Modern Parathyroid Surgery

A Cost-benefit Analysis of Localizing Strategies

Bridget N. Fahy, MD; Richard J. Bold, MD; Laurel Beckett, PhD; Philip D. Schneider, MD, PhD

Hypothesis: Preoperative and intraoperative localizing techniques are more cost-effective than a nondirected bilateral neck exploration in the initial treatment of primary hyperparathyroidism (HPT).

Design: A clinical outcome model was developed to simulate the surgical management of primary HPT. Clinical scenarios modeled included a nondirected bilateral neck exploration and surgery using the following localizing strategies: preoperative technetium Tc 99m sestamibi scanning, intraoperative “quick” intact parathyroid hormone assay, or intraoperative radioguidance. Average total charges based on intent to treat were estimated from our practice and from the literature.

Main Outcome Measures: Average total charges per patient (for the primary operation and for reexploration for persistent HPT, if needed), incidence of surgical failure (ie, persistent HPT), and risk of recurrent laryngeal nerve injury (cumulative risk of the primary procedure and a subsequent operation for persistent HPT).

Results: The use of any localizing strategy reduced total charges, risk of persistent HPT, and cumulative risk of recurrent laryngeal nerve injury compared with a nondirected bilateral neck exploration. The greatest cost savings and the lowest risk of recurrent laryngeal nerve injury were achieved when technetium Tc 99m sestamibi scanning was combined with intraoperative radioguidance. The lowest rate of persistent HPT was found when technetium Tc 99m sestamibi scanning was combined with an intraoperative parathyroid hormone assay.

Conclusions: Limited parathyroid surgery using any localizing strategy is cost-effective, safe, and efficacious in the management of primary HPT. The cost benefit was primarily achieved by reduced operative charges and immediate hospital discharge rather than a lower need for reexploration for persistent HPT.

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Advances in technology have significantly affected the surgical management of hyperparathyroidism (HPT). The first parathyroidectomy was performed in 1925 using a nondirected bilateral neck exploration (BNE), and this remained the treatment of choice for primary HPT into the 1990s. The superiority of a nondirected BNE was affirmed in the 1990 National Institutes of Health Consensus Statement, which stated that “preoperative localization in patients without previous neck operation is rarely indicated and has not proved to be cost effective.” However, since this statement was issued, improvements in radiologic imaging and the development of a rapid intraoperative parathyroid hormone assay (IOPTH) and intraoperative radioguidance (IORG) procedures have occurred. Nondirected BNE for primary HPT is successful in 95% of patients, causing some surgeons to question the necessity of localizing strategies. Furthermore, increasing pressure from patients and third-party payers to minimize medical costs have led many to ask if localization techniques add unnecessarily to the cost of treating primary HPT.

Ideally, clinical decision making is based on the results of well-designed, prospective, randomized, clinical trials. Statistical modeling has become an attractive alternative to this gold standard because such models are able to estimate the efficacy or cost-effectiveness of several interventions without the time or expense required to conduct a clinical trial. A decision tree, as used in this study, is one commonly used model that presents a clinical problem as a sequence of decisions and consequences. The likelihood of a clinical end point is determined by calculating the probability that a given outcome will be achieved and then summing across all of the possible outcomes for that clinical end point. The cost (ie, financial or adverse outcome) of each end

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PATIENTS AND METHODS

A computer-generated mathematical model was created to simulate the surgical management of primary HPT. The model was used to determine the difference in charges per patient, incidence of surgical failure, and risk of RLN injury following nondirected BNE or surgery using various localizing strategies. The risk of RLN injury included the risk during the initial operation and during a subsequent operation, if needed, for persistent HPT. The model assumes equal access to all localizing procedures.

Five strategies for treating primary HPT are illustrated in Figures 1, 2, 3, 4, and 5. Strategy 1 is a nondirected BNE without preoperative or intraoperative localizing studies. Strategy 2 uses IOPTH to confirm resection of diseased glands. Strategy 3 uses a preoperative technetium Tc 99m sestamibi scan to localize diseased glands. Strategy 4 localizes parathyroid disease using preoperative technetium Tc 99m sestamibi scanning and confirms excision of diseased glands with IOPTH. Strategy 5 uses preoperative technetium Tc 99m sestamibi scanning to localize diseased glands and IORG to confirm resection of diseased glands.

