Technetium-99m DTPA Aerosol Contamination in Lung Ventilation Studies

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Contamination of working areas by ^{99m}Tc DTPA aerosol is of concern to nuclear medicine technologists. This study sought to determine the extent of ^{99m}Tc DTPA contamination to technologists, and to localize sources of aerosol leakage so that methods could be identified that would minimize contamination.

Methods: Fifty to eighty millicuries ^{99m}Tc DTPA, diluted to a volume of 4–5 ml with normal saline, were injected into the nebulizing chamber of two commercially available inhalation aerosol systems. The patient's nostrils were clamped and a damp washcloth was wrapped around the patient's mouth. An alcohol swab was placed in the exit port of the exhaust filter in each delivery system, and the technologist involved wore a face mask during the inhalation phase. The patient breathed DTPA-labeled aerosol by mouth until the counting rate in the lungs was four times greater than the counting rate from the pulmonary perfusion phase. Connecting joints of the delivery system were then wipe tested. Last, a Geiger-Mueller detector (pancake probe) was used to survey all device components. Readings above 0.05 mR/hr were considered contaminated.

Results: The patient was the greatest source of leakage as determined by the damp washcloth, followed by the joints of the tubes of the delivery system and, finally, the system's exhaust filter. Contamination readings from face masks worn by technical personnel during the lung ventilation studies were slightly greater than 0.05 mR/hr.

Conclusion: The findings support trace levels of contamination to both the technologist and room while performing ^{99m}Tc DTPA aerosol ventilation studies. Comparative data using the two delivery systems revealed little difference in sources of leakage and little variation in contamination measurements.

Key Words: technetium-99m DTPA aerosol; contamination; radiation safety

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In our facility, ^{99m}Tc DTPA aerosol studies became a major concern after technologists and physicians tested positive for technetium contamination on quarterly whole-body bioassays. The contamination was traced to exposure during radioactive aerosol procedures. While ^{99m}Tc DTPA aerosol imaging has been reported to cause contamination, as discussed by Crawford et al. (*1*) and McGraw et al. (2), these studies disagree on the major source of contamination. The purposes of this study were to: determine the sources of contamination to the technologist when performing ^{99m}Tc DTPA aerosol ventilation studies; evaluate the significance of the contamination; and develop methods to reduce contamination.

Data was lacking on ^{99m}Tc DTPA aerosol contamination, however, there was concern shown by technologists involved with the study in Crawford et al. (*1*). Hart et al. (*3*) reviewed surface contamination following radio-aerosol airborne contamination, while McGraw et al. (*2*) proposed operator error as a source of leakage. In most studies, different methods of determining contamination were used. A valuable method was continuous air monitoring of airborne radio-aerosol concentration discussed by McFarland et al. (*4*). Finally, Parker et al. studied the design and planning of workplace air sampling (*5*).

MATERIALS AND METHODS

Two commercially available nebulizer kits, named Kit 1 and Kit 2 here, were used in this study. The kits only differed in design as follows: Kit 1 needed to be assembled by the user, while Kit 2 was preassembled by the manufacturer. Twelve patients were studied with Kit 1 and five patients were studied with Kit 2.

A room reading was taken before each study, then 50–80 mCi ^{99m}Tc DTPA, diluted to a volume of 4 ml with normal saline, were infused into the reservoir of an aerosol unit connected to an oxygen tank with a flow rate between 9–13 liter/min. The patient's nose was clipped, and the patient inhaled and exhaled radio-aerosol by mouth at a rate of 6 sec per frame dynamic mode until a predetermined number of counts was achieved on the computer.

During the administration, a damp washcloth was placed around the patient's lips to pick up aerosol contamination around the patient's mouth. An alcohol swab was inserted into the exit port of the unit's exhaust filters to determine any possible leakage. The technologist involved wore a face mask

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TABLE 1
Leakage and Contamination Measurements in mR/hr for Kit 1

Study	Washcloth	Exhaust	Joints	Mask
1	0.18	0.03	1.70	0.03†
2	35.00	0.15	9.50	4.0
3	8.00	0.30	0.80	1.50
4	*	0.12	0.40	0.02†
5	1.50	0.30	1.90	0.13
6	0.60	0.10	0.50	0.06
7	0.30	0.08	0.35	0.02
8	11.00	0.06	0.40	0.07
9	3.00	0.40	0.50	0.50
10	0.15	0.08	1.30	0.04†
11	7.00	1.40	0.11	0.07
12	3.50	2.00	1.10	0.30
Average	6.38	0.42	1.55	0.56

*No wash cloth was used in Study 4.
†The technologist was farther than 1 m from the patient.

during the administration of the aerosol. An alcohol swab wipe test was performed on the tubing joints of the aerosol unit, and on the bed or chair used by the patient during the study. Alcohol swab wipe tests also were performed on the floors of the rooms involved in the study at preset floor markings.

