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A 66-year-old man with abnormal thyroid function tests

He presented with an acute exacerbation of COPD requiring hospitalization

A 66-year-old man presented to the emergency department with increasing shortness of breath and productive cough, which had begun 5 days earlier. Three years previously, he had been diagnosed with chronic obstructive pulmonary disease (COPD).

One week before the current presentation, he developed a sore throat, rhinorrhea, and nasal congestion, and the shortness of breath had started 2 days after that. Although he could speak in sentences, he was breathless even at rest. His dyspnea was associated with noisy breathing and cough productive of yellowish sputum; there was no hemoptysis. He reported fever, but he had no chills, night sweats, chest pain, or paroxysmal nocturnal dyspnea. The review of other systems was unremarkable.

His COPD was known to be mild, in Global Initiative for Chronic Obstructive Lung Disease (GOLD) grade 1, group A. His postbronchodilator ratio of forced expiratory volume in 1 second (FEV_1) to forced vital capacity (FVC) was less than 0.70, and his FEV_1 was 84% of predicted. Apart from mild intermittent cough with white sputum, his COPD had been under good control with inhaled ipratropium 4 times daily and inhaled albuterol as needed. He said he did not have shortness of breath except when hurrying on level ground or walking up a slight hill (Modified Medical Research Council dyspnea scale grade 1; COPD Assessment Test score < 10). In the last 3 years, he had 2 exacerbations of COPD, 1 year apart, both requiring oral prednisone and antibiotic therapy.

Other relevant history included hypertension and dyslipidemia of 15-year duration, for which he was taking candesartan 16 mg twice daily and atorvastatin 20 mg daily. He was compliant with his medications.

Though he usually received an influenza vaccine every year, he did not get it the previous year. Also, 3 years previously, he received the 23-valent pneumococcal polysaccharide vaccine (PPSV23), and the year before that he received the pneumococcal conjugate vaccine (PCV13). In addition, he was immunized against herpes zoster and tetanus.

The patient had smoked 1 pack per day for the past 38 years. His primary care physician had advised him many times to quit smoking. He had enrolled in a smoking cessation program 2 years previously, in which he received varenicline in addition to behavioral counseling in the form of motivational interviewing and a telephone quit-line. Nevertheless, he continued to smoke.

He was a retired engineer. He did not drink alcohol or use illicit drugs.

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PHYSICAL EXAMINATION

On physical examination, the patient was sitting up in bed, leaning forward. He was alert and oriented but was breathing rapidly and looked sick. He had no cyanosis, clubbing, pallor, or jaundice. His blood pressure was 145/90 mm Hg, heart rate 110 beats per minute and regular, respiratory rate 29 breaths per minute, and oral temperature 38.1°C (100.6°F). His oxygen saturation was 88% while breathing room air. His body mass index was 27.1 kg/m^2.

His throat was mildly congested. His neck veins were flat, and there were no carotid bruits. His thyroid examination was normal, without goiter, nodules, or tenderness.

Intercostal retractions were noted around the anterolateral costal margins. He had no

chest wall deformities. Chest expansion was reduced bilaterally. There was hyperresonance bilaterally. Expiratory wheezes were heard over both lungs, without crackles.

His heart had no murmurs or added sounds. There was no lower-limb edema or swelling. The rest of his physical examination was unremarkable.

Chest radiography showed hyperinflation without infiltrates. Electrocardiography showed normal sinus rhythm, with a peaked P wave (P pulmonale) and evidence of right ventricular hypertrophy, but no ischemic changes.

Results of initial laboratory testing are shown in **Table 1**.

Assessment: A 66-year-old man with GOLD grade 1, group A COPD, presenting with a severe exacerbation, most likely due to viral bronchitis.

INITIAL MANAGEMENT

The patient was given oxygen 28% by Venturi mask, and his oxygen saturation went up to 90%. He was started on nebulized albuterol 2.5 mg with ipratropium bromide 500 µg every 4 hours, prednisone 40 mg orally daily for 5 days, and ceftriaxone 1 g intravenously every 24 hours. The first dose of each medication was given in the emergency department.

The patient was then admitted to a progressive care unit, where he was placed on noninvasive positive pressure ventilation, continuous cardiac monitoring, and pulse oximetry. He was started on enoxaparin 40 mg subcutaneously daily to prevent venous thromboembolism, and the oral medications he had been taking at home were continued. Because he was receiving a glucocorticoid, his blood glucose was monitored in the fasting state, 2 hours after each meal, and as needed.