Input variables were used to determine the charges per patient, the incidence of surgical failure, and the risk of RLN injury for each of the treatment strategies. The input variables were obtained from the literature and included the following: (1) frequency of cure following nondirected BNE, (2) accuracy of IOPTH, (3) accuracy of preoperative technetium Tc 99m sestamibi scanning, and (4) accuracy of IORG. Nondirected BNE successfully treats primary HPT in greater than 95% of cases\(^2,3\); therefore, it was assumed that the risk of persistent RLN injury following nondirected BNE was 5%. The accuracy of IOPTH is reportedly \(97\%^4,5\) and this value was used in determining outcomes for strategies 2 and 4. The accuracy of preoperative technetium Tc 99m sestamibi scanning was set at 85% for strategies 3 and 5 based on reports ranging from \(81\%^6\) to \(91\%^7,8\). The accuracy of IORG in localizing diseased glands is \(78\%^8\) and increases to \(89\%\) when used following a localizing technetium Tc 99m sestamibi scan.\(^9\) Consequently, a sensitivity of \(90\%\) was used following a localizing preoperative technetium Tc 99m sestamibi scan, while a value of \(78\%\) was chosen when the technetium Tc 99m sestamibi scan was nonlocalizing and a limited exploration was initiated by randomly choosing one side of the neck to explore.

The average charges per patient were estimated from our practice and from the literature. Because of the variability in reimbursement depending on the payer source, we elected to use charges alone in the economic analysis. Financial data for all hospital-associated and professional charges were provided by Patient Financial Services, University of California, Davis, Sacramento, as of April 1, 2001, or from the literature in the case of IOPTH and IORG. Table 1 summarizes the charges used in calculating the cost analysis. The risk of permanent RLN injury following nondirected BNE was set at 0.5% based on the frequency reported in several studies.\(^12,13\) Similarly, the frequency of RLN injury following unilateral neck exploration (UNE) was half that of BNE, and is consistent with previously published reports.\(^16,17\) The risk of permanent nerve injury following a subsequent operation for persistent HPT was set at 3.8% based on the findings of 3 studies.\(^12,18,19\)

A statistician (L.B.) was consulted during the design and execution of our computer-generated mathematical model. Because the values for the input variables were taken from published literature and confidence intervals for these values were not readily available or able to be calculated for each of the studies cited, statistical analyses were not able to be performed.

Table 1: summarizes the charges used in calculating the cost analysis. The risk of permanent RLN injury following nondirected BNE was set at 0.5% based on the frequency reported in several studies.\(^12,13\) Similarly, the frequency of RLN injury following unilateral neck exploration (UNE) was half that of BNE, and is consistent with previously published reports.\(^16,17\) The risk of permanent nerve injury following a subsequent operation for persistent HPT was set at 3.8% based on the findings of 3 studies.\(^12,18,19\)

Use of any preoperative or intraoperative localizing strategy during an initial operation for primary HPT produced a cost benefit when compared with a nondirected BNE. A total of $16,440 in charges per patient were ac-

Figure 1. Strategy 1: algorithm used to estimate total charges and outcomes following parathyroidectomy with a nondirected bilateral neck exploration.

Figure 2. Strategy 2: algorithm used to estimate total charges and outcomes following parathyroidectomy with a limited neck exploration and intraoperative parathyroid hormone assay (IOPTH) confirmation of removal of diseased glands. BNE indicates bilateral neck exploration.

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A nondirected BNE, a UNE can lead to reduced charges through lower operating room charges and earlier hospital discharge. This assertion is supported by the literature, which has shown that most UNEs are performed as outpatient procedures while nondirected BNEs are usually followed by 23-hour inpatient observation.

We next considered whether the use of a localizing procedure continued to provide a cost benefit if the initial operation was unsuccessful and a patient required a subsequent operation for persistent HPT. The frequency of surgical failure, total average charges (including the charges from the initial operation plus the subsequent operation, if needed), and the incremental cost of the subsequent operation are shown in Table 2. The lowest risk of surgical failure was found when preoperative technetium Tc 99m sestamibi scanning was com-

Table 1. Charges for Procedures Related to the Surgical Management of Primary Hyperparathyroidism

