

Breast-Milk Radioactivity after a Tc-99m DTPA Aerosol/Tc-99m MAA Lung Study

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Measurements were made of the concentration of Tc-99m activity in samples of breast milk following an administration of Tc-99m DTPA aerosol for a lung ventilation image and one of Tc-99m MAA for lung perfusion. The activity was 222 nCi/ml of milk (8.2 kBq/ml) at 2 hr after the MAA injection, and it was found to be excreted exponentially with an effective half-life of 4.6 hr. There was a small incorporation of Tc-99m into breast-milk protein. We conclude that the combined use of these two Tc-99m agents did not indicate the interruption of breast feeding beyond 24 hr after administration of the MAA, and that for an aerosol ventilation study alone, breast feeding need not be interrupted for more than 4 hr after the test.

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In the few reported cases where radioactivity in breast milk has been monitored after administration of Tc-99m macro-aggregated albumin (MAA) to a lactating mother, it was found safe to resume breast feeding 24 hr after administration (1–4). With the recent advent of nebulizers from commercial sources, ventilation lung imaging with Tc-99m diethylenetriaminepenta-acetic acid (DTPA) aerosol has become more common. A suspected pulmonary embolus in a lactating mother, referred for ventilation and perfusion lung imaging, provided an opportunity to determine the pattern and levels of Tc-99m activity excreted in breast milk as a result of the combined use of both of these Tc-99m agents.

CASE REPORT AND METHOD

A 22-yr-old woman presented with a 2-day history of persistent right-sided pleuritic chest pain but without other respiratory symptoms. A chest radiograph was normal. She had been delivered by caesarean section of a premature baby 3 wk earlier. Lactation had proceeded normally. The possibility of a pulmonary embolus was raised, and a ventilation/perfusion lung study was requested. This was performed following administration of ~ 0.8 mCi (30 MBq) of Tc-99m DTPA aerosol. About 2 hr later, a perfusion image was made after intravenous administration of 2 mCi (74 MBq) of Tc-99m MAA. All ventilation and perfusion images were reported as normal. The patient was instructed not to breast-feed her baby for the next 24 hr, and to obtain milk samples with a breast pump at her normal feeding times during this period.

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The activity in each breast-milk sample was measured by loading aliquots from the samples and from a standard in turn into a sodium iodide well scintillation counter. The proportion of Tc-99m bound to breast-milk protein in three of the samples was determined by precipitating the protein with 10% (W/V) trichloroacetic acid (5).

RESULTS

The total volumes and the concentrations of Tc-99m activity measured in the six milk samples are given in Table 1. The concentration of Tc-99m at 2.25 hr after injection of the MAA was 222 nCi/ml; that at 24.5 hr was 8 nCi/ml. Also shown in Table 1 are the proportions of protein-bound Tc-99m in the three precipitated milk samples. There was a small incorporation of Tc-99m into breast protein, and the level appeared to increase with time after administration. An exponential curve, fitted by least squares to the decline of the total concentrations, produced an effective excretion half-life of 4.6 hr, with a correlation coefficient (r^2) of 0.99.

DISCUSSION

Wyburn found that the Tc-99m activity in breast milk 7 hr after injection of Tc-99m EDTA was 4% of the activity at 4 hr (6). This early rapid clearance was followed by a slower clearance of a much lower concentration of activity for the period 7–24 hr, where a least squares fit produced an effective half-life of 4.0 hr. Even though DTPA has a metabolism similar to that of EDTA, there was no evidence in our measurements of an early more rapid clearance, and thus we concluded that the pattern of excretion between 2 hr and 25 hr must have been dominated by the MAA injection. Because of the similarity in the half-life of the second phase of ex-

TABLE 1. MEASURED CONCENTRATION OF Tc-99m IN BREAST MILK, PERCENTAGE OF PROTEIN-BOUND ACTIVITY, AND TOTAL-BODY ABSORBED DOSES TO A NEWBORN INFANT

Time since MAA injection (hr)	Volume of milk sample (ml)	Activity concentration (nCi/ml)	Protein-bound (%)	Total-body absorbed dose (mrad) per 8-oz feed
2.25	16	222	10	9.6
5.75	10	140		6.0
9.50	14	60	13	2.6
16.50	7	22		1.0
20.50	10	16		0.7
24.50	10	8	22	0.3

cretion of EDTA found by Wyburn (6) and the excretion rate of MAA found here, the effect of the DTPA aerosol could have been identified only by taking milk samples either between administration of the two radiopharmaceuticals, or earlier than 2 hr after the injection of MAA.

A comparison between the above results and three other published sets of Tc-99m MAA breast-milk measurements is given in Fig. 1 (1-3). Included in the legend are the ages of the babies, the effective half-life ($t_{1/2}$) from our results, and the $t_{1/2}$ values

from two of the other sets (1,2). The $t_{1/2}$ and the concentration of activity at any particular time were inversely proportional to the age of the baby. This relation was supported by Heaton's measurements (Fig. 1, curve D) after about 20 hr, when colostrum had been replaced by a rising milk content (3).