Two hours after he started noninvasive positive pressure ventilation, his arterial blood gases were remeasured and showed the following results:

- pH 7.35
- Partial pressure of carbon dioxide ($Paco_2$) 52 mm Hg
- Bicarbonate 28 mmol/L
- Partial pressure of oxygen (Pao_2) 60 mm Hg
- Oxygen saturation 90%.

TABLE 1

Initial laboratory results

Test	Value[a]	Reference range
Hemoglobin	15.9 g/dL	13.5–17.5 g/dL
White blood cell count	**16.7 x 10^9/L**	4.5–11.0 × 10^9/L
Neutrophils	**85%**	40%–75%
Lymphocytes	**10%**	20%–45%
Monocytes	3%	2%–10%
Eosinophils	1%	1%–6%
Basophils	1%	0%–1%
Platelet count	260 x 10^9/L	150–400 × 10^9/L
Sodium	136 mmol/L	135–145 mmol/L
Potassium	5.1 mmol/L	3.5–5.2 mmol/L
Blood urea nitrogen	15 mg/dL	7–20 mg/dL
Creatinine	1.0 mg/dL	0.5–1.1 mg/dL
Glucose	110 mg/dL	70–140 mg/dL
Calcium	9.5 mmol/L	8.9–10.1 mmol/L
Albumin	3.7 g/dL	3.5–5.5 g/dL
Alanine aminotransferase	32 U/L	7–35 U/L
Aspartate aminotransferase	30 U/L	7–35 U/L
Troponin I	0.21 ng/mL	0.00–0.40 ng/mL
Brain natriuretic peptide	73 pg/mL	< 125 pg/mL
Sputum gram stain	Negative	Negative
Sputum culture and sensitivity	Pending	No growth
Blood culture	Pending	No growth
Partial pressure of oxygen	**54 mm Hg**	75–100 mm Hg
Oxygen saturation	**88%**	94%–100%
Arterial blood pH	7.37	7.35–7.45
Partial pressure of carbon dioxide	**50 mm Hg**	35–45 mm Hg
Serum bicarbonate	28 mmol/L	22–28 mmol/L

[a] Abnormal values are in bold.

HOSPITAL COURSE

On hospital day 3, his dyspnea had slightly improved. His respiratory rate was 26 to 28 breaths per minute. His oxygen saturation remained between 90% and 92%.

At 10:21 PM, his cardiac monitor showed an episode of focal atrial tachycardia at a rate

TABLE 2

Thyroid function test results in patients with nonthyroidal illness

Thyroid test	Result	Mechanisms
Thyroid-stimulating hormone (TSH)	Normal, high, or low	Low TSH because of: • Suppression of hypothalamic-pituitary axis by inflammatory cytokines • Abnormal TSH glycosylation • Decreased leptin resulting in low thyrotropin-releasing hormone, resulting in low TSH • Increased hypothalamic and pituitary type 2 iodothyronine deiodinase (D2) activity resulting in increased local T_3 and thus decreased TSH Transient TSH increase during recovery from acute illness can be seen
Serum free thyroxine (T_4)	Normal, high, or low	Increased "direct" free T_4 possibly because of inhibitors of T_4 to its binding proteins[6] Decreased free T_4 index possibly because of very low binding protein concentrations[7]
Total T_4	Normal or low	Decreased total T_4 because of: • Low production of its binding proteins • Decreased binding to thyroxine-binding globulin (inhibitors of T_4 binding, glycosylated thyroxine-binding globulin) • Low TSH
Total triiodothyronine (T_3)	Low	Decreased type 1 iodothyronine deiodinase (D1) activities (by cytokines, increased cortisol, free fatty acids, and drugs) Low production of thyroxine-binding globulin Decreased binding to thyroxine-binding globulin (inhibitors of T_3 binding, glycosylated thyroxine-binding globulin) Low TSH
Reverse T_3	High[a]	Increased type 3 iodothyronine deiodinase (D3) activity Decreased D1 activity

[a]Except in patients with end-stage renal disease and in some patients with acquired immune deficiency syndrome.

of 129 beats per minute that lasted for 3 minutes and 21 seconds, terminating spontaneously. He denied any change in his clinical condition during the episode, with no chest pain, palpitation, or change in dyspnea. There was no change in his vital signs. He had another similar asymptomatic episode lasting 4 minutes and 9 seconds at 6:30 AM of hospital day 4.

Because of these episodes, the attending physician ordered thyroid function tests.

