Delivery Efficiency of Technetium-99m DTPA Aerosol

TO THE EDITOR: Lung ventilation imaging employing radioaerosols of technetium-99m diethylenetriaminepentaacetic acid ([^{99m}Tc]DTPA) has now become established as an alternative to radiogases in the differential diagnosis of pulmonary emboli. However, all the commercial aerosol systems have low efficiency when the activity retained in the patient's lung is expressed as a percentage of the activity nebulized. As we have been long-time advocates of the use of radioaerosols we were very interested to read the report by Sirr et al. (*1*) on the increased efficiency obtained by using a solution of 10% ethanol in saline with the [^{99m}Tc]DTPA. We hoped that this might enable us to reduced the activity required for nebulization. Unfortunately we have been unable to document any significant increase in the average delivery efficiency to our patients.

The delivery efficiency was measured in 14 consecutive patients in whom the [^{99m}Tc]DTPA was prepared using 10% ethanol and compared to a previous study in 22 patients with the same nebulizer system* in whom saline alone was used. The activity retained in the lungs from the aerosol was calculated by noting the count rate from the posterior view and comparing this to the count rate from the perfusion image for the same patient for whom the perfusion activity was accurately known. The delivery efficiency in the 22 patients using saline alone ranged from 1.6% to 15.7% with a mean of 7.6%. In the 14 patients in whom 10% ethanol in saline was used, the range of delivery efficiency was 2.4% to 15.2% with a mean of 7.8%.

Sirr et al. (*1*) employed a different aerosol system† although this is unlikely to be the cause of the discrepancy in the results. They presented quantitative data in only 2 normal subjects although they state that several hundred patients have been imaged. It is our experience that a much wider variation in delivery efficiency is found in patients than in controls due to greater variation in depth and rate of breathing. Although small increases in efficiency may be achieved in some patients by using 10% ethanol, the average efficiency remains unchanged, thereby negating our efforts to reduce the activity.

FOOTNOTES

*Cadema Medical Products, Inc., Middetown, NY.

†Diagnostic Products Division, Mallinckrodt, Inc., St. Louis, MO (Ultravent).

References

1. Sirr SA, Juenemann PJ, Tom H, et al: Effect of ethanol on droplet size, efficiency of delivery, and clearance characteristics of technetium-99m DTPA aerosol. *J Nucl Med* 26:643–646, 1985

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REPLY: We agree with Smart et al. that [^{99m}Tc]DTPA aerosol ventilation imaging of regional ventilation is a viable alternative to radioactive gases. Our work described a simple method, the introduction of ethanol to the radioactive solution in the nebulizer, which increases the density of radioactive droplets in aerosol.

Smart et al. described clinical trials in two groups of patients some who received aerosol containing ethanol and others without ethanol. In these two groups of patients, no statistically significant increase in delivery of aerosol efficiency was achieved with ethanol.

We postulate that the apparent lack of effect of ethanol may be due to the use of different aerosol systems. Smart et al. employed an aerosol system* with a large volume "settling" bag in order to remove large droplets. We used an aerosol generator which removes large droplets by passing the aerosol through a series of baffles.† Because ethanol is hygroscopic, it is possible that when droplets containing ethanol reside within the "settling" bag, they will attract water and gain mass. This would result in a high extraction rate of particles within the "settling bag". Therefore, a gain in the delivery efficiency by introducing ethanol to the [^{99m}Tc]DTPA solution may be offset by decreased number of aerosol droplets leaving the "settling" bag resulting in no apparent gain in delivery efficiency to the patient.

We suggest that further investigation of this hypothesis is warranted.

FOOTNOTES

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Uterine Blush in Multiphase Imaging

TO THE EDITOR: We would like to add some observations to those of Mandell et al. regarding the uterine blush in multiphasic bone imaging (*1*). We studied 28 menarchal women, ages 13–51 yr (mean 29.8 yr), who had three-phase bone scans of the anterior pelvis. Technetium-99m methylene diphosphonate was used in all cases. Images were acquired using a gamma camera fitted with a high-sensitivity parallel hole collimator. Flow studies were performed by setting the camera to collect serial 3-sec images for 45 sec. Immediately after the dynamic study, blood-pool images were acquired for a minimum of 500,000 counts.

