tc-succimer adsorbed to plastic syringes up to 82% often resulting in a lower administered dose than intended or inaccurate dosing.*(9)* This is especially problematic with low doses used with the pediatric population, which led us to investigate syringes with clinically acceptable levels of adsorption.

MATERIALS AND METHODS

^{99m}Tc-succimer kits were compounded according to manufacturer's instructions. A series of ^{99m}Tc-succimer doses (37 – 185 MBq) were drawn into 3-mL type A (BD 3 mL, 309572, B-D, Franklin Lakes, NJ USA) and type B (HSW 3 mL, 4020-X00V0 2 mL (3 mL) NORM-JECT®, Henke Sass Wolf, Tuttlingen, Germany) syringes with a volume of 1 mL. Both syringe types are composed of a blend of laboratory grade polyethylene and polypropylene in sterile individually wrapped packaging. Thirty min, 1hr, 2hr, and 4 hr later, the syringes were assayed in a dose calibrator, and assayed again after being emptied and rinsed with saline. In addition, we examined the data collected from 129 ^{99m}Tc-succimer doses administered in a pediatric department located in a tertiary care academic pediatric hospital licensed for 230-inpatient beds with approximately 7,000 admissions per year serving all pediatric subspecialties. A research protocol and application was submitted to the campus institutional review board, and was approved. The pediatric nuclear medicine department is staffed by four CNMT's who shared the responsibility of administering and recording the ^{99m}Tc-succimer doses. Doses were administered using a small bore T-port extension set with 5 mL of NS divided over two rinses through the syringe and the administration set. The activity in the syringe

was assayed immediately before and after injection with decay correction figuring into the analysis.

Results

The labeling efficiency of the ^{99m}Tc-succimer kits was more than 95%. Residual activity left in the inert non-reactive syringes was 0.73% (SD ± 0.18%), which is significantly lower than the activity left in the silicone-coated syringes, 20.9% (SD ± 5.6%) ($P<0.0001$). Table 2. The extent of adsorption did not change significantly between 30 min and 4 hours of incubation. 134 data points were collected with 129 included in analysis. The clinical data show that the residual activity was 30.6% (SD±12.5%) from doses dispensed in silicone-coated syringes and 6.38% (SD±2.95%) from doses dispensed in inert non-reactive syringes ($P<0.001$). Table 2.

DISCUSSION

This study demonstrated that syringe B had significantly less residual than syringe A. Previously with syringe A, the clinic was calculating the low pediatric doses and adding additional activity to compensate for variable adsorption loss, in which the correlation between assayed activity and administered dose was 0.94. This method of dose calculation confounded efforts to lower the recommended minimum dose and reduce the radiation burden to the patient. As a result of the study, the clinic changed the

ordering procedure for the patient population eliminating the arbitrary addition for residual loss. With syringe B the correlation between assayed activity and administered dose was 0.99. The five injections not used in the analysis were from the same technologist who did not rinse the syringe during administration. Keskintepe et al. have shown that administration technique can greatly affect residual. *(10)* In a controlled environment the adhesion was less than 1% regardless of incubation time with the inert syringes (syringe B). In the clinic, syringe B still had a much wider range for adsorption indicating variances with rinsing technique or difficult patient dynamics at times. The technologist did report that the new method only called for 2 rinses with normal saline vs previously using 4 to 5 rinses to reduce the ^{99m}Tc-succimer residual. One problem reported was from the staff pharmacists drawing the doses. There is a small learning curve to overcome the increased resistance in syringe B. In order to have a liquid tight seal as the piston moves through the barrel, the barrel in syringe B flexes to accommodate the slightly larger diameter piston tip. Swanson, et.al studied six syringe brands of which one showed significantly low adhesion of 5.2% ± 2.5% with technetium 99m sestamibi and concluded that much of the adhesion appeared in the syringe barrel and the plunger with minimal residual activity in the butterfly and tubing.(*1*) Overall the selection of a low adhesion syringe gives more reproducible

residual activities and reduces the dispensed activity used in clinical procedures. This type of inert non-reactive syringes with no silicone could be used for other radiopharmaceuticals with high syringe adsorption reports such as ^{99m}Tc-tetrofosmin *(7)* and ^{99m}Tc-sestamibi. *(1)*

Conclusions

The inert non-reactive syringes had significantly less average residual than the commonly used silicone coated syringes. This change made it possible to eliminate the arbitrary addition of activity to account for residual loss and more accurately administer desired doses in this pediatric population.

