being found in the urinary bladder wall (0.08 mGy/MBq), the mean effective dose for 8 patients was 0.017 mSv/MBq. The mean administered activity of 141 MBq corresponds to an effective dose of 2.4 mSv per ^{18}F-NaF examination. Hence, the effective dose is 20% lower than the effective dose for skeletal scintigraphy using ^{99m}Tc-methylene diphosphonate (MDP), that is, 2.95 mSv with a mean administered activity of 518 MBq (*2*). In this report, Grant et al. listed an effective dose of 3.99 mSv using 148 MBq of ^{18}F-NaF (*2*). The difference is related to the biokinetic data. As Kurdziel et al. explained, their measured urinary excretion fraction (15.3%) and biologic half-life (1.37 h) were lower than the data given in ICRP report 53 (50% excretion fraction) (*3*).

Our own experiences indicate a nearly 50% excretion fraction, too. Nevertheless, the effective dose might be less than the values obtained by Grant et al. based on the simple bladder model that is implemented in OLINDA. A more realistic dynamic urinary bladder model that considers different parameters such as initial bladder volume, initial voiding time, voiding interval, and bladder fill rate is described in MIRD pamphlet 14 (*4*).

Because of the detailed data on organ doses that Kurdziel et al. provide, we performed dose calculations using OLINDA and the dynamic urinary bladder model. For convenience, a software tool based on the dynamic urinary bladder model was developed (http://nuklearmedizin.uniklinikum-dresden.de/forschung-research/mird-14-dosis-kalkulator/). For ^{18}F-NaF, the bladder dose could be reduced by 25% if the voiding interval was shortened to 2 h with a first voiding at 60 min after injection. Additionally, a dose reduction of 70% can be achieved by increasing the initial bladder volume at the time of administration from 0 to 300 mL. Thus, optimizing the voiding scheme can reduce the effective dose significantly because the urinary bladder wall is the organ with the highest dose.

Assuming a clinical setup (300-mL initial bladder volume, first voiding at 60 min after injection, voiding interval of 2 h), the bladder dose is 30% lower than the dose calculated with OLINDA and results in an effective dose of 2.96 mSv per ^{18}F-NaF examination. The effective dose can be additionally reduced to 2.26 mSv by good hydration of the patients, as can be demonstrated in the model calculations by increasing the urine flow rate from 1 to 5 mL/min. These effects are less pronounced in ^{99m}Tc-MDP because of the different physical properties and different local dose depositions of γ-rays and positrons. Applying these considerations to clinical practice, the radiation exposure of the patients can be reduced remarkably when using ^{18}F-NaF as a radiotracer that provides better imaging properties than ^{99m}Tc-MDP (*5*).

The "SNM Practice Guideline for Sodium ^{18}F-Fluoride PET/CT Bone Scans 1.0" (*6*) points out that conventional bone scans cause lower radiation doses than ^{18}F-NaF bone scans (effective dose of 8.9 mSv compared with 5.3 mSv); however, the above-mentioned details have not been taken into consideration. Additionally, the administered activity may be reduced. As Kurdziel et al. stated, they obtained high-quality images by administering only 111–185 MBq of ^{18}F-NaF (*1*).

From the view of radiation protection, ^{18}F-NaF ought to replace ^{99m}Tc-MDP wherever available, and the imaging should be performed with a prefilled urinary bladder.

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REPLY: I would like to thank Drs. Freudenberg, Oehme, and Kotzerke for their insightful comments and for sharing their software tool for implementation of the dynamic bladder model.

I am uncertain why our urinary fraction (calculated as the fraction of total activity within an expanded volume of interest encompassing the bladder) with respect to the total activity within the torso (calculated as the total activity within an expanded volume of interest encompassing the torso) differs from Drs. Freudenberg, Oehme, and Kotzerke's experience. Retrospectively, analyzing the first 20 patients of our dataset (as opposed to the initial 8 used for dosimetry) who underwent continuous 3-time-point serial imaging, the mean urinary fraction was 0.16 ± 0.04 with a range of 0.05–0.27. Our patients were requested to maintain good hydration for the 24 h before imaging, likely increasing the urine flow rate. This precaution should increase the urinary clearance rate but may not have a large effect on the urinary fraction (because of the rapid skeletal uptake).

Contrary to prior reports, the radiation dose for ^{18}F-NaF PET is lower than that for ^{99m}Tc-methylene diphosphonate (MDP) or similar planar bone scans. By our calculations, using ICRP 103 weighting factors, the effective dose of a 740-MBq (20-mCi) ^{99m}Tc-MDP scan is 5.0 mSv (*1*) and that of a 185-MBq (5-mCi) ^{18}F-NaF PET scan is 3.1 mSv (*2*). It is the addition of the whole-body (vertex to toes) low-dose CT transmission scan, which in our clinic is 4.5 mSv (whole-body Phillips Gemini PET/CT scanner using the ImPACT CT patient dosimetry calculator, version 0.99x 20/01/06, for an adult subject, a pitch of 1.438, 60 mAs, 120 kV, and collimation of 24) (*3*), that increases the radiation exposure. In our experience, in prostate cancer and multiple myeloma, the transmission CT increases reader confidence in interpretation as it better defines areas of degenerative disease. If ^{99m}Tc-MDP SPECT/CT were performed, the combined effective dose would be 9.5 mSv (as compared with 7.6 mSv for ^{18}F-NaF PET/CT). The real question is whether the CT adds sufficient medical benefit to warrant the increased radiation exposure.

