Limited Value of Repeat Recombinant Human Thyrotropin (rhTSH)-Stimulated Thyroglobulin Testing in Differentiated Thyroid Carcinoma Patients with Previous Negative rhTSH-Stimulated Thyroglobulin and Undetectable Basal Serum Thyroglobulin Levels

M. G. Castagna, L. Brilli, T. Pilli, A. Montanaro, C. Cipri, C. Fioravanti, F. Sestini, M. Capezzone, and F. Pacini

Department of Internal Medicine, Endocrinology and Metabolism and Biochemistry, Section of Endocrinology and Metabolism, University of Siena, 53100 Siena, Italy

Downloaded from https://academic.oup.com/jcem/article/93/1/76/2598169 by guest on 09 April 2024

Context: One year after initial treatment, low-risk differentiated thyroid cancer (DTC) patients undergo recombinant human (rh)TSH-stimulated serum thyroglobulin (Tg) (rhTSH-Tg) and neck ultrasound (US).

Objective: The need for more rhTSH-Tg in these patients is controversial. We evaluated the utility of a second rhTSH-Tg in DTC patients 2–3 yr after their first evaluation.

Results: At the first rhTSH-Tg, basal and stimulated serum Tg was undetectable in 68 of 85 patients. Neck US was unremarkable in all but one, who had evidence of lymph node disease. Seventeen of 85 patients had undetectable serum Tg that became positive after rhTSH, with negative imaging in 10 and evidence of disease in seven. Patients with no evidence of disease were reevaluated 2–3 yr later (second rhTSH-Tg). In patients in which the first stimulated Tg was undetectable, all had undetectable basal serum Tg, which remained undetectable after rhTSH in 66 of 67 patients (98.5%) and became detectable in one (1.5%) (positive neck US). In the 10 patients with detectable stimulated Tg in the first test, basal serum Tg and US were negative at the second test, but rhTSH-Tg became detectable in six. Compared with the first rhTSH-Tg, the second stimulated Tg in these six patients decreased in one, increased in three, and stabilized in two patients.

Conclusions: The second rhTSH-Tg was informative in patients who had first stimulated Tg detectable but not in those who had undetectable Tg at the first test, in which the only patient with recurrence was diagnosed by neck US. Thus, rhTSH-Tg should be repeated only in patients who have had a positive first rhTSH-Tg and negative imaging. **(*J Clin Endocrinol Metab* 93: 76–81, 2008)**

The aim of postsurgical follow-up in patients with differentiated thyroid carcinoma (DTC) is the early discovery and treatment of persistent or recurrent disease. In low-risk patients, sensitive monitoring for thyroid cancer recurrence includes measurement of stimulated serum thyroglobulin (Tg) after recombinant human TSH (rhTSH) (1–6) or thyroid hormone withdrawal (7–10) and neck ultrasound (US) (4, 10, 11). Diagnostic ^{131}I whole body scan (WBS) is of little clinical utility in these patients (1, 4–9), although it may still be recommended in high risk patients (12).

Recent reports and guidelines (13–18) have incorporated this strategy, indicating that after total thyroidectomy and ^{131}I ablation, the short-term follow-up, at least in low-risk patients, should consist of an rhTSH-Tg stimulation test and neck US within 1 yr after initial treatment. At this time, most patients (nearly 80%) will appear free of disease as assessed by a negative

0021-972X/08/$15.00/0

Printed in U.S.A.

Copyright © 2008 by The Endocrine Society

doi: 10.1210/jc.2007-1404 Received June 22, 2007. Accepted October 22, 2007.

First Published Online October 30, 2007

Abbreviations: CT, Computed tomography; DTC, differentiated thyroid carcinoma; FNAC, fine-needle aspiration cytology; rhTSH, recombinant human TSH; Tg, thyroglobulin; TgAb, Tg antibody; US, ultrasound; WBS, whole-body scan.

neck US and an undetectable basal and stimulated serum Tg [with negative serum Tg antibody (TgAb)]. These patients have a very low risk of recurrence and according to some guidelines may be shifted from suppressive to replacement L-T_4 therapy, although direct proof of this strategy has not yet been published (15, 16, 19). Uncertainty does persist regarding whether the subsequent follow-up of these patients should be based on the periodical measurement of basal serum Tg (with or without neck US) or whether a second rhTSH-Tg should be obtained some years later. To answer this question, we retrospectively evaluated the clinical utility of a second rhTSH-Tg in DTC patients with undetectable basal serum Tg and who had no evidence of disease at their first rhTSH-Tg, performed within 1 yr after initial treatment.

