No Interruption of Lactation Is Needed After ^{11}C-WAY 100635 or ^{11}C-Raclopride PET

TO THE EDITOR: We are using PET with ^{11}C-WAY 100635 and ^{11}C-raclopride (sequentially) to measure brain serotonin-1A and dopamine-2 receptor binding, respectively, in depressed and nondepressed postpartum research subjects. We received permission from our Institutional Review Board and Radioactive Drug Research Committee to scan lactating women with 2 provisions: that the subjects express their breast milk after each scan for analysis of radioactivity and cold WAY 100635 and raclopride content, and that the subjects nurse their infants no sooner than 200 min (i.e., 10 times the half-life of ^{11}C) after the final radiopharmaceutical injection.

Five lactating women underwent ^{11}C-WAY 100635 (*1*) and ^{11}C-raclopride (*2*) PET according to methods previously described. The ^{11}C-WAY 100635 injection was followed by 90 min of scanning. Sixty minutes later, ^{11}C-raclopride injection was followed by 60 min of scanning. Approximately 15 min after the conclusion of each scan, study participants expressed their milk with a multiuse electronic double-breast pump (Medela, Inc.) for 10–30 min. The mean subject age ($\pm$SD) was 27.4 $\pm$ 6.9 y; the range was 20–36 y. The mean infant age was 9.4 $\pm$ 3.4 wk; the range was 4–13 wk.

The radioactivity content of breast milk was measured for both radiotracers. The mean activity concentration of ^{11}C in breast milk (455 $\pm$ 107 Bq/mL) was similar to that in plasma (355 $\pm$ 99 Bq/mL) 60 min after 526 $\pm$ 61 MBq of ^{11}C-WAY 100635 had been injected. For ^{11}C-raclopride, the mean activity concentration of ^{11}C in breast milk (105 $\pm$ 32 Bq/mL) was significantly less than that in plasma (913 $\pm$ 361 Bq/mL) 60 min after radiopharmaceutical injection (384 $\pm$ 24 MBq).

A commonly used model was applied to predict the radioactive dose to an infant through breast milk after the mother had received an injection of tracer for PET (effective dose = activity in breast milk [Bq/mL] at 60 min $\times$ 100 mL $\times$ effective dose for a newborn from OLINDA/EXM (*3*) using generic biokinetic model for ^{11}C brain receptors in addendum 6 to ICRP 53 [0.0594 mSv/MBq] (*4*)). We chose a worst-case model that assumed an infant weight of 3.4 kg (10th percentile for a 1-mo-old infant (*5*)), rapid breast milk uptake from the gut (immediate absorption and distribution through the body), and breast milk intake as early as 60 min after tracer injection, in the event the subject could not tolerate the scan procedure. The model also assumed that other drug exposures were absent and that 100 mL of breast milk were consumed within a feeding. In this model, the mean radioactive dose to the nursing infant at 1 h was 2.7 $\pm$ 0.6 μSv after ^{11}C-WAY 100635 and 0.6 $\pm$ 0.2 μSv after ^{11}C-raclopride injection. Because the mean dose from breast milk for each radioligand was under the limit identified for radiation protection of the general population (1 mSv/y) (and also well under the daily exposure to background radiation in the environment), we concluded that interruption of breastfeeding was not warranted.

Breast milk samples were also assayed for cold WAY 100635 and raclopride content by the method of standard addition, so that each sample served as its own matrix. WAY 100635 and raclopride concentrations were measured with high-performance liquid chromatography using ultraviolet detection, as previously described (*6*). Neither WAY 100635 (detection limit, 1 ng/mL) nor raclopride (detection limit, 5 ng/mL) was detectable in any of the samples. WAY 100635 and raclopride metabolites were also undetectable, assuming detection limits similar to those of the parent compounds.

Because of concerns about transmission of radioactivity to infants through breast milk, lactating women are generally excluded from research protocols that administer radiopharmaceuticals. These data demonstrate negligible radioactivity and cold ligand in breast milk after ^{11}C-WAY 100635 and ^{11}C-raclopride brain PET imaging in our laboratory and, thus, negligible risk to breast-fed, healthy infants who are 4–13 wk old, weigh at least 3.4 kg, and have no other drug exposures. These data also demonstrate that lactation can proceed without interruption in such studies. These findings support removing an important barrier to neurobiologic research in lactating women and may be most relevant to studies of postpartum mental health and the neurochemistry of lactation. Future work must also examine how the inclusion of lactating women within samples of the general female population might influence outcomes of interest because of the potential neurobiologic effects of oxytocin and prolactin.

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JNM Supplement on Molecular Radiotherapy

TO THE EDITOR: I have read the recent *JNM* supplement on the clinical practice of molecular radiotherapy (*1*) with great interest and enthusiasm. The editors have done a superb job of bringing out the importance of radiotherapy, besides PET/CT molecular imaging, in the future growth of nuclear medicine. There are comprehensive sections on radiodosimetry, oral treatments, and various intravenous treatments. But there appears to be an omission in the area of emerging intraarterial treatments, such as ^{90}Y-microspheres for hepatocellular and metastatic liver cancers (*2–5*). Because nuclear medicine is a part of intraarterial interventional radiologic or surgical procedures, it may be important for readers to be aware of the possibility that such procedures may offer a vast integral opportunity in the future. In addition, because nuclear medicine procedures such as PET, PET/CT, arterial ^{99m}Tc-macroaggregated albumin scans, multiple gated acquisitions, and bone scans are often used in both initial treatment planning and subsequent monitoring of response, a separate section on these aspects would also have been enlightening to our profession.

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REPLY: We appreciate the comments from Dr. Wong regarding radiotherapy with ^{90}Y-microspheres. As Dr. Wong quite rightly points out, the lack of a chapter on ^{90}Y-microspheres within our supplement (*1*) was an omission, which should be corrected in the future, since the product (SIR-Spheres; Sirtex Medical Limited) has been approved for use in the United States.

This therapy provides an alternative to radiation or chemotherapy in nonresectable cases of liver cancer. Unlike external-beam radiation, which can harm normal tissue, this method takes advantage of the greater arteriolar density of hepatic tumors for selective delivery of radiation via microspheres that become trapped in the tumor microcirculation. Significantly greater radiation exposure to the tumor results from this method than from external irradiation, with little damage to the normal tissue. Many liver tumors, including carcinoid, are quite sensitive to radiation and highly suitable for this therapy. A number of studies done abroad have shown the usefulness of ^{90}Y-microspheres and ^{131}I-Lipiodol in the treatment of inoperable hepatocellular carcinoma, prevention of recurrence, and improvement of prognosis and survival in patients with hepatocellular carcinoma (*2–4*).

^{90}Y-Microspheres were evaluated in a phase I study to assess safety and therapeutic benefit with absorbed raidiation dose ranging from 50 to 150 Gy in patients with unresectable hepatocellular carcinoma or with carcinoma metastatic to the liver (colorectal, neuroendocrine, carcinoid, islet cell tumors) (*5–7*). The use of SIR-Spheres in combination with chemotherapy has been shown useful for metastatic colorectal carcinoma (*8,9*) and has been approved by the U.S. Food and Drug Administration. Another commercial product is TheraSpheres (Theragenics).

In the past, the approved uses of these products were restricted; however, with increasing evidence of the effectiveness of therapy, their use is likely to grow. Further discussion and a comprehensive review of this topic will greatly enhance the awareness of this therapy. We support and recommend publication of a focused review on ^{90}Y-microspheres.

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