More than one technologist was involved in data collection. All measurements were performed within 0.5 hr of obtaining the samples in mR/hr using a Geiger-Mueller detector with a pancake probe. There was no decay correction for any of the samples.

RESULTS

Results for Kit 1

The room reading before each study was below 0.05m R/hr and after the study the room returned to below 0.05 mR/hr. Measurements of the washclothes from the 12 patients ranged from 0.18 mR/hr to 35 mR/hr. This was the worst contamination of the study. Next were the joints of the tubing of the aerosol unit. Measurements ranged from 0.35 mR/hr to 9.5 mR/hr. Another source of leakage was the exit port of the delivery system exhaust filter. Measurements ranged from 0.03 mR/hr to 0.4 mR/hr. Only one measurement of the exhaust filter was below 0.05 mR/hr (Table 1). Measurements of the face mask worn by the technologist ranged from 0.02 mR/hr to 0.5 mR/hr. All other measurements were less than 0.05 mR/hr as shown in Table 1.

Results for Kit 2

Similar results were obtained using Kit 2. The only differences were that Kit 2 was preassembled, therefore eliminating the joints as a leak source, and Kit 2 was shielded in such a way as to enclose the nebulizer and the exhaust pipe.

DISCUSSION

We found there was significant contamination during the administration of ^{99m}Tc DTPA aerosol from the patient in contrast to one previous study (*2*), but in agreement with the study by Crawford et al. (*1*). It should be noted that previous studies reported their results in dpm in contrast to our method where results are in mR/hr.

TABLE 2
Leakage and Contamination Measurements in mR/hr for Kit 2

Study	Washcloth	Exhaust	Joints	Mask
1	3.00	0.20	None	0.05
2	20.00	0.50	None	0.20
3	11.00	0.50	None	0.40
4	20.00	0.15	None	0.25
5	3.00	0.20	None	0.05
Average	11.40	0.31	None	0.19

Patient practice and compliance was the single most important variable in lowering leakage and contamination during the aerosol study. This also corresponds with the study by Crawford et al (*1*). Measurements varied widely based upon the patient's ability to maintain a seal around the mouthpiece.

The joints of Kit 1 were further evaluated. All the connecting parts from the nebulizer intake port to the tubes on Kit 1 had cracks that most likely caused leakage at the joints. Cracks were found on all nebulizers. Finally, technologist mask measurements were below 0.05mR/hr when patients practiced before the study and the technologist was more than 1 m away from the patient (*1,3*).

CONCLUSION

In this study there was contamination to both the technologist and the room while performing ^{99m}Tc DTPA aerosol ventilation studies regardless of which kit was used. Patient practice and a thorough explanation of the procedure helped reduce contamination from the patient.

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REFERENCES

1. Crawford ES, Quinn BC, Zaken AM. Air and surface contamination resulting from lung ventilation aerosol procedures. *J Nucl Med Technol* 1992;20: 151–154.
2. McGraw RS, Culver CM, Juni JE, et al. Lung ventilation studies: surface contamination associated with technetium-99m DTPA aerosol. *J Nucl Med Technol* 1992;20:228–230.
3. Mackie A, Hart GC, Ibbett DA, et al. Airborne radioactive contamination after aerosol ventilation studies. *Nucl Med Commun* 1994;15:161–167.
4. McFarland AR, Ortiz CA, Rodgers JC. Performance evaluation of continous air monitoring (CAM) sampling heads. *Health Phys* 1990;58:275–281.
5. Parker RC, Bull RK, Stevens DC, et al. Studies of aerosol distribution in a small laboratory containing a heated phantom. *Ann Occup Hyg* 1990;34:35–44.