<table>
<thead>
<tr>
<th>Service or Procedure</th>
<th>Charge, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parathyroid exploration†</td>
<td>3221</td>
</tr>
<tr>
<td>Surgeon fee</td>
<td>3221</td>
</tr>
<tr>
<td>Anesthesiologist fee</td>
<td>1170</td>
</tr>
<tr>
<td>Anesthesia fee (per hour)</td>
<td>1600</td>
</tr>
<tr>
<td>OR fee (per hour)</td>
<td>3500</td>
</tr>
<tr>
<td>Frozen section (each)</td>
<td>200</td>
</tr>
<tr>
<td>Recovery room fee (per hour)</td>
<td>1275</td>
</tr>
<tr>
<td>23-h Observation</td>
<td>1477</td>
</tr>
<tr>
<td>Preoperative technetium Tc 99m sestamibi scanning</td>
<td>611</td>
</tr>
<tr>
<td>Intraoperative parathyroid hormone assay‡</td>
<td>645</td>
</tr>
<tr>
<td>Intraoperative radioguidance‡</td>
<td>134</td>
</tr>
</tbody>
</table>

†The Current Procedural Terminology code for surgeon fee is 60500; and for anesthesiologist fee, 60500.
‡Data from Flynn et al.11

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provide treatments that produce shorter hospital stays, in addition to these 2 criteria, surgeons are being challenged to avoid surgery when unnecessary the charges for the initial operation. The results of this analysis revealed that the cost of reexploration plays a limited role in overall costs because of the small differences in surgical success seen among the 5 localization strategies.

In addition to the financial cost of the 5 treatment strategies considered, we sought to determine whether any of the strategies was associated with a lower risk of operative morbidity. Permanent RLN injury was chosen as an index of operative morbidity. The frequency of permanent RLN injury following the initial operation for primary HPT and the subsequent operation for persistent HPT (if necessary) for each of the 5 treatment strategies is as follows. The highest risk of permanent RLN injury occurs following nondirected BNE (0.69%). The lowest risk of this complication was found when preoperative technetium Tc 99m sestamibi scanning was combined with IOPTH (0.33%) or IORG (0.33%). (The risk with the use of IOPTH to guide limited neck exploration was 0.44%, and with preoperative technetium Tc 99m sestamibi scanning alone, 0.38%.) The reduction in RLN injuries seen in the localized strategies vs a nondirected BNE is due to the high frequency with which these strategies allow for a UNE.

Nondirected BNE as the initial operation for primary HPT is safe and efficacious, with success rates of greater than 95% and significant morbidity (ie, permanent RLN injury) occurring in less than 1% of the patients. In addition to these 2 criteria, surgeons are being challenged to provide treatments that produce shorter hospital stays, better cosmesis, reduced pain, and reduced costs. Strategies for localizing diseased glands have been used to address these secondary aims.

Technetium Tc 99m sestamibi scanning, IOPTH, and IORG are 3 tools increasingly being used to localize diseased parathyroid glands in the setting of primary HPT. Much of the benefit of these techniques is derived from their ability to allow a limited neck exploration or a UNE. Limited dissection, in turn, reduces operative time, the need for general anesthesia, and inpatient postoperative observation in many patients. However, it is uncertain whether the use of these localizing strategies confers an economic advantage when one considers not just the cost of the initial operation (including the cost of the localizing procedure) but the cumulative charges, which include the cost of the initial operation and the cost of a subsequent operation should the initial procedure be unsuccessful. In addition, it is unclear whether use of these localizing strategies leads to a higher cure rate or a reduction in RLN injuries compared with a nondirected BNE.

The results of our cost-benefit analysis revealed that the use of any localizing strategy provided a cost savings compared with nondirected BNE during the initial operation for primary HPT. Our findings are consistent with those reported by Chen et al, who noted that a minimally invasive parathyroidectomy that included a preoperative technetium Tc 99m sestamibi scan, local anesthesia, and limited incisions costs approximately half as much as a nondirected BNE. Goldstein et al also reported that minimally invasive parathyroidectomy afforded a cost savings compared with BNE. Similar to our analysis, these researchers reported that the economic advantage of the minimally invasive approach was due to lower hospital and operating room charges. Based on their mathematical model, Denham and Norman found that routine preoperative technetium Tc 99m sestamibi scanning was cost-effective in treating primary HPT when 51% or more of the patients are able to undergo a limited neck exploration and when surgeons use the information from the technetium Tc 99m sestamibi scan to proceed with a smaller and more directed operation. In contrast, Greene et al reported that the cost of their nondirected BNE was 17% less than the cost of the technetium Tc 99m sestamibi-directed limited exploration calculated in the Denham and Norman model. However, BNE is performed on an outpatient basis by this group, resulting in significant cost savings that may not be achievable by surgeons performing inpatient BNE. While Flynn et al were unable to show significant savings when they compared total charges following a minimally invasive radio-guided parathyroidectomy with those following a nondirected BNE, they did note decreases in operating room charges, anesthesia charges, hospital stay, and intraoperative tissue analysis, which resulted in a $965 savings per patient.