Patients and Methods

Patients

The study group included 85 DTC patients with an undetectable basal serum Tg (and negative TgAb) at their first rhTSH-Tg, performed within the first year after initial treatment. There were 21 males and 64 females with a mean (± SD) age of 47.3 ± 16.4 yr (range 14–75 yr). Thyroid carcinomas were classified as papillary in 75 patients (88.2%) and follicular in 10 patients (11.8%). Sixty-one patients had stage I (71.8%), 11 had stage II (12.8%), and 13 had stage III (15.3%). According to the results of this first test, those with undetectable or detectable rhTSH-Tg and no evidence of disease at imaging (n = 77) underwent a second rhTSH stimulation test during 2–3 yr of follow-up. The remaining eight patients who had evidence of disease at the time of the first rhTSH-Tg underwent different treatments and were not subjected to the second rhTSH-Tg. The mean (± SD) follow-up after diagnosis was 56 ± 30 months (range 13–228 months, median 48 months).

In all patients, the initial treatment consisted in total thyroidectomy and ^{131}I postsurgical thyroid ablation after L-T_4 withdrawal with a mean dose of 2830 ± 1295 MBq of ^{131}I (range 1110–5550). Both the first and the second rhTSH-Tg were performed during suppressive L-T_4 therapy as previously described (20). Briefly, patients received one injection of rhTSH (0.9 mg im, Thyrogen; Genzyme Therapeutics, Cambrige, MA) for two consecutive days. Serum samples for TSH, Tg, and TgAb measurement were collected before the first rhTSH injection and 3 d after the last injection of rhTSH. Additional diagnostic tests included neck US and chest x-rays in all patients, and diagnostic ^{131}I WBS in 26 of 85 patients at the first rhTSH-Tg and in one of 77 at the second rhTSH-Tg. Additional imaging procedures, mainly computed tomography (CT) scan of the chest, were performed in a few patients to rule out the presence of distant metastases.

In our institution, patients with undetectable serum Tg (<1.0 ng/ml), negative TgAb, and no evidence of disease (at clinical examination, neck US, chest x-rays, and diagnostic ^{131}I WBS when performed) were defined as free of disease, whereas patients with detectable stimulated serum Tg and/or evidence of disease were classified as having persistent/recurrent disease.

Materials and Methods

Serum Tg, TSH, and TgAb were measured by chemiluminescent assay (Immulite 2000; Diagnostic Products Corp., Los Angeles, CA). Tg assay had a functional sensitivity of 0.9 ng/ml and an analytical sensitivity of 0.2 ng/ml. The interassay variability of Tg assay in our laboratory is 3.95%. TgAb were considered negative when less than 20 IU/ml. All patients underwent neck US performed with a color Doppler apparatus (AU 590 Asynchronous; Esaote Biomedica, Firenze, Italy) and a 7.5-MHz linear transducer. Ultrasonography was performed by experienced endocrinologists (members of our staff) trained in neck US with a high-resolution US system. Neck US was routinely performed in all patients, independently of the results of the rhTSH-Tg test, and the ultrasonographer was blind to the patients' Tg status. Fine-needle aspiration cytology (FNAC) was performed whenever ultrasound criteria of malignancy (cystic appearance, hyperechoic punctuations, loss of hilum, and peripheral vascularization) were present.

Statistical analysis

All data are presented as the mean ± SD, with medians when appropriate. The nonparametric Mann-Whitney *U* test was used to compare quantitative data when it was not normally distributed, and the *t* test was performed for unpaired data. We analyzed 2 × 2 contingency tables using the Fisher exact test or by χ^2 for the 2 × 3 contingency table to evaluate significant differences in frequencies.

