of the ICMA QPTH results and the 24-hour IRMA control appears satisfactory. Kao and associates,[15] using a similar chemiluminescence method to measure intact PTH, reported very good correlation of their intraoperative assay with a 15-minute incubation time and their standard 18-hour assay. The cost of intraoperative PTH monitoring has not been determined at this stage of its development.

The combination of MIBI parathyroid scintigram for accurate localization of tumors and rapid intraoperative determination of possible hypersecretion by the remaining glands after tumor excision is a useful surgical adjunct. Using a combination of these two new techniques, operating time has decreased, which suggests a cost-effective approach to improving the success rate of parathyroidectomy.

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Discussion

DR. JOHN P. WEI (Augusta, Georgia): Today, Dr. Irvin has attempted in this circumstance to join two new emerging technologies in the hopes of improving the success of initial parathyroidectomies for patients with primary hyperparathyroidism. As with any emerging new technique, an experience to define the limitations and refinement of the techniques are necessary, and delineation of areas of potential failure is necessary prior to wide dissemination and common use of these techniques. In the old days, when a woman was first found to be with child, people had to wait until the rabbit died before they knew she was pregnant. Nowadays, all you have to do is look in the bottom of the test tube and see whether it turns blue or not. Now until parathyroid localization can be developed to the point that it can be done in a rapid time and in such a manner that everyone can apply it with a 100% success rate, then by and large it should still be considered investigational. First, the nature of the parathyroid embryological development and potential mediastinal descent will always contribute to a small percentage of initial parathyroid surgical failure. As in Dr. Irvin's case, two out of his 18 patients in this series were surgical failures because of this anatomic constraint. I ask Dr. Irvin if, given successful preoperative localization, he would proceed to mediastinotomy for resection if he has sufficient confidence in his techniques that he would open the sternum after a failed surgical operation. Second, the limits of resolution of any radionuclide study will always be dependent upon the atomic physics of that isotope. By and large, most of the currently existing technologies have fallen by the roadside. Technetium-thallium has been deemed a failure by John Doppman. A year and a half ago in Miami, he basically stated that, as they quoted, "All you need is a good surgeon to find the parathyroid adenoma." The limitations of the test have to considered in the utilization of that test. The physical relationships to the thyroid gland and specific pathologic anomalies of a thyroid may give rise to difficulties in interpretation of that test. As Dr. McGarity showed, it is possible to have false-positives because of thyroid pathology. And as Dr. Irvin himself noted, he had two cases in which he had difficulty with interpretation of his scans. Third, the ultimate success rate of the operation is dependent upon a surgeon and his capability to recognize and identify intraoper-

atively the pathologic parathyroid glands and to resect them successfully. In Dr. Irvin's case, inadvertent resection of a large hyperplastic lymph node, initially occurred. The development of the quick PTH assay adds confirmatory evidence to a procedure if one were to pursue solitary adenomectomy as a sole surgical maneuver for parathyroid surgical success. However, the level of complexity for performance of this quick PTH assay would make it quite forbidding to most of those practicing surgeons here in the audience. I suspect that 85% of the audience here could not even pronounce immunochemiluminescence as one word without taking a breath. How many surgeons in this audience have to send their intact PTH or their C-terminal, mid-region assays outside of their hospital to Smith-Kline-Beecham Laboratories, for instance, just to have that assay performed? Now if you consider to modify your hospital procedures so that you could have intraoperative PTH measurements, that would be a leap of faith, I think. How practical is this approach? Could I, as a surgeon, get the requisite machines and the chemicals and whatnot and be able to perform this in my hospital? Or better yet, could a surgeon who practices at the Bath Community Hospital here in Hot Springs, Virginia, be able to do this and apply the procedure that you are advocating.

DR. COLIN G. THOMAS, JR. (Chapel Hill, North Carolina): Dr. Irvin is to be congratulated on his persistent efforts to improve the effectiveness of parathyroidectomy in a management of primary of parathyroidism by combining radionuclear imaging and intraoperative assay of PTH. The manuscript which I reviewed complements Dr. Irvin's excellent presentation. The approach, as has been mentioned by others, would seem to be particularly valuable in patients with reoperative surgery, those individuals who are poor risks, those individuals who have had previous neck surgery, perhaps patients with secondary hyperparathyroidism, and those few individuals with parathyroid carcinoma. I do have some concern, however, which should be resolved before applying this approach to the 10,000 or more patients undergoing parathyroidectomy in this country every year. Although the paper emphasizes the utility of the methods, all patients had involvement of only one parathyroid gland. Can we expect similar results in patients who've had multiglandular disease? In the data presented, I don't think this question has been answered. What is your experience with diffuse hyperplasia? Is there a quantitative relation between the amount of parathyroid tissue resected and the fall in the intraoperative IPTH? I ask this question because in the presence of one enlarged parathyroid gland, there may suppression of the remaining normal glands. This may not be true in patients who have diffuse hyperplasia or more than one gland involved. Is the size of the hyperfunctioning parathyroid gland a limiting factor in its identification by sestamibi scanning? In your manuscript—and I recommend this for your perusal—Dr. Irvin has pointed out that the average size or the median size—or median weight was 700 milligrams. This you can calculate from the dimensions by applying the formula for a prolate spheroid. There were three glands that were less than 300 mg. Is there any correlation between the gland size and the intraoperative fall in IPTH? One patient had a false-negative assay intraoperatively which must have been very misleading. And I ask Dr. Irvin, how did you resolve that problem? Dr. Irvin indicates that he excises only the glands identified by scan, without biopsy of the remaining glands. What would he do if he stumbled on a second parathyroid gland three to four times normal size that had not appeared by the radionuclear imaging? Finally, costs have been cited as one of the benefits of this approach. The most effective method of controlling costs in the treatment of primary hyperparathyroidism is to prevent persistent disease. This approach is promising, but until we have more experience with the method proposed, I think the prevention of persistent hyperparathyroidism is best accomplished by meticulous dissection with examination of all four parathyroid glands at the initial operation. Overall, this is a significant contribution to our management of patients with primary hyperparathyroidism, and Dr. Irvin and his colleagues are to be congratulated and I hope will continue their efforts to improve our methods of intraoperative identification and assurance of a complete operation.

