minimum practical administered activity (MPAA), which is the lowest activity that will yield a useful image of an infant. (The MPAA is often higher than a simple scaled down calculated activity in infants.) In order to determine our MPAA, we reviewed 11 [^{111}In]leukocyte studies on children aged 2½ to 18 yr performed at our institution. We estimated our MPAA to be ~100 μCi.

We are unaware of any pediatric biodistribution data for [^{111}In]leukocytes, and so we used data from three adult human volunteers; these data were submitted to the FDA in support of the Amersham NDA (*2*). The distribution was as follows: 30% to spleen, 30% to liver, 34% to red marrow, 6% to remainder of body, with no excretion. Instantaneous uptake was assumed for the dosimetry calculations.

Pediatric "S" values for newborn, 1 yr, 5 yr, 10 yr, 15 yr, and 18 yr groups were generated from specific absorbed fractions at various ages (*3*) and physical data tables (*4*). The standard MIRD equation was used. We estimated radiation absorbed doses from [^{111}In] and from contaminant [^{114m}In] and [^{114m}In]measured in 11 random samples of Amersham's [^{111}In]oxine (*5*).

The information on administered activity and radiation absorbed dose appears in Table 1. Doses to the newborn red marrow, spleen, and liver are four, three, and two times that in adults, respectively. Doses to the 1-yr-old red marrow, spleen, and liver are 1.8, 1.6, and 1.3 times that in adults, respectively. By age 5 yr, doses approach that of adults.

It is very difficult to estimate the degree of uncertainty in these calculations. The specific absorbed fractions for the pediatric age groups are probably about as accurate as the corresponding fractions for adults, but we do not have quantitative error terms for adults or children. The errors associated with the values in the physical data tables make a negligible contribution to the uncertainty of our dosimetry values. The errors in the determination of the contribution of contaminant [^{114m}In] and [^{114}In] to the overall dosimetry are probably rather small. The largest source of error, by far, is due to the biodistribution assumptions. Variability in a normal population is large. Variability in sick patients is probably even larger. The assumption that biodistribution in children is the same as that in adults is risky, even though pediatric images of [^{111}In] leukocytes appear similar to adult scans. Anyone having pediatric biodistribution and kinetic data on [^{111}In]leukocytes is encouraged to contact Michael Stabin [(615)576-3449] for an upgraded dosimetry calculation or a printout of the "S" tables.

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Unsuccessful Iodine-131 MIBG Imaging of Carcinoid Tumors and Apudomas

TO THE EDITOR: In 1984 it was reported (*1*) that [^{131}I] MIBG, a radiopharmaceutical agent which had been successfully used for diagnosis (*2,3*) and treatment (*4,5*) of pheochromocytoma and neuroblastoma, might also be helpful in the diagnosis of apudomas. Based upon the common histopathologic and biochemic features of these tumors we investigated ten patients with histologically verified tumors and/or metastases, all of them exhibiting negative [^{131}I]MIBG imaging.

All ten patients received 750 μCi [^{131}I]MIBG 48 hr after blocking of the thyroid gland which was continued for 8 days. Patients were imaged daily beginning from the third to seventh day after the tracer application by computer assisted gamma camera imaging, using a 15-min exposure time. The patients did not take reserpine, MAO-inhibitors, or other drugs known to inhibit the uptake of MIBG. Four patients had received cytostatic therapy. Actual plasma epinephrine and norepinephrine, as well as urinary 5-hydroxyacetic acid, vanillinmandelic acid, epinephrine, and norepinephrine values were available. In all the patients, a marked salivary gland tracer accumulation as originally described by Nakajo (*6,7*) was monitored reaching a maximum between the third and fifth day. This uptake lasted up to the sixth day in six and up to the seventh day in four patients.

The patients ranged in age from 52 to 65 yr (mean 57 yr). There were seven males and three females. Seven were primary in the intestinal tract, two in the pancreas, and one had diffuse liver metastases with uncertain primary. Eight were metastatic to the liver, two infiltrated the pancreas, and one had metastasized to retroperitoneal lymph nodes. One patient with carcinoid primary in the rectum had no metastases. Three tumors were active hormonally.