The following variables were studied by univariate analysis: age at diagnosis (<45 or >45 yr old), sex, histology of primary tumor (papillary/follicular), local or distant metastases (yes/no), stage at diagnosis, results of postablative WBS (residues or residues plus metastases), and results of the first rhTSH stimulation test (detectable/undetectable Tg). Statistically significant variables found in univariate analysis were entered into a multivariate analysis to identify those with independent prognostic significance and to calculate the odds ratio. We used StatView for Windows version 5.0.1 (SAS Institute, Cary, NC) and MedCalc statistical program for Windows for statistical analyses. We considered $P < 0.05$ to be statistically significant.

Results

Results of the first rhTSH stimulation test within 1 yr after surgery and radioiodine ablation

As shown in Fig. 1, at the time of the first rhTSH stimulation test, both basal and rhTSH-Tg were undetectable in 68 of 85 patients (80%) (first stimulated Tg undetectable). Neck US in this group was negative in 67 of 68 patients (98.5%) and suspicious for a lymph node metastasis in one (1.5%) (false-negative rhTSH-Tg). The metastatic origin of this lymph node was confirmed by FNAC and by WBS performed after the administration of a large activity of radioiodine. In 17 of 85 patients (20%), basal Tg was undetectable, but it became detectable after rhTSH (first stimulated Tg detectable). The mean (± SD) serum peak Tg after rhTSH was 3.8 ± 3.9 ng/ml with a range of 1.1–14.8 ng/ml and a median of 2.4 ng/ml. Ten of 17 patients (58.8%) had no evidence of disease by clinical examination, neck US and chest x-rays and were left untreated.

The other seven of 17 patients (41.2%) had evidence of disease detected by neck US and FNAC in six and by diagnostic WBS in 1 with lung and bone metastases confirmed at CT scan. Peak serum Tg after rhTSH was significantly higher in patients with documented disease than in patients with no evidence of disease (6.7 ± 4.9 *vs.* 1.9 ± 0.8 ng/ml; $P = 0.01$, Mann-Whitney *U* test).

The seven patients with documented disease were treated with therapeutic doses of ^{131}I (mean ± SD cumulative dose of 9,250 ± 5,402 MBq of ^{131}I, range 3,700–20,350). Two patients with lymph node metastases at neck US had no uptake in the posttherapeutic WBS and underwent lymph node surgery. One patient had ^{131}I uptake in the lung and bone and was scheduled for more ^{131}I therapy. The remaining four patients had uptake in regional lymph nodes and are still receiving therapy with ^{131}I.

Downloaded from https://academic.oup.com/jcem/article/93/1/76/2598169 by guest on 09 April 2024