Having found that use of localization techniques is cost-effective in the management of primary HPT, we sought to determine if localization techniques led to fewer failures following parathyroidectomy. Compared with nondirected BNE, use of a localization procedure reduced surgical failures by 46% to 140%. The most successful approach used preoperative technetium Tc 99m sestamibi scanning with IOPTH (risk of persistent HPT,

### Table 2. Risk of Surgical Failure Following the Initial Operation Total Charges (for the Initial Operation Plus a Subsequent Operation, If Needed), and Charges for a Subsequent Operation for Each Localizing Strategy

<table>
<thead>
<tr>
<th>Strategy*</th>
<th>Risk of Surgical Failure, %</th>
<th>Average Charge, $</th>
<th>Incremental Cost of a Subsequent Operation, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral neck exploration</td>
<td>5.0</td>
<td>17,358</td>
<td>918</td>
</tr>
<tr>
<td>IOPTH</td>
<td>1.6</td>
<td>14,962</td>
<td>600</td>
</tr>
<tr>
<td>Preoperative technetium Tc 99m sestamibi scanning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone</td>
<td>2.3</td>
<td>13,380</td>
<td>125</td>
</tr>
<tr>
<td>Plus IOPTH</td>
<td>0.7</td>
<td>13,854</td>
<td>388</td>
</tr>
<tr>
<td>Plus IORG</td>
<td>1.2</td>
<td>13,158</td>
<td>270</td>
</tr>
</tbody>
</table>

*IOPTH indicates intraoperative parathyroid hormone assay; IORG, intraoperative radioguidance."
Our findings are consistent with those of Carty et al,23 who found that routine single-photon emission computed tomographic technetium Tc 99m sestamibi scanning in conjunction with IOPTH resulted in successful parathyroidectomy in 98.5% of cases. However, other investigators24 have proposed that, while occasional parathyroid surgeons may be able to improve their success rates using a localization technique, it is less likely that a meaningful improvement can be achieved by experienced parathyroid surgeons who routinely cure primary HPT in greater than 95% of those they treat. Moreover, while equivalent success rates between localized and nonlocalized parathyroidectomies have been reported by several investigators,22,25,26 this may reflect a reporting bias. Similar to the learning curve observed for sentinel lymph node biopsy, there is a learning curve involved with the use of these localization procedures.11 Therefore, it is uncertain how readily the results of those most adept at these new techniques can be replicated by the average general surgeon. One advantage of the model proposed, however, is its ability to be modified to reflect the practice environment of any given surgeon. For example, the values of the input variables may be changed to reflect the experience at a given institution, thereby allowing the experienced and the occasional parathyroid surgeon to determine the cost benefit of a given technique.

While use of localization techniques seems to be cost-effective and efficacious compared with BNE, one must also consider whether explorations based on these techniques are as safe as a nondirected BNE. Our model revealed that use of any localization technique reduced the risk of RLN injury by 37% to 52%. Use of preoperative technetium Tc 99m sestamibi scanning in conjunction with either IOPTH or IORG led to the largest risk reduction of permanent nerve injuries. This finding correlates with the increased frequency with which a UNE can be performed in these situations. Our findings are consistent with those of Carty et al,23 who reported no cases of permanent RLN injury when routine preoperative technetium Tc 99m sestamibi scanning was combined with IOPTH, compared with 1 case (1.6%) of permanent RLN injury when preoperative technetium Tc 99m sestamibi scanning was used selectively. They also found that reduced morbidity correlated with a higher rate of UNE. In addition, a UNE during the initial operation theoretically makes reexploration in the case of initial surgical failure less dangerous because the contralateral neck has not been violated.

