Assessment of ^{99m}Tc-Succimer Residual Activity Using Inert Nonreactive Syringes

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It has been widely reported that ^{99m}Tc-succimer adsorbs to plastic syringes significantly (up to 50%), often resulting in a lower administered dose than intended or inaccurate dosing. This adsorption rate is especially problematic in the pediatric population. To improve ^{99m}Tc-succimer dosing, we compared the adsorption of ^{99m}Tc-succimer with 2 types of syringes: silicone-coated syringes with nonlatex rubber on the plunger and inert nonreactive syringes with no silicone coating and no rubber on the plunger. **Methods:** ^{99m}Tc-succimer kits were compounded according to the manufacturer's instructions. ^{99m}Tc-succimer doses (37–185 MBq) were drawn into 3-mL (silicone-coated or inert nonreactive) syringes in a 1-mL volume. Thirty min, 1 h, 2 h, and 4 h 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, in which 52 were dispensed in silicone-coated syringes and 77 were dispensed in inert nonreactive syringes. The doses were assayed immediately before and after injection. The syringes were flushed with normal saline. **Results:** The labeling efficiency of the ^{99m}Tc-succimer kits was more than 95%. Residual activity left in the inert nonreactive syringes was 0.73% (SD, ±0.18%), which was significantly lower than the activity left in the silicone-coated syringes, 20.9% (SD, ±5.6%; $P < 0.0001$). The extent of adsorption did not change significantly between 30 min and 4 h 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 nonreactive syringes ($P < 0.001$). **Conclusion:** The inert nonreactive syringes had significantly less residual of ^{99m}Tc-succimer than silicone-based syringes, making it possible to accurately administer calculated doses of ^{99m}Tc-succimer to pediatric patients.

Key Words: ^{99m}Tc-dimercaptosuccinic acid; succimer; syringe residual; radiopharmaceutical; administered activity

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The adsorption or adhesion of radiopharmaceuticals to administration sets and syringes has been well documented (Table 1) (*1–8*). 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 rate of adsorption 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 the manufacturer's instructions. ^{99m}Tc-succimer doses (37–185 MBq) were drawn into 3-mL type A, silicone-coated (BD 3 mL, 309572, B-D) and type B, inert nonreactive (Fig. 1) (HSW 3 mL, 4020-X00V0 2 mL [3 mL]) NORM-JECT (Henke Sass Wolf) 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, 1 h, 2 h, and 4 h 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 approved. The pediatric nuclear medicine department is staffed by 4 CNMTs 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 normal saline divided over 2 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 nonreactive syringes (Type B) was 0.73% (SD, ±0.18%), which was significantly lower than the activity left in the silicone-coated syringes (Type A), 20.9% (SD, ±5.6%; $P < 0.0001$) (Table 2). The extent of adsorption did not change significantly between 30 min and 4 h of incubation. One hundred thirty-four data points were collected, with 129 included in the analysis. Of these, 52 were dispensed in Type A

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TABLE 1
Factors Affecting Adsorption

Factors affecting adsorption	Reference
Factors contributing to syringe adsorption	
Silicone or lubricant	*1*
Elastomeric plunger tips	*2,3,4*
Barrel	*4,5*
Volume of radiopharmaceutical in syringe	*6*
Rinsing during administration	*3,4*
Brand and lot of syringe	*2,4,7,8*
Factors not contributing to syringe adsorption	
Time > 30 min	*2,7*
Volume of radiopharmaceutical in syringe	*1,2,6*
Dead space in syringe if rinsed	*2*

TABLE 2
Results

Description	Syringe A	Syringe B
Lab setting		
No. of syringes	12	12
Activity range	37–185 MBq	37–185 MBq
Residual average	20.9% (SD, ±5.6)	0.73% (SD, ±0.18)
Clinic administration		
Syringes in clinic	52	77
Activity range	37–240 MBq	21–218 MBq
Residual range	8.32%–73.91%	1.49%–17.44%
Residual average	30.6% (SD, ±12.5)	6.38% (SD, ±2.95)

syringes, and 77 were dispensed in Type B syringes. 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 nonreactive 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 5 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 technologists did report that the new method called only for 2 rinses with normal saline versus previously using 4–5 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 6 syringe brands, 1 of which showed a significantly low adhesion of 5.2% ± 2.5% with ^{99m}Tc-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 nonreactive 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*).

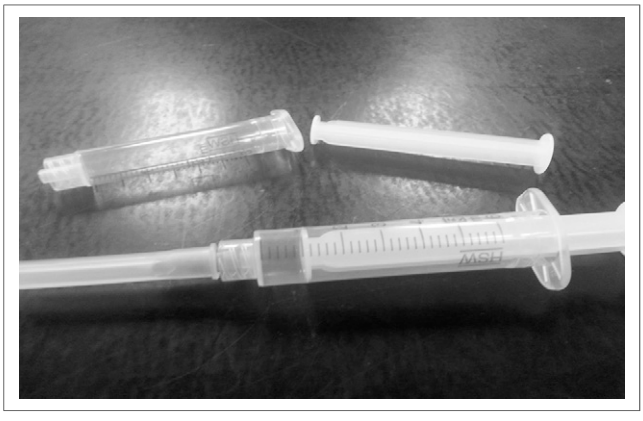

FIGURE 1. Inert nonreactive syringe.

CONCLUSION

The inert nonreactive 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.

DISCLOSURE

No potential conflict of interest relevant to this article was reported.

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REFERENCES

1. Swanson TN, Troung DT, Paulsen A, Hruska CB, O'Connor MK. Adsorption of ^{99m}Tc-sestamibi onto plastic syringes: evaluation of factors affecting the degree of adsorption and their impact on clinical studies. *J Nucl Med Technol.* 2013;41:247–252.
2. Gunasekera RD, Notghi A, Mostafa AB, Harking LK. Adsorption of radiopharmaceuticals to syringes leads to lower administered activity than intended. *Nucl Med Commun.* 2001;22:493–497.
3. Cheng K, Ngo T. Stability and absorption of Tc99m sestamibi in plastic syringes. *J Am Pharm Assoc.* 2002;42:306.
4. Jansson BA, Goransson MB, Agren BN. Adsorption of some technetium-99m radiopharmaceuticals onto disposable plastic syringes. *J Nucl Med Technol.* 1998;26:196–199.
5. Mushtag A, Rehman TU, Mansur MS, Jehangir M. Adsorption of ^{99m}Tc-radiopharmaceuticals onto injection vials and syringes. *J Nucl Med Technol.* 2008;36:91–94.
6. Stopar TG, Socan A, Peitl PK. Adsorption of radiopharmaceuticals to syringes: setting up a reliable protocol for its assessment. *Nucl Med Commun.* 2007;28: 951–955.
7. Bartosch R, Granegger S, Sinzinger H. Adsorption of technetium-99m tetrofosmin and technetium-99m furifosmin on plastic syringes. *Eur J Nucl Med.* 1998; 25:1333–1335.
8. Hurless LM, Graves MW, Mufti OI, Quinton TM. The adsorption of technetium-99m sestamibi onto three plastic syringes: an evaluation of dosage administration error. *J Nucl Med.* 2000;41(suppl):250P–251P.
9. Galbraith W, Nguyen A, Harrison DL, Chen X, Talley K. Evaluation of ^{99m}Tc-succimer dosing in pediatric patients. *J Nucl Med Technol*. 2013; 41:81–84.
10. Keskintepe D, Ozer AY. Residual radioactivity in the syringes used in injection of RP and factors affecting the amount of residual radioactivity. *FABAD J Pharm Sci.* 2005;30:176–180.