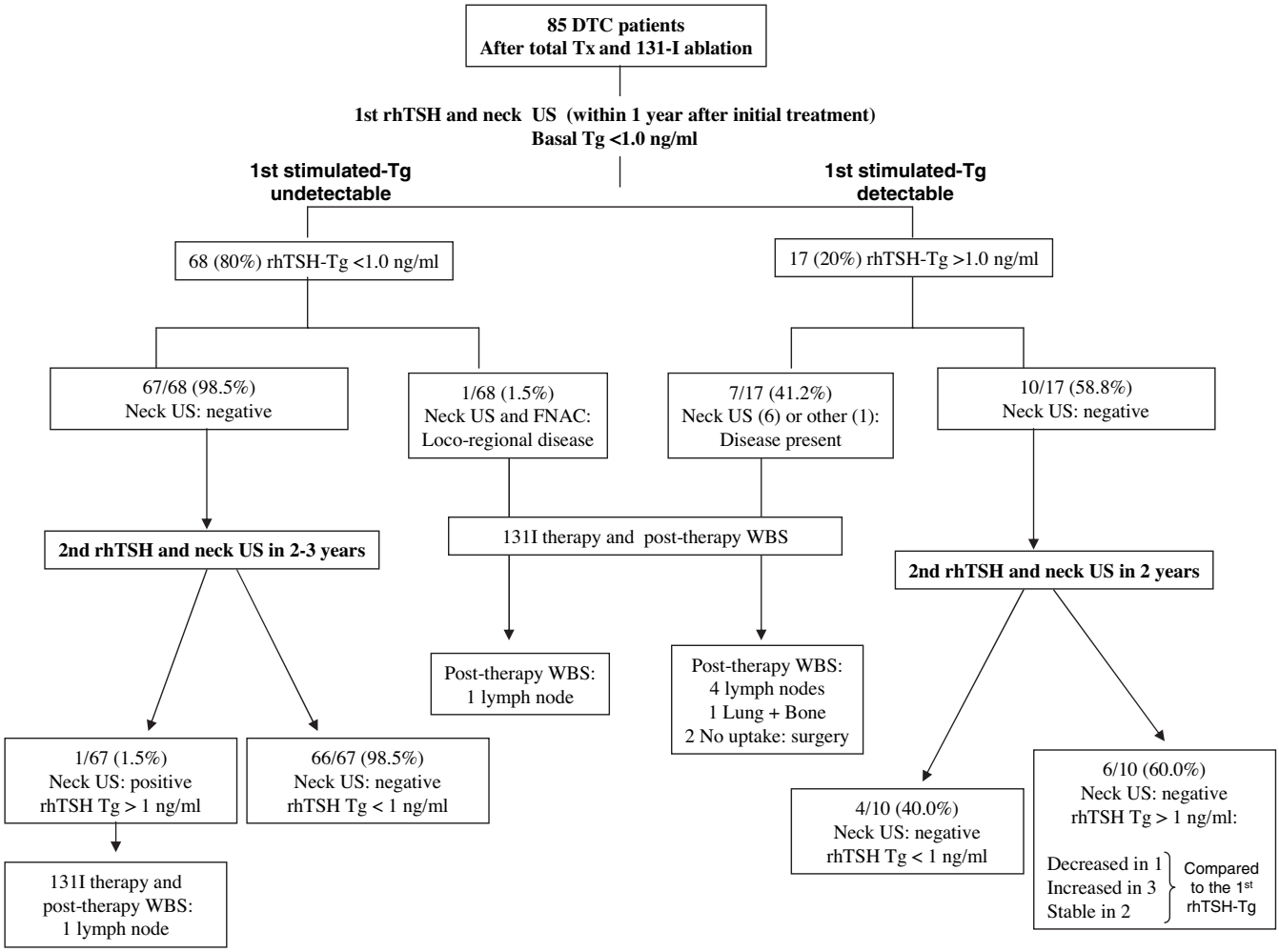

FIG. 1. Results of diagnostic and therapeutic procedures at the first and second rhTSH stimulation tests.

Results of the second rhTSH stimulation test

A second rhTSH stimulation test was performed at an average (± SD) of 35.9 ± 16.0 months (range 12–84 months, median 29 months) after the first test in the 67 patients with an undetectable first stimulated Tg and who were free of disease at that time (Fig. 1). In all but one (98.5%), serum Tg (and TgAb) was still undetectable both in basal conditions and after rhTSH stimulation, and the neck US was negative. In one patient, serum Tg converted from undetectable to detectable (>1 ng/ml) after rhTSH and neck US showed the presence of one lymph node confirmed by FNAC. This patient was treated with ^{131}I therapy, and the disease was confirmed in the posttherapy WBS.

In patients with detectable first stimulated Tg, a second rhTSH stimulation test was performed at an average (± SD) of 22.3 ± 6.1 months (range 13–30 months, median 24 months) in the 10 patients who had detectable rhTSH-Tg but negative imaging at the time of the first rhTSH stimulation test and were left untreated at that time (Fig. 1).

Basal serum Tg was undetectable in all these patients and remained undetectable in four patients with negative neck US after rhTSH stimulation. In six patients, basal serum Tg was undetectable but rose to more than 1.0 ng/ml after rhTSH, and neck US was unremarkable. Compared with the first test, stimulated serum Tg levels had decreased in one patient (from 2.4 to 1.8 ng/ml), remained unchanged in two patients, and increased in three patients (from 2.6, 1.3, and 2.9 to 3.2, 2.2, and 3.6 ng/ml, respectively). These last three patients were considered at risk in view of the increasing trend of stimulated serum Tg and were submitted to intensive imaging procedures (chest CT and [^{18}F]deoxyglucose positron emission tomography), which resulted negative, and in one case, which also resulted negative, to empiric ^{131}I therapy and posttherapy scan.