THYROID FUNCTION TESTING

1 Which thyroid function test is most likely to be helpful in the assessment of this patient's thyroid status?

- ☐ Serum thyroid-stimulating hormone (TSH) alone
- ☐ Serum TSH and total thyroxine (T_4)
- ☐ Serum TSH and total triiodothyronine (T_3)
- ☐ Serum TSH and free T_4
- ☐ Serum TSH and free T_3

There are several tests to assess thyroid function: the serum TSH, total T_4, free T_4, total T_3, and free T_3 concentrations.[1]

In normal physiology, TSH from the pituitary stimulates the thyroid gland to produce and secrete T_4 and T_3, which in turn inhibit TSH secretion through negative feedback. A negative log-linear relation exists between serum free T_4 and TSH levels.[2] Thus, the serum free T_4 level can remain within the normal reference range even if the TSH level is high or low.

TSH assays can have different detection limits. A third-generation TSH assay with a detection limit of 0.01 mU/L is recommended for use in clinical practice.[3]

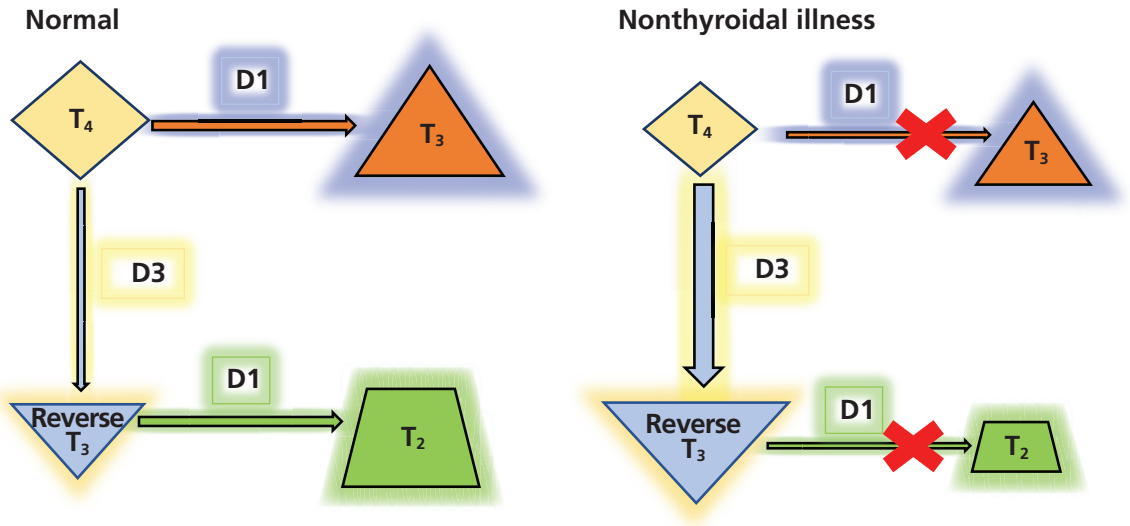

Figure 1. Peripheral conversion of thyroxine (T_4) to triiodothyronine (T_3), reverse T_3, and diiodothyronine (T_2) by deiodinase types 1, 2, and 3 (D1, D2, D3) in healthy people and in patients with nonthyroidal illness.

TSH testing alone. Given its superior sensitivity and specificity, serum TSH measurement is considered the best single test for assessing thyroid function in most cases.[4] Nevertheless, measurement of the serum TSH level alone could be misleading in several situations, eg, hypothalamic or pituitary disorders, recent treatment of thyrotoxicosis, impaired sensitivity to thyroid hormone, and acute nonthyroidal illness.[4]

Because our patient is acutely ill, measuring his serum TSH alone is not the most appropriate test of his thyroid function. Euthyroid patients who present with acute illness usually have different patterns of abnormal thyroid function test results, depending on the severity of their illness, its stage, the drugs they are receiving, and other factors. Thyroid function test abnormalities in those patients are shown in **Table 2**.[5–7]

Free vs total T_4 and T_3 levels

Serum total T_4 includes a fraction that is bound, mainly to thyroxin-binding globulin, and a very small unbound (free) fraction. The same applies to T_3. Only free thyroid hormones represent the "active" fraction available for interaction with their protein receptors in the nucleus.[8] Patients with conditions that can affect the thyroid-binding protein concentrations usually have altered serum total T_4 and T_3 levels, whereas their free hormone concentrations remain normal. Accordingly, measurement of free hormone levels, especially free T_4, is usually recommended.

Although equilibrium dialysis is the method most likely to provide an accurate serum free T_4 measurement, it is not commonly used because of its limited availability and high cost. Thus, most commercial laboratories use "direct" free T_4 measurement or, