HUMAN BREAST MILK EXCRETION OF RADIONUCLIDES FOLLOWING ADMINISTRATION OF RADIOPHARMACEUTICALS

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Radioactivity levels were determined in breast milk from six nursing mothers given diagnostic radiopharmaceuticals. Acceptable levels were achieved within 2 weeks in two mothers receiving ^{131}I and within 2 days in four mothers receiving ^{99m}Tc.

Although it is usual practice to avoid the administration of radiopharmaceuticals to nursing mothers, there are occasions when the patient's clinical condition is the overriding factor. The administration of ^{131}I-sodium iodide to nursing mothers has been well documented (*1–3*) and Karjalainen, et al (*4*) have more recently reported on milk levels following the administration of ^{131}I-labeled macroaggregated human serum albumin (MAA), orthoiodohippuric acid, and human serum albumin. There is, however, little information regarding ^{99m}Tc, only one case having been reported by Vagenakis, et al (*5*), who described milk levels after the administration of 10 mCi of ^{99m}Tc-sodium pertechnetate.

Over the past 3 years we have administered radiopharmaceuticals to six nursing mothers. Two of these received ^{131}I-MAA and the remainder ^{99m}Tc compounds. In each case breast milk samples were obtained after administration and radioactivity levels determined.

CASE REPORTS AND METHODS

Case 1. A 21-year-old female developed a pulmonary embolism 3 days after Caesarean section. A lung scan was performed after the intravenous administration of 200 μCi of ^{131}I-MAA.

Case 2. A 27-year-old female with a 3-month-old infant was admitted with suspected pulmonary embolus. A lung scan was performed after the intravenous administration of 200 μCi of ^{131}I-MAA.

Case 3. A 30-year-old female with a 2½-week-old infant was admitted for neurological investigation. A brain scan was performed after the intravenous administration of 12 mCi of ^{99m}Tc-sodium pertechnetate.

Case 4. A 25-year-old female with a 5-month-old infant was admitted for neurological investigation. A brain scan was performed after the intravenous administration of 12 mCi of ^{99m}Tc-sodium pertechnetate.

Case 5. A 28-year-old female with a 2-week-old infant was admitted with suspected cerebral haemorrhage. A brain scan was performed after the intravenous administration of 10 mCi of ^{99m}Tc-labeled EDTA.

Case 6. A 40-year-old female with a 2-week-old infant was admitted with suspected pulmonary embolus. A lung scan was performed after the intravenous administration of 1.2 mCi of ^{99m}Tc-labeled macroaggregated ferrous hydroxide (MAFH).

Milk was expressed from the breasts at varying intervals, and either the whole sample or an aliquot was forwarded to the laboratory for assay. Activity determinations were performed in a Packard Autogamma spectrometer, results being calculated in terms of activity/ml at the time of expression.

RESULTS

Results are shown in Table 1 and Fig. 1. Of the two cases receiving ^{131}I-MAA, Case 1 had a peak at about 24 hr, followed by an approximately exponential decay with a $T_{1/2}$ of 20 hr. Although it is not seen, probably because of the smaller number of samples, it seems that a similar peak probably occurred in Case 2, this being followed by the same fall in activity. It is of interest to note that although these two patients each received the same activity

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TABLE 1. ^{131}I AND ^{99m}Tc EXCRETION IN MILK OF NURSING MOTHERS (ACTIVITY IN $\mu Ci/ML$)

Time post injection (hr)	Case 1 (200 μCi ^{131}I-MAA)	Case 2 (200 μCi ^{131}I-MAA)	Case 3 (12 mCi $^{99m}TcO_4^-$)	Case 4 (12 mCi $^{99m}TcO_4^-$)	Case 5 (10 mCi ^{99m}Tc-EDTA)	Case 6 (1.2 mCi ^{99m}Tc-MAFH)
2			0.61			
3	0.002					
4					0.13	0.00064
7					0.0054	
9	0.0089					
10				0.1		
11					0.003	
14		0.0042				
16						0.0019
19	0.027					
20					0.0006	
22				0.04		
23			0.003			
24					0.0003	
25	0.028					
29				0.008		
32	0.02					
38		0.0039				Nil
39	0.018					
42			0.00028			
44	0.016					
51	0.018					
57	0.0091					
62		0.001				
64	0.0068					
81	0.005					
85		0.00034				
93	0.0048					
99	0.0032					
105	0.002					
134		0.00007				
136	0.00092					
158		0.000034				
159	0.00026					
182		0.000018				
183	0.00011					
207	0.00004					
231	0.00002					

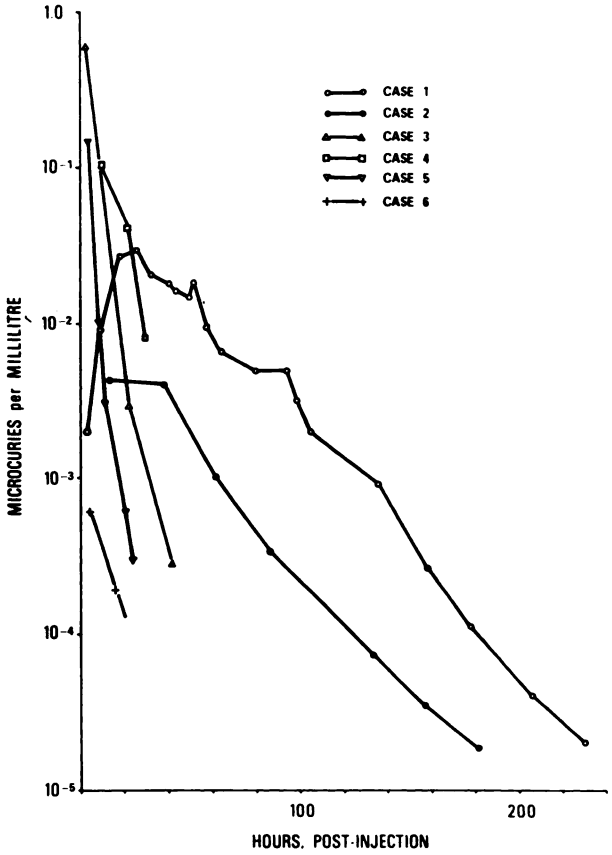

FIG. 1. Breast milk activity levels following intravenous injection of ^{131}I- and ^{99m}Tc-labeled radiopharmaceuticals.

of ^{131}I, there is an almost tenfold difference in milk activity levels. As may have been expected, higher concentrations occurred in Case 1 where the infant was only 3 days old and the mother was probably less freely lactating than in Case 2 where the infant was 3 months old. In the case of lung scanning agents there are, however, many variables contributing to excretion rates such as particle size and uptake and release from the lungs. After making allowance for the different activity administered, these results are very similar to those of Karjalainen, et al (*4*) who reported on seven cases each receiving 300 μCi of ^{131}I-MAA.

The two cases receiving ^{99m}Tc-pertechnetate showed quite high levels of activity in the first 24 hr with only small concentrations after this time. There is a wide variation in excretion between the two cases and an even wider variation is demonstrated when these results are compared with the case reported by Vagenakis, et al (*5*). If their reported 22-hr level is adjusted for the smaller dose given, then the result is 44 times the 23-hr level of Case 3 reported here. This difference cannot be accounted for by lactation volume alone and appears to demonstrate a wide variation in the concentrating mechanism.

EDTA is rapidly excreted by the kidneys and, as may be expected, the levels in Case 5 are much lower than in the cases receiving pertechnetate. Making allowance for the slightly smaller dose, the 24-hr level in this case is a factor of seven down on Case 3 and a factor of 83 down on Case 4.

Case 6, who received ^{99m}Tc-MAFH, showed far less activity than the other cases receiving ^{99m}Tc, even making allowance for the much smaller dose. This can be accounted for by the slow rate of release from the lungs.

DISCUSSION

When radiopharmaceuticals are administered to patients under the conditions described in this report, it is important to decide when the mother can recommence breast feeding. In this hospital we have

insisted that the milk activity level should fall to the level recommended by the International Commission on Radiological Protection (ICRP) for drinking water for continuous occupational exposure (*6*). Although these levels are laid down for occupational exposure of adults and may be considered somewhat arbitrary when applied to the short exposure of an infant, it was considered that the safety factor of the rapidly decreasing milk excretion level was sufficient to ensure an acceptable radiation dose. Investigation has shown, however, that in the case of ^{131}I this level may not be low enough to avoid a significant dose to the infant thyroid. Wellman, et al (*7*) gave an average dose of 21 rads/μCi ^{131}I administered for a newborn infant assuming 30% uptake in the thyroid. They also showed that high uptakes up to 100% are common in the first 2 weeks of life. In Case 1 reported here the activity level of the milk had fallen to 2×10^{-5} μCi/ml after 10 days, this level being the ICRP maximum permissible level for drinking water for continuous occupational exposure. Assuming a 500-ml daily intake at this activity level, then the dose to the infant thyroid would range from about 0.2 rads for a 30% uptake to 0.7 rads for a 100% uptake. If there is a simple cumulative effect from the ^{131}I intake and continuing exponential decay in milk activity levels, then the thyroid dose from the first week's intake could range from 0.35 to 1.2 rads. Although this is within the ICRP recommended limit of 1.5 rads/year for the infant thyroid (*8*), we do not consider it acceptable to give an annual permissible dose over a short period of time. In view of this and of the large range in thyroid uptake and milk consumption levels, we consider that a more acceptable level for recommencing breast feeding is one tenth of the level for continuous occupational exposure, i.e., 2×10^{-6} μCi/ml in the case of ^{131}I, giving one tenth of the above thyroid doses from the first week's intake and insignificant doses from intake after this time. Extrapolating the results of Cases 1 and 2 this level would have been reached in 12 and 10 days, respectively.

In the absence of any data regarding oral doses of ^{99m}Tc to infants we have adopted the same standard for recommencing breast feeding in these cases. For ^{99m}Tc the level would thus be 6×10^{-3} μCi/ml, which was reached in 32 and 20 hr, respectively, in Cases 3 and 4 receiving pertechnetate, and in 8 hr in the case receiving EDTA. In Case 6, where the patient received only 1.2 mCi of ^{99m}Tc-MAFH, the maximum level recorded was only one tenth of this level.

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