Concordance between US findings and FNAC

Cumulating the data at the time of the first and the second rhTSH tests, a total of 13 patients underwent FNAC for suspicious findings at neck US. FNAC confirmed the presence of lymph node metastases in eight of 13 (61.5%). Thus, the possibility of exposing a significant proportion (38.5%) of patients to unnecessary FNAC should be considered when interpreting the US finding.

Prognostic variable: univariate and multivariate analysis

The prognostic impact of demographic, clinical, and pathologic features of the patients (age, gender, tumor stage, histotype, local or distant metastases, results of the postablative WBS, and

Downloaded from https://academic.oup.com/jcem/article/93/1/76/2598169 by guest on 09 April 2024

result of the first rhTSH-Tg) on final outcome were evaluated by univariate and multivariate analyses. As shown in Table 1, by univariate analysis, only the presence/absence of metastases (odds ratio 4.8; 95% confidence interval, 1.3–17.2; $P < 0.01$) and the results of the first rhTSH-Tg (detectable or undetectable serum Tg) (odds ratio 60; 95% confidence interval, 10.8–338; $P < 0.0001$) were significant predictors of persistent disease. However, in the multivariate analysis, only the results of the first rhTSH-Tg were found to be an independent prognostic indicator.

Discussion

Recent evidence has shown that, in low-risk patients, an rhTSH stimulation test associated with neck US within 1 yr after initial treatment is sufficient for identifying the large majority of patients (more than 80%) free of disease (negative neck US and undetectable serum Tg) and the small minority with persistent disease (1–6, 10, 11). This strategy has been incorporated into recent guidelines provided by the American Thyroid Association and the European Thyroid Association (15, 16).

Several large retrospective series (7–9) have documented the strong prognostic significance of an undetectable serum Tg obtained after L-T_4 withdrawal 6–12 months after initial treatment. On the contrary, the use of rhTSH is relatively recent; thus, the long-term negative predictive value of this methodology is not yet well defined. A recent prospective study by authoritative authors (21) has indicated that a single rhTSH-Tg of less than 0.5 ng/ml without TgAb has an approximately 98% likelihood of identifying patients completely free of disease who do not require frequent imaging and only a Tg stimulation test in the subsequent follow-up. However, these authors included patients who had had their first rhTSH stimulation test at a median of 3.3 yr (mean ± SD 6.9 ± 0.4 yr, range 10 months to 35 yr) after initial treatment, and not all cases were revaluated with the second rhTSH test. Our study addressed the same issue but, although it is retrospective, it is more homogeneous because all patients had a first rhTSH stimulation test within 1 yr after initial treatment and a second rhTSH stimulation test an average of 3 yr later. Despite these differences, the results follow the same direction. The only divergence in the conclusion is that Kloos and Mazzaferri (21) envisage the possible need to perform additional imaging (neck US) and an rhTSH test at some point during follow-up, whereas, according to our protocol (including neck US as a routine procedure in any examination of the patient), we do not see the need for additional rhTSH tests as long as basal Tg remains undetectable and neck US is unremarkable.

The execution of a second rhTSH stimulation test was of little clinical utility in patients who had no biochemical (undetectable stimulated serum Tg) or clinical (imaging) evidence of disease at the time of their first rhTSH-Tg. In this group, the second test confirmed complete remission in all but one patient, in whom the rhTSH stimulation test was positive and the neck US was also diagnostic. On the contrary, the second test was clinically informative in all patients who had biochemical evidence of possible persistent disease at their first rhTSH stimulation test. In patients of this group, stimulated Tg was undetectable in 40% of patients, demonstrating spontaneous remission (without any treatment), whereas it remained detectable in 60%, indicating the need for further imaging or treatment (in case of an increasing trend of stimulated serum Tg) or the opportunity to wait and see (in case

TABLE 1. Univariate and multivariate analysis of demographic and clinical features affecting final outcome (persistent disease or disease free)