The hormonally active patients were as follows. One patient had severe hypertension, and weight loss. Her plasma epinephrine (154 compared with normal 6,4 ± 2,6 ng/100 ml), and norepinephrine value (460 compared with normal 30,5 ± 14,1 ng/100 ml) were significantly increased as well as the urinary excretion of both components. A second patient had extreme facial flushing, diarrhea, vomiting, and weight loss; however, aside from an increased serotonin, the other parameters were negative. Another patient had mild hypertension, with increased epinephrine (86 ng) and norepinephrine (231 ng) values. In no patient was there sufficient [^{131}I]MIBG uptake for imaging and eventual therapeutic maneuvers. As we do not have systematic electron micoscopic documenta-

tion, data on the amount of the storage granules of the chromaffin cells or the differentiation cannot be given. Whether certain subgroups of carcinoids and apudoma are candidates for this procedure has to be evaluated further. We did not obtain any false positive image using MIBG so far. As we observed patients with and without hormonally active tumors, with primary tumor only and recurrence of the disease as well as ones with and without cytostatic therapy, it is likely that these parameters are not the key determinants for a positive imaging (*8*) at least in patients suffering from carcinoid or apudoma.

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Iodine-131 MIBG for Locating Pheochromocytoma

TO THE EDITOR: In a recent paper in the Journal, Shapiro et al. (*1*) presented their reasoning for iodine-131 metaiodobenzylguanidine ([^{131}I]MIBG) scintigraphy as the study of choice to locate suspected pheochromocytoma. This is an interesting and most useful review; however, in our opinion, several points need further discussion.

1. As [^{131}I]MIBG is a functional imaging method, we believe kinetic measurements of MIBG should be part of these studies, for the evaluation of further therapy in primary tumor or metastatic tissue.

2. A significant number of patients (n = 82) were classified as true negative with lesser degree of certainty. In the formula used for sensitivity, specificity, etc. they are classified in the real "true negatives." A receiver operating characteristic analysis would be helpful for medical decision making. We would also like to have seen a comment on the low negative predictive accuracy of 17% in malignant pheochromocytoma.

3. The published scintigraphy (particularly Fig. 1B) with the corresponding confirmation of the endocrine active tumor is less convincing, compared with the figures of Sone et al. (*3*) in the same issue of the Journal, and from our own routine clincial work. We agree with Mahlstedt (*2*) that a standardization of the imaging procedure is needed.

4. Although the role of computed tomography (CT) and angiography is thoroughly discussed, other noninvasive methods, e.g., ultrasound and bone scan are not considered.

In conclusion, the conformity of this overall "Michigan" and the "Combined German" (*2*) experience concerning sensitivity, specificity, and negative and positive predictive accuracy is promising of a major role for MIBG scintigraphy in the investigation of neuroendocrine tumors. Our strategy in the diagnostic workup of pheochromocytoma is: 1. history and physical examination; 2. clinical laboratory studies; 3. ultrasound examination; 4. [^{131}I]MIBG scintigraphy and CT scan; and 5. angiography followed by surgical intervention.

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REPLY: We thank Drs. Schober et al. for their interest in our recent publication (*1*). In response to the points raised in their letter we wish to point out that:

1. The paper addressed the ability of iodine-131 metaiodobenzylguanidine ([^{131}I]MIBG) scintigraphy, a functional imaging modality, to locate pheochromocytoma deposits. Kinetic data is obtained over a period of 7 days to permit the calculation of radiation dosimetry to those lesions which might benefit from therapeutic MIBG administration of MIBG, but this lay outside the scope of the paper.

2. The patients classified as negative with a lower level of certainty were subjected to a separate analysis but both reviewers and the editor felt this confused the issue and suggested their inclusion with the high certainty patients. The criteria are clearly defined in the paper and most fall into this category due to the presence of minor (nondiagnostic) elevations of catecholamines, and with up to 4½ years follow-up, not one