Thus, it is important that when we compare PET and conventional bone scans we appropriately consider the CT compo-

nent. As we all strive to reduce the overall radiation exposure to our patients, we must continue to balance both the radiation dose (risk) and the clinical benefit.

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Role of SPECT/CT, Versus Traditional Practices, in Individualizing Treatment of Thyroid Carcinoma

Individualizing patient management has been a major development in the field of oncology and has been conceptualized in recent management protocols for differentiated thyroid carcinoma. Dr. Avram, in a lucid review (*1*), has nicely portrayed the advantages of SPECT/CT over conventional planar imaging. We thank the author for her excellent deliberation and would like to share traditional teachings about planar radioiodine imaging and our own experience with dose decisions and risk stratification in patients with multifocal radioiodine uptake in the neck or upper mediastinum.

At the time of our residency (in a center considered to be the busiest in thyroid cancer management in India), a common teaching was that multifocal uptake in the neck (especially outside the thyroid bed) on preablation scintigraphy would argue for a higher ablative dose of radioiodine than when uptake is confined to a solitary area, as the former likely suggests diseased nodes. This scenario corresponds to cases 2 (Fig. 2) and 3 (Fig. 3) of the review by Dr. Avram. If the foci on radioiodine scintigraphy corresponded to a clinically obvious neck node on palpation or was adjudged sufficiently large by ultrasonography (as mentioned in case 3), the preference would be for surgery before radioiodine therapy, whereas foci that represented a subcentimeter-sized nonpalpable node would be considered for radioiodine ablation upfront. Another common teaching was that after radioiodine ablative therapy, if an abnormal focus was seen in the neck on the 6-mo follow-up ^{131}I scan, its location and pattern required comparison with findings on the preablation and posttherapy scans obtained at the postthyroidectomy visit. If they matched, that would suggest persistent residual neck tissue, whereas if they did not, that would be indicative of a diseased lymph node. This was particularly the case when uptake in the thyroid neck residue merged with uptake in an adjacent node, as corresponds to case 4 (Fig. 4). If this group of patients is treated with a lower ablative dose of ^{131}I, the follow-up scan at 6 mo might demonstrate uptake only in the lymph node, as the residual normal thyroid (being the first filter of administered iodine) would have been ablated by that time. Surgeons commonly prefer not to perform surgery again if the node is subcentimeter-sized on ultrasonography or not clinically palpable and suggest that the referring physician consider radioiodine therapy. As mentioned by Dr. Avram, the prescribed dose for patients in whom unsuspected regional nodal metastases are discovered is 5.5 GBq, compared with 1.1 GBq for patients who have only neck residue.

The scenarios represented by cases 2–4 are common in practice and often are the cause for recurrence or persistence of disease in patients with differentiated thyroid carcinoma. The better lesion delineation and clarification offered by SPECT/CT thus lead to a change in the prescribed radioactivity to higher than the commonly used ablative dose. Many of us now have become quite attuned to interpreting and deciding on these intricacies in planar imaging, but beyond doubt, the better-quality images of SPECT/CT would obviate assumptions and be particularly useful to beginners. We strongly believe that risk stratification in thyroid carcinoma should not be restricted to clinical and histopathologic characteristics alone and that scan patterns (particularly multifocal uptake in a preablation study or an iodine-avid node on a follow-up scan) also should play an important role in clinical decision making, a pertinent fact highlighted by the author. Although well recognized by practitioners, this issue has been given relatively less emphasis in the current guidelines and needs to be addressed.

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REPLY: I thank Drs. Basu and Abhyankar for their letter and excellent comments on the use of preablation radioiodine scintigraphy for the management of thyroid cancer patients. As outlined in their letter, a classic teaching in nuclear medicine was that preablation radioiodine planar scans provide important information that may influence ^{131}I therapeutic decisions. The findings on preablation scans defined the target of radioiodine therapy (remnant ablation, nodal metastases, or distant metastases), directly affecting the selection of prescribed ^{131}I activity for ablative or tumoricidal treatment. Despite these advantages, over the years—as the controversy over stunning developed—the field evolved toward fixed-dose ^{131}I ablation of residual thyroid tissue after thyroidectomy, because posttherapy ^{131}I scans with better count density appeared to provide more diagnostic information than preablation scans. In this process, the contribution of preablation scans to therapeutic decisions was minimized, and staging, risk stratification, and management decisions became increasingly