	Persistent disease	Disease free	Univariate analysis	Odds ratio	Multivariate analysis
Age (yr)					
>45	4	40	$P = 0.13$	NA	NA
<45	9	32			
Sex					
Male	6	15	$P = 0.07$	NA	NA
Female	7	57			
Histotype					
Papillary	13	62	$P = 0.34$	NA	NA
Follicular	0	10			
Stage					
I	11	50	$P = 0.31$	NA	NA
II	0	11			
III	2	11			
Postablative WBS					
Residues	9	53	$P = 0.47$	NA	NA
Metastases	4	14			
Metastases					
Yes	9	23	$P = 0.01$	4.8 (95% CI 1.3–17.2) $P = 0.01$	$P = 0.10$
No	4	49			
First rhTSH-Tg (ng/ml)					
Undetectable (<1)	2	66	$P < 0.0001$	60 (95% CI 10.8–338) $P < 0.0001$	$P < 0.0001$
Detectable (>1)	11	6			

NA, Not applicable.

Downloaded from https://academic.oup.com/jcem/article/93/1/76/2598169 by guest on 09 April 2024

of decreasing or unchanged stimulated serum Tg) and no evidence of disease at imaging.

It is important to stress that our approach is appropriate for a center specifically concerned with thyroid cancer, but it probably could not be reproduced in an average hospital setting where the risk of performing unnecessary FNAC may be even higher than that encountered by us.

In conclusion, our results suggest that a second rhTSH stimulation test should be repeated during follow-up only in patients who have positive stimulated serum Tg levels at the time of the first rhTSH test and that have continued to display undetectable basal serum Tg in subsequent years. In the other patients, those defined as free of disease at the time of their first rhTSH-Tg, a second rhTSH test is unnecessary as long as basal serum Tg remains undetectable, neck US is negative, and no other clinical or physical suspicion of recurrence is apparent. Our conclusions and those of Kloos and Mazzaferri (21) are quite similar. They state that patients with undetectable stimulated Tg (<0.5 ng/ml) do not require repeated rhTSH-Tg tests but only annual basal serum Tg measurement on replacement L-T_4. We give the same indications for patients with undetectable stimulated rhTSH-Tg levels but with a cutoff of 1.0 ng/ml. We recommend additional testing only if basal serum Tg becomes detectable during follow-up. A limitation of these studies is the short follow-up. However, our speculation is supported by the results of at least two similar studies (7, 8) performed in patients studied by thyroid hormone withdrawal, showing that when stimulated serum Tg is less than the institutional cutoff, the rate of recurrence is very low (<1%) at a 12-yr follow-up. The final answer to the question of the best follow-up protocol will probably emerge after more studies.

Finally, some recent studies have shown that with the use of supersensitive assays for Tg measurement, an undetectable basal serum Tg has the same predictive value of an rhTSH stimulated Tg performed with less sensitive assays and that a higher percentage of patients have detectable serum Tg after rhTSH (22, 23). The question is whether the use of these sensitive assays will lose specificity.

Acknowledgments

We gratefully acknowledge the assistance of Miss Colleen Connell in reviewing the English wording of the manuscript.

Address all correspondence and requests for reprints to: Furio Pacini, M.D., Section of Endocrinology and Metabolism, Department of Internal Medicine, Endocrinology and Metabolism and Biochemistry, University of Siena, Policlinico Santa Maria alle Scotte, Viale Bracci 1, 53100 Siena, Italy. E-mail: pacini8@unisi.it.

This work was supported by grants from Ministero dell'Istruzione, Università e Ricerca (MIUR) Italy, 2005, and Associazione Italiana per la Ricerca sul Cancro (AIRC, Italy), Regional Grant, 2006/2007.

Disclosure Information: The authors have nothing to disclose.