It has been shown that a small amount of activity became bound to breast-milk protein. After injection of MAA, Berke et al. (2) found by chromatography that their breast-milk activity was free pertechnetate. Assuming that all the breast-milk activity in Table

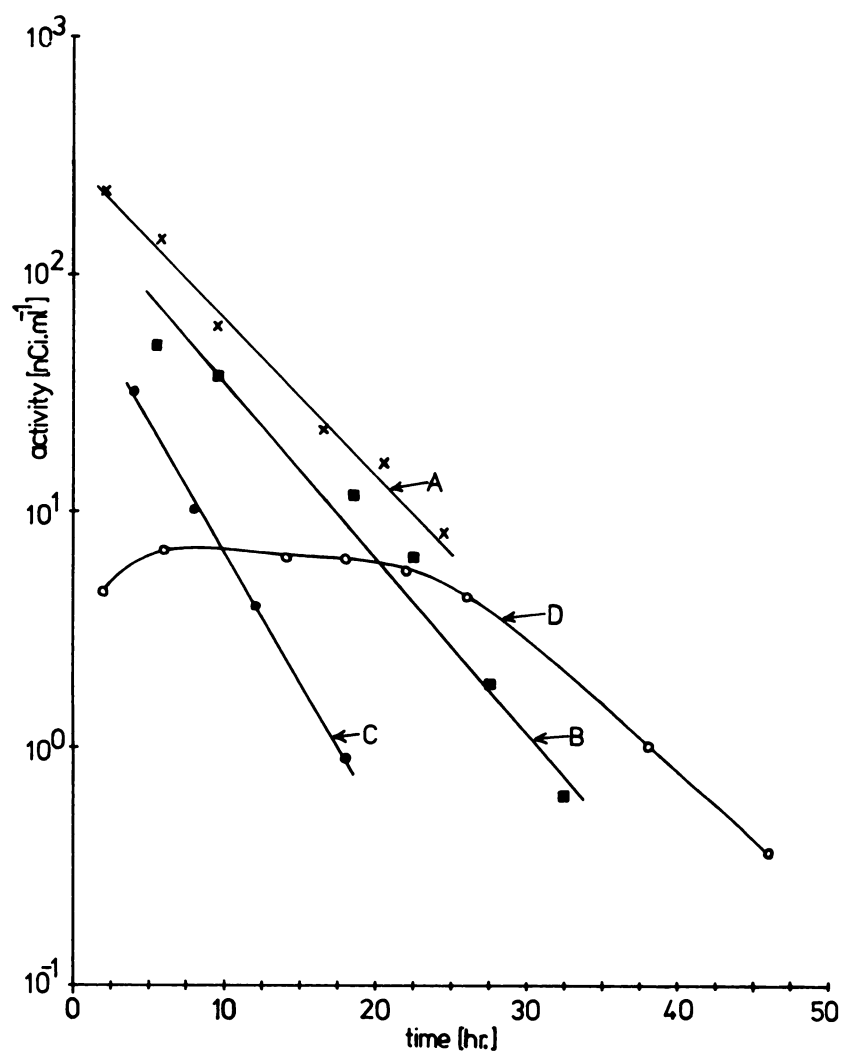


FIG. 1. Comparison between results in Table 1, and three other published sets of measurements of breast-milk activity after injection of Tc-99m MAA alone. Effective half-lives ($t_{1/2}$) were calculated from least squares fits to exponential curves shown (excluding D). A. Results in Table 1: infant's age = 3 wk; $t_{1/2}$ = 4.6 hr; B. Tribukait and Swedjemark (1); age = 3 mo, $t_{1/2}$ = 4.1 hr; C. Berke et al. (2); age = 6 mo, $t_{1/2}$ = 2.8 hr; D. Heaton (3); age = newborn, [adjusted to 2 mCi (74 MBq) injection].

If free pertechnetate, we calculated the potential whole-body doses (per 8-oz feeding) to a newborn infant (Table 1), on the basis of an absorbed dose of 0.19 mrad/ μ Ci (52 μ Gy/MBq) deduced from the data in ICRP 17 (7). If this patient's infant had been allowed to receive all these 8-oz feedings, then the accumulated total-body absorbed dose would have been about 20 mrad (200 μ Gy), and the accumulated absorbed doses to the intestine and to the thyroid would have been about 0.5 rad (5 mGy) and 0.4 rad (4 mGy), respectively (7).

Two further conclusions were drawn from these calculations and from the measured rate of excretion. Firstly, the combined use of Tc-99m DTPA aerosol and Tc-99m MAA for ventilation/perfusion lung imaging did not warrant a proscription of breast feeding beyond 24 hr after administration of the second agent. Secondly, for a Tc-99m DTPA aerosol ventilation study alone, breast feeding need not be interrupted for more than 4 hr after inhalation of the aerosol.

ADDENDUM

We had the opportunity to evaluate the secretion of Tc-99m in the breast milk of a patient following a dynamic renal study using 2 mCi of Tc-99m DTPA administered i.v. Fifteen minutes later, 40 mg of Furosemide were administered. The concentration of Tc-99m over a period of 3–22 hr was found to be approximately 0.5% of that observed in the combined DTPA AEROSOL/MAA study described; the effect excretion half-time was 4.3 hr, similar to that found in the combined study (4.6 hr).

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