DR. THOMAS M. DANIEL (Charlottesville, Virginia): I arise as a thoracic surgeon and not an endocrine surgeon to make a brief comment on Dr. Irvin's paper by presenting a case to illustrate my question. Dr. John Hanks, who is a member of this association and an endocrine surgeon at our institution, asked our opinion about a case that had had a preoperative sestamibi scan and ultrasound done by the referring endocrinologist. This is not our routine yet, but we were left with the following quandary. Our advice surgically was that this could be removed thoracoscopically, and a week ago yesterday we did that. We changed our approach a little bit from the ordinary approach, as you've seen, with shelling out the gland. We didn't trust endoscopic instruments to be able to do this without the possibility of entering the gland, so we removed the gland with a generous amount of tissue. We were able endoscopically to see the branch of the internal mammary artery leading to this gland, and this came out without any difficulty. We kept the patient 2 days after surgery. He could have gone home at that time, but we kept him one additional day for his calcium to fall and plateau, which it did. My question, given this setting—negative ultrasound and a positive sestamibi in the mediastinum and no previous neck exploration—are we justified in going directly to mediastinal removal?

DR. GEORGE L. IRVIN III (Closing Discussion): Dr. McGarity, I do hope I can change your mind. When you have a clear-cut, single hyperfunctioning gland like you saw on the scans that I showed, you can justify a very quick operation by showing with intraoperative PTH monitoring that you have cured that patient, you can do this as an outpatient. With a 25-minute operation, less than an hour anesthesia, you can send the patient home the same day, follow him the next day for his calcium in the clinic—we've done that on two patients. That's the way to justify your cost. Dr. Wei, we don't have any rabbits, but if I saw those sestamibi scans again with those parathyroid adenomas sitting in the aortic window, no way am I going to go through the neck to try to get them. Patients that you can identify with the preoperative scans, localized elsewhere, where it makes it very difficult through the cervical approach— preop-

erative localization studies are indicated, and you can directly go to it without doing the neck exploration if you have the PTH assay to back you up. You asked about the C-terminal and mid-molecule assays. We don't use them anymore; I think they're outdated. We go directly with the intact PTH assay at the present time. You asked about whether this is commercially available and would it be of use here in Hot Springs. I think it will be in the future. This is why we've gone to the chemiluminescence assay rather than the IRMA. The IRMA, using an isotope with a short half-life, logistically is pretty difficult to do. You have to schedule your operation and have the isotope sent in air express the day before, and it has a limited shelf life; whereas, the chemiluminescence assay has a shelf life of about 6 months, and you can put it on the shelf and use it whenever you want. Now, I know there are a lot of surgeons in the audience who probably couldn't do this, and I probably couldn't either. But any operating room nurse or lab technician can very quickly learn how to do this assay. It's very easy. Dr. Thomas asked about multiglandular disease. And, yes, we have had some experience with multiglandular disease with the intraoperative PTH assay. If you have a patient on dialysis who has multiglandular disease and you want to take the time—which we did—you can take out one gland and step it down. You can watch the PTH five minutes later come down. Take out another gland, and it'll come right on down. It can quantitatively decrease as you take out this tissue. You have to be very careful though because in dissecting out these glands, if you squeeze them a little bit, you can make the PTH go way up. That's why we don't use just the preoperative measurement; we do a preexcision measurement because—to take into account that manipulation which will increase your PTH. The size of one centimeter that you mentioned, I don't know the size correlation yet between the PTH output and the size of the tumors. Dr. Thomas asked if I stumbled on another large gland, would I take it out? Of course, I would. That's the way you taught me, sir. I think I answered Dr. Daniel's question about going directly to the mediastinum. Absolutely. If you localize that thing with a sestamibi scan and you can then get a CT scan or whatever else you need, I would not go to the neck. I would go directly to the mediastinum, take the tumor out, as long as you had the PTH assay to be sure that you got all the hyperfunctioning tissue. That's why I think these two techniques together make a beautiful package.