The flow study was negative or equivocal in six cases. The absence of increased blood flow did not correlate with time of menstruation nor with the intensity of uterine activity on the

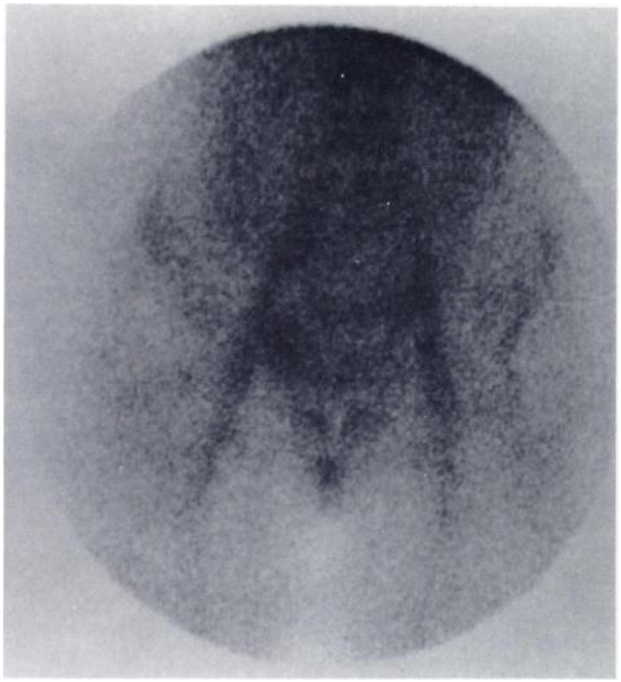

FIGURE 1
Blood pool image showing patchy uterine activity with focal area of hyperemia to right of midline

subsequent blood-pool images. The blood-pool images were positive in all cases, including four women who had amenorrhea for 2–7 mo. None of the four women was pregnant at the time of the study. One woman was taking tamoxifen. Of the remaining 23 women, two were taking estrogen. The intensity of uterine activity was variable and did not correlate with time of menstruation. Activity was not always discrete and midline (Fig. 1).

Clinicians should be familiar with the varied patterns of the uterine blush on the early phases of the bone scan to prevent confusion with soft tissue inflammation and inflammatory bone disease.

Reference

1. Mandell GA, Harcke HT, Sharkey C, et al: Uterine blush in multiphase bone imaging. *J Nucl Med* 27:51–55, 1986

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REPLY: We appreciate the opportunity to comment upon the additional observations on uterine blush proffered in the letter to the editor by Segall and Gurevich. Their blood-pool images demonstrated characteristic supravesical activity in all menstruating women in their population with a mean age of 29.8 yr. Our population, mean of 20.1 yr, exhibited similar findings. The discordant blood flow and blood-pool images they describe in six instances could possibly be related to their technique. Our blood flow images were acquired as 24 5-sec images vs. their 15 3-sec images. The lack of recognition of the uterus on the blood flow images in some of their patients could be attributed to the variation in statistics. Our images lasted longer (5 sec vs. 3 sec) and duration of blood flow segment of the study was greater (120 sec vs. 45 sec).

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Dosimetry for Cystic-Type Tumors

TO THE EDITOR: Taasan et al. have presented data which further illustrates the possibilities for radiopharmaceutical treatment of cystic type tumors (*1*). However, as in most cases previously reported, there appear to be some fundamental considerations which should be more completely addressed in order to deliver appropriate therapy. It would appear obvious that, in order to evaluate the effects of therapy to the cyst itself, the effect must be related to the dose delivered to the cyst wall. In Taasan et al. the radiation dose strived for is the dose to the inner surface of the cyst wall, which they give as 20,000 rad [as calculated by a formula given by Loevinger (*2*)]. In order for the dose to the inner surface of the cyst to be meaningful, though, one must assume that the energy of the beta emissions is completely absorbed in the wall. We have shown that a more meaningful descriptor of the dose relationship is the dose as a function of depth in the wall (*3*, *4*), since there may be significant penetration of the beta particle outside the wall where it is thin (3mm in certain cystic tumors). The dose delivered is also very dependent upon the distribution of the radioactivity inside the cyst. We have noted, as have others previously (*5*,*6*), that after a short time most of the radiocolloid apparently tends to be "plated out" onto the inner surface of the cyst. Thus, rather than making the assumption of a uniform distribution inside the cyst fluid, the more appropriate geometrical configuration of activity for dosimetry purposes is the spherical shell geometry. With regard to the calculated dose to be delivered, we feel that the expected dose should be computed at distances through the wall, and some points beyond the wall if necessary, until the range of the beta particle is reached. The endpoint consideration should thus include both cyst wall dose as well as the surrounding tissue dose. The cyst wall thickness can be determined with modern imaging techniques (computed tomography or nuclear magnetic resonance).

The need for preciseness in the delivery of the dose has been demonstrated by reports of possible partial visual impairment (*7–9*) resulting from intracystic radioactive sources which can occur because of the frequent close proximity of the optic nerve of the adjacent cyst wall.

Equations and graphs to compute the desired dose as a function of distance in the cyst wall have been described in our recent articles (*3*,*4*). The spherical shell model given for phosphorus-32 (*4*) gives similar results to the infinite plane model originally proposed (*3*).