Limited parathyroidectomy using any localizing method is cost-effective, safe, and efficacious in the treatment of primary HPT. The cost benefit is primarily achieved through reduced operative charges and early hospital discharge. While the use of localizing techniques seemed to reduce surgical failures using our mathematical model, it is unlikely that a significantly improved outcome can be expected compared with nondirected BNE, which is successful in 95% or more of patients. A modest improvement in surgical safety was apparent when localizing procedures were used in our model. While we do support the use of localization strategies in the initial treatment of primary HPT, we believe that the era of the localized parathyroidectomy is still in its infancy. Until the long-term outcome from localized parathyroidectomy is established, a nondirected BNE will continue to be the gold standard against which a localized parathyroidectomy must be compared. Furthermore, the application of these techniques must be made judiciously by each surgeon, bearing in mind that there is no test that can substitute for good surgical technique and sound clinical judgment.

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REFERENCES


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DISCUSSION

John A. Butler, MD, Orange, Calif: Drs Fahy, Bold, Beckett, and Schneider present a well-crafted clinical outcome model to test the hypothesis that preoperative and intraoperative localizing techniques both reduce costs and decrease morbidity in the surgical management of primary HPT. Preoperative sestamibi scan, intraoperative hormone assay, and IORG were the techniques evaluated either alone or in combination, using charges billed by the surgical group at U.C. [University of California] Davis as the standard for the financial analysis, a rather optimistic viewpoint probably not shared by everybody in this room and certainly not by your colleagues from southern California. The authors document savings on the order of 15% to 20%, with the greatest savings accorded to the combination of preoperative scanning with radioguided surgery. While they postulate a 2% to 3% reduction in surgical failures with these techniques, the cost savings are largely attributable to the lower OR [operating room] charges and conversion to outpatient surgery conferred by a unilateral neck exploration.

Finally, using permanent RLN injury as a surrogate for operative morbidity, the authors postulate that localizing studies will reduce morbidity by 30% to 50%, again due to the increased use of a unilateral exploration.

Several caveats must be addressed prior to acceptance of the conclusions based on the computational model. Two of the major ones are in fact the subjects of papers at this very meeting. Yesterday, the Kaiser group demonstrated that the early discharge following colon surgery initially advocated by people performing laparoscopic colectomy can be safely utilized in elderly patients undergoing open colectomy. There are studies in the literature that suggest that with calcium and vitamin D supplementation, most of the bilateral neck exploration patients can also be safely discharged on the day of operation. That is eliminating the major cost reduction associated with the unilateral exploration.

The second caveat will be highlighted in the next presentation, which documents an incidence of 20% for multigland disease in patients undergoing bilateral exploration vs only 5% in patients with unilateral exploration. While intraoperative hormone measurements would substantially mitigate this discrepancy, it is an expensive technique not available to most surgeons and at most hospitals. Would the authors comment on the possible increased risk of recurrent as opposed to persistent disease associated with unilateral explorations driven by preoperative scans?

I would also question the assumption that unilateral exploration will halve the incidence of injury to the RLN. While this is currently supported in the literature, what we are talking about here are the results of surgeons who are leaders in this field. The smaller incisions now being used with radioguided techniques actually make decreased exposure and may, in fact, increase the risk of injury, particularly in cases where the procedure is being performed by surgeons schooled in the technique of radioguided surgery for sentinel nodes but with more limited exposure to thyroid and parathyroid surgery.

In closing, I would like to draw attention to the enormous success of parathyroid surgery as it has been practiced prior to these localizing procedures. It is hard to substantially improve on a procedure that has a greater than 95% success rate as a curative operation and with a major morbidity of only 1%. Certainly, Dr Schneider, myself, and Dr O’Connell, as oncologic surgeons, would be happy with any procedure done in oncology that had those same curative rates and lack of significant morbidity.

Sestamibi scanning is a significant advance and has a clear role in reoperative surgery and identifying ectopic glands, but would nevertheless have a difficult time substantially improving on those results.

And finally, the natural progression from bilateral neck exploration to unilateral exploration to perhaps localized resection of a hot parathyroid gland reminds me of surgery of another endocrine organ, the breast. Screening for diagnosis, preoperative localization, and lesser surgical procedures are now common to both. It is pretty clear that in the next 5 to 10 years, breast surgery will become wand surgery, with the only question being which wand, and more importantly, whose hand will be directing the wand? Would the authors care to comment on the future of a percutaneous approach to parathyroid disease as it is being practiced now to a limited extent with mediastinal lesions?