References

1. **Pacini F, Molinaro E, Lippi F, Castagna MG, Agate L, Ceccarelli C, Taddei D, Elisei R, Capezzone M, Pinchera A** 2001 Prediction of disease status by recombinant human TSH-stimulated serum Tg in the post surgical follow-up of differentiated thyroid carcinoma. J Clin Endocrinol Metab 86:5686–5690
2. **Wartofsky L** 2002 rhTSH-Stimulated Thyroglobulin Study Group. Management of low-risk well-differentiated thyroid cancer based only on thyroglobulin measurement after recombinant human thyrotropin. Thyroid 12:583–590
3. **Haugen BR, Ridgway EC, McLaughlin BA, McDermott MT** 2002 Clinical comparison of whole-body radioiodine scan and serum thyroglobulin after stimulation with recombinant human thyrotropin. Thyroid 12:37–43
4. **Pacini F, Molinaro E, Castagna MG, Agate L, Elisei R, Ceccarelli C, Lippi F, Taddei D, Grasso L, Pinchera A** 2003 Recombinant human thyrotropin-stimulated serum thyroglobulin combined with neck ultrasonography has the highest sensitivity in monitoring differentiated thyroid carcinoma. J Clin Endocrinol Metab 88:3668–3673
5. **David A, Blotta A, Bondanelli M, Rossi R, Roti E, Braverman LE, Busutti L, degli Uberti EC** 2001 Serum thyroglobulin concentrations and (131) I whole-body scan results in patients with differentiated thyroid carcinoma after administration of recombinant human thyroid-stimulating hormone. J Nucl Med 42:1470–1475
6. **Mazzaferri EL, Kloos RT** 2002 Is diagnostic iodine-131 scanning with recombinant human TSH useful in the follow-up of differentiated thyroid cancer after thyroid ablation? J Clin Endocrinol Metab 87:1490–1498
7. **Cailleux AF, Baudin E, Travagli JP, Ricard M, Schlumberger M** 2000 Is diagnostic iodine-131 scanning useful after total thyroid ablation for differentiated thyroid cancer? J Clin Endocrinol Metab 85:175–178
8. **Pacini F, Capezzone M, Elisei R, Ceccarelli C, Taddei D, Pinchera A** 2002 Diagnostic 131-iodine whole-body scan may be avoided in thyroid cancer patients who have undetectable stimulated serum Tg levels after initial treatment. J Clin Endocrinol Metab 87:1499–1501
9. **Baudin E, Do Cao C, Cailleux AF, Leboulleux S, Travagli JP, Schlumberger M** 2003 Positive predictive value of serum thyroglobulin levels, measured during the first year of follow-up after thyroid hormone withdrawal, in thyroid cancer patients. J Clin Endocrinol Metab 88:1107–1111
10. **Torlontano M, Attard M, Crocetti U, Tumino S, Bruno R, Costante G, D'Azzo G, Meringolo D, Ferretti E, Sacco R, Arturi F, Filetti S** 2004 Follow-up of low risk patients with papillary thyroid cancer: role of neck ultrasonography in detecting lymph node metastases. J Clin Endocrinol Metab 89:3402–3407
11. **Frasoldati A, Pesenti M, Gallo M, Caroggio A, Salvo D, Valcavi R** 2003 Diagnosis of neck recurrences in patients with differentiated thyroid carcinoma. Cancer 97:90–96
12. **Robbins RJ, Chon JT, Fleisher M, Larson SM, Tuttle RM** 2002 Is the serum thyroglobulin response to recombinant human thyrotropin sufficient, by itself, to monitor for residual thyroid carcinoma? J Clin Endocrinol Metab 87:3242–3247
13. **Mazzaferri EL, Robbins RJ, Spencer CA, Braverman LE, Pacini F, Wartofsky L, Haugen BR, Sherman SI, Cooper DS, Braunstein GD, Lee S, Davies TF, Arafah BM, Ladenson PW, Pinchera A** 2003 A consensus report of the role of serum thyroglobulin as a monitoring method for low-risk patients with papillary thyroid carcinoma. J Clin Endocrinol Metab 88:1433–1441
14. **Schlumberger M, Pacini F, Wiersinga WM, Toft A, Smit JW, Sanchez Franco F, Lind P, Limbert E, Jarzab B, Jamar F, Duntas L, Cohen O, Berg G** 2004 Follow-up and management of differentiated thyroid carcinoma: a European perspective in clinical practice. Eur J Endocrinol 151:539–548
15. **Cooper DS, Doherty GM, Haugen BR, Kloos RT, Lee SL, Mandel SJ, Mazzaferri EL, McIver B, Sherman SI, Tuttle RM, The American Thyroid Association Guidelines Taskforce** 2006 Management guidelines for patients with thyroid nodules and differentiated thyroid cancer. Thyroid 16:109–142
16. **Pacini F, Schlumberger M, Dralle H, Elisei R, Smit JW, Wiersinga W, European Thyroid Cancer Taskforce** 2006 European consensus for the management of patients with differentiated thyroid carcinoma of the follicular epithelium. Eur J Endocrinol 154:787–803
17. **Thyroid Carcinoma Task Force** 2001 AACE/AAES medical/surgical guidelines for clinical practice: management of thyroid carcinoma. American Association of Clinical Endocrinologists. Endocr Pract 7:202–220
18. **British Thyroid Association** 2002 Guidelines for the management of differentiated thyroid cancer in adults. London: Royal College of Physicians
19. **Biondi B, Filetti S, Schlumberger M** 2005 Thyroid-hormone therapy and thyroid cancer: a reassessment. Nat Clin Pract Endocrinol Metab 1:32–40
20. **Haugen BR, Pacini F, Reiners C, Schlumberger M, Ladenson PW, Sherman SI, Cooper DS, Graham KE, Braverman LE, Skarulis MC, Davies TF, DeGroot LJ, Mazzaferri EL, Daniels GH, Ross DS, Luster M, Samuels MH, Becker DV, Maxon HR 3rd, Cavalieri RR, Spencer CA, McEllin K, Weintraub BD, Ridgway EC** 1999 A comparison of recombinant human thyrotropin and thyroid hormone withdrawal for the detection of thyroid remnant or cancer. J Clin Endocrinol Metab 84:3877–3885
21. **Kloos RT, Mazzaferri EL** 2005 A single recombinant human thyrotropin-