Acknowledgements

The authors would like to thank Ann Kirkpatrick and the staff of the University of Oklahoma Nuclear Pharmacy. The authors would like to thank the following faculty and staff of the OU Medical Center: Dr. Leann Smith, Kim Brush and Jean Nelson.

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Figure 1. Inert non-reactive syringe

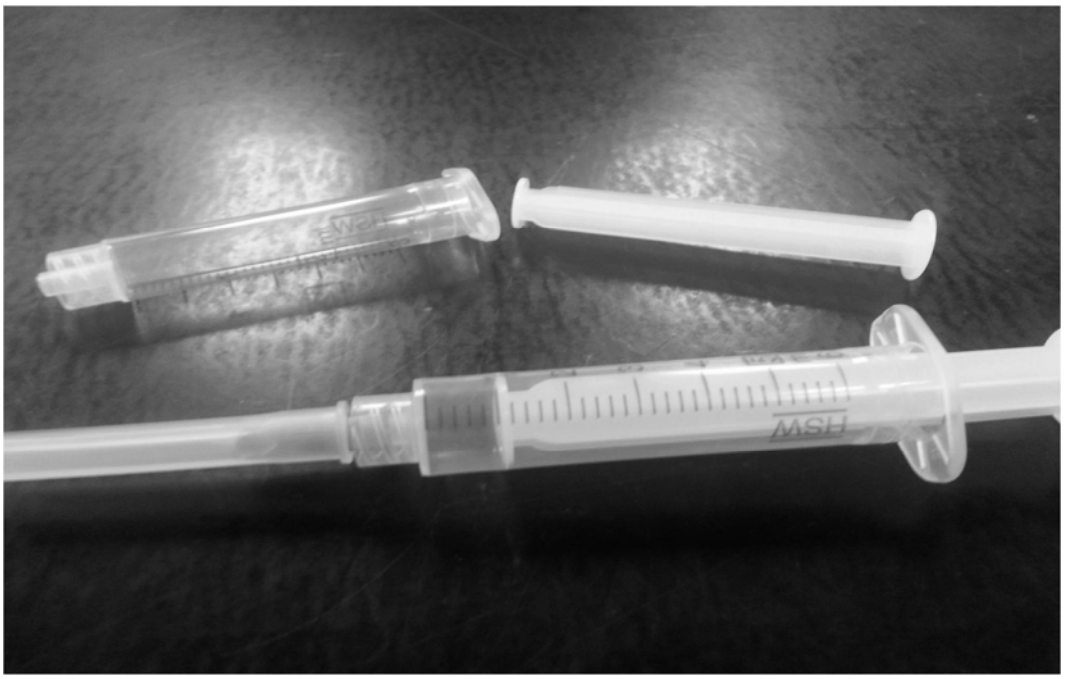

Table 1- Factors affecting adsorption

Factors contributing to syringe adsorption	**Factors NOT affecting syringe adsorption**
Silicone or lubricant	Time > 30 min
-Swanson JNMT 2013 (1)	-Bartosch EJNM 1998 (7)
Elastomeric plunger tips	-Gunasekera NMC 2001 (2)
-Gunasekera NMC 2001 (2)	Volume of radiopharmaceutical in syringe
-Cheng JAPhA 2002 (3)	-Gunasekera NMC 2001 (2)
-Jansson JNMT1998 (4)	-Stopar NMC 2007 (6)
Barrel	-Swanson JNMT 2013 (1)
-Jansson JNMT 1998 (4)	Dead space in syringe if rinsed
-Mushtag JNMT 2008 (5)	-Gunasekera NMC 2001 (2)
Volume of radiopharmaceutical in syringe	
-Stopar NMC 2007 (6)	
Rinsing during administration	
-Cheng JAPhA 2002 (3)	
-Jansson JNMT 1998 (4)	
Brand and lot of syringe	
-Bartosch EJNM 1998 (7)	
-Hurless JNM 2000 (8)	
-Gunasekera NMC 2001 (2)	
-Jansson JNMT 1998 (4)	

Table 2- Results

Description	Syringe A	Syringe B
Syringes in lab (n=24)	20.9% (SD±5.6)	0.73% (SD±0.18)
Syringes in clinic	52	77
Activity range	37 – 240 MBq	21 – 218 MBq
Residual range	8.32% to 73.91%	1.49% to 17.44%
Residual average	30.6% (SD±12.5)	6.38% (SD±2.95)