Steven N. Parks, MD, Fresno, Calif: Dr Fahy started out and said, “in the absence of data,” and then proceeded to quote several papers. She made assumptions based on results of papers from different places; she went to UC Davis for their charges (which we all know have nothing to do with cost). Then, Dr Fahy came up with conclusions that had to do with “cost-effectiveness.” I believe that we still have “absence of data” as much as we had at the beginning.

Quan-Yang Duh, MD, San Francisco, Calif: I agree with their conclusion that the failure rate and nerve injury rate are so low for a standard bilateral exploration that additional tests are unlikely to improve these significantly. I also agree that when we use these tests, we increase the chance that a limited exploration can be done and fewer patients will need bilateral exploration. As a general rule nowadays, we believe that shorter incision and less exploration is good if the results are similar. I disagree, however, that these tests are cost-effective, and this point is debatable. While Bayesian calculation, which is what the computer modeling has done in decision analysis, is mathematical and exact, the problem is that it depends on the premises from which you make these calculations. The conclusion depends on the 2 premises that Dr Butler has already mentioned. One is that the operating time is shorter when you use these tests, and the other is that the patients can go home earlier if you do limited operations. I would like to ask Dr Fahy to provide us with some more solid data on these premises.

One additional point that can affect the result of the analysis is the problem of patients with multiglandular disease. As it turns out, all of these studies are excellent for solitary adenomas, but they are usually poor for multiglandular disease. So, your results of this analysis will depend on how often you have multiglandular disease. I would like to know in your practice how often you see multiglandular disease, and do you see the same problem that multiglandular diseases are poorly localized by these studies?

Earl S. Schuman, MD, Portland, Ore: I noticed in the lineup here that the last combination is sort of missing: sestamibi scan, gamma probe, and IOPTH. Just wondering if you thought of looking at that because that would theoretically address the multigland issue if you knew at the end of the surgery that the parathyroid hormone was plummeting. Then, also, if you could comment on any use you may have had of this test’s allegedly rapid PTH or IOPTH determination, which I have found is neither rapid nor completed by the time the operative procedure is.

Orlo H. Clark, MD, San Francisco: Mathematical models are useful for evaluating different treatment plans, as in this case, patients with primary HPT. I worry about the data that were used from the literature to determine cost. I have several questions: (1) Have you validated your model since you did this cost-benefit analysis? Our group has investigated various approaches
for treating patients with primary HPT during the past several years and has determined that the intraoperative probe is no better than preoperative sestamibi scanning. (2) Do you repeat the sestamibi scan a second time when you use the probe? If so, did you use this cost in your calculations? (3) The duration of hospitalization perhaps depends more on the surgeon's opinion as to whether it is safe to send a postparathyroidectomy patient home a few hours after operation than on whether they have a unilateral or bilateral operation. I would recommend caution about same-day (6-hour) discharge because rare postoperative hematoma may result in respiratory compromise and death. Virtually all of our patients are discharged at 23 hours after parathyroidectomy. (4) Did you also take into account the cost for a 23-hour hospitalization vs immediate discharge after 6 hours in the recovery room since there is usually a higher charge for time in the recovery room? The information in the literature regarding the radioguided probe and IOPTH, I believe, is not correct.

Patients having a focal approach are, in general, easier patients to treat since they have one gland identified preoperatively, whereas the bilateral approach is used for all patients and includes more patients with multiple abnormal glands. The true test is to compare the bilateral approach and the focused approach when just one parathyroid gland is identified in both groups.

Lawrence A. Danto, MD, Stockton, Calif: I would like to expand a little bit on what Dr Quan-Yang Duh mentioned about multiple adenomas. Very often the second adenoma is nonfunctioning and will not image. It will throw your analysis out of focus just by the fact that you will not see the nonfunctioning adenoma with a probe or on scan. It has been my experience that it is usually the case that when there are 2 adenomas present, one dominates functionally over the other. This is something that has to be considered in your analysis tree.

Edward A. Dainko, MD, San Bernardino, Calif: One of the things I missed on the paper was the sample size. I do not know how many patients were used to bring up the data that were presented. Can you give us that?

James J. Peck, MD, Portland: I just want to reinforce the caution that Dr Butler mentioned about RLN injury with small incisions. As the surgical consultant for a state board of medical examiners, this issue has already come up with surgeons that are doing sentinel nodes for other reasons. It is a standard-of-care issue.

Audience question: What is Dr Peck referring to?

Theodore X. O'Connell, MD, Los Angeles, Calif: He is talking about the small, tiny, supposedly noninvasive, minimally invasive type of incision where you can hang the RLN perhaps more easily. Again, this is not part of the discussion, but I think you can use the probe with a regular incision and mobilize the gland and so forth. You do not have to use the small incision.

Dr Schneider: One of the critical questions is, “Who should do parathyroid surgery?” This has been addressed by several of the esteemed members of this group, in fact. Fundamentally, a well-trained general surgeon with a sustained and ongoing interest in parathyroid surgery and its problems should probably be able to capably perform this surgery with very good results. How, then, do you make sense of the burgeoning literature about the use of new techniques, including rapid IOPTH, functional imaging, and radioguidance? And, more particularly, how do you relate these to your current practice?

As an individual who is a general surgeon who came back into parathyroid surgery after being away for some time, this was a daunting process. We began this study with a lot of skepticism about the safety and efficacy of some of the limited surgeries. In particular, like Dr Butler, we had this image in our mind of surgery with microincisions performed by unskilled and unknowledgeable practitioners, increasing the morbidity and also increasing costs unnecessarily.

We should agree that the goals of parathyroid surgery are basically two: to be safe first and foremost and, secondarily, to characterize and properly treat the disease that is found. We must always be prepared to do a bilateral exploration. It is a great operation. It works, and it cures most patients. However, can localization studies help, and how do they help? The boogeyman of parathyroid surgery ever since I have been in the field has really been the specter of multigland disease and, most particularly, the double and triple adenomas.

We believe that our paper supports the conclusion that limited surgery, particularly the unilateral neck dissection, can be safe and successful. This is a modeling study. It is based on the literature and our interpretation of that literature. But, fundamentally, as Dr Duh has announced, the problem with computer decision analysis is that the statistical basis for looking at statistical significance is actually based only on the validity of the individual components of the analysis. The only way to combine data is to really look at the error bars for each of the individual tests and, actually, there are no significance statistics that can be applied to the overall analysis. But it is a starting point.

Let us go to issues of cost vs charges. It is a well-worn debate. The former is the goal, and the latter is often what we are left with. Daphne Denham and James Norman are the Gallahads of this literature. They have gained the Holy Grail of the cost data in parathyroid surgery, and they reported that in 1997 at the meeting of the American College of Surgeons. Their numbers are difficult to export outside of Florida. Yet, no one else has really done a comparable job. They are consistent with our data. We have found a 20% to 30% reduction in our charges for unilateral vs bilateral neck dissection, which compares to their costs for unilateral vs bilateral neck dissection. At our institution, the slightly more than 1 hour that is saved by doing a unilateral exploration (we realize that some people save a lot more time) saves us essentially $5000 in charges. We are the most expensive hospital in the state, maybe one of the most expensive hospitals in the country. Our reduction in charges is proportionate to the Denham and Norman data.

Of particular note with regard to the boogeyman of double- and triple-gland adenomas is the low incidence of reexploration and that the incremental cost seems rather insignificant, ranging from $100 to $1000 if we set the incidence of double or triple adenomas from 2% to 6%. This is a small proportion of the charges overall when compared to the amount that can be saved by saving an hour of surgery.

There is a caveat here and that is, if you are going to do a unilateral exploration, you should deliberately commit to that. Otherwise, you have to do a full-scale bilateral exploration. Any dabbling with the other side with an inadequate operation only compromises the patient’s potential subsequent operation.

The area which this study seems to suggest that we concentrate on is the area of cost savings with postoperative length of stay. Obviously, both Drs Butler and Duh have insightfully inquired about the validity of these data. Again, based on the literature, most people are not discharging their patients early. This is a clear-cut matter where clinical pathways and protocols may have some benefit in defining when outpatient surgery is feasible.

Finally, I would like to address Dr Butler’s question about what I interpret to be minimally invasive scope surgery rather than percutaneous therapy, which I think is inherently dangerous. In the movie The Graduate, Dustin Hoffman’s character is told that the future, in one word, is in “plastics.” In this field, the future is “optics.” As with all surgery, exposure and vision are the key to surgical success. The quality of modern optics and cameras is so astounding that there really should be no reluctance to pursue minimally invasive surgery. In this setting, with a skilled operator who has an understanding of the disease, one should get results comparable to the ones that we have described from the literature.