Downloaded from https://academic.oup.com/jcem/article/93/1/76/2598169 by guest on 09 April 2024

stimulated serum thyroglobulin measurement predicts differentiated thyroid carcinoma metastases three to five years later. J Clin Endocrinol Metab 90: 5047–5057

22. **Schlumberger M, Hitzel A, Toubert ME, Corone C, Troalen F, Schlageter MH, Claustrat F, Koscielny S, Taieb D, Toubeau M, Bonichon F, Borson-Chazot F, Leenhardt L, Schvartz C, Dejax C, Brenot-Rossi I, Torlontano M, Tenenbaum F, Bardet S, Bussière F, Girard JJ, Morel O, Schneegans O, Schlienger JL, Prost A, So D, Archambaud F, Ricard M, Benhamou E** 2007 Comparison of seven serum thyroglobulin assays in the follow-up of papillary and follicular thyroid cancer patients. J Clin Endocrinol Metab 92:2487–2495
23. **Smallridge RC, Meek SE, Morgan MA, Gates GS, Fox TP, Grebe S, Fatourechi V** 2007 Monitoring thyroglobulin in a sensitive immunoassay has comparable sensitivity to recombinant human TSH-stimulated thyroglobulin in follow-up of thyroid cancer patients. J Clin Endocrinol Metab 92:82–87

Erratum

In the article "Role of ^{18}F-Fluorodeoxyglucose Positron Emission Tomography in Preoperative Assessment of Cytologically Indeterminate Thyroid Nodules" by Fernando M. Sebastianes, Juliano J. Cerci, Patricia H. Zanoni, José Soares, Jr., Lilian K. Chibana, Eduardo K. Tomimori, Rosalinda Y. A. de Camargo, Marisa Izaki, Maria Clementina P. Giorgi, José Eluf-Neto, José Cláudio Meneghetti, and Maria Adelaide A. Pereira (*The Journal of Clinical Endocrinology & Metabolism* **92:**4485-4488), the authors report an error in the labeling of column 4 in Table 2, which should be 'Specificity (%)' rather than 'Percentage of true-negative results.' *The authors apologize for their error*.

Downloaded from https://academic.oup.com/jcem/article/93/1/76/2598169 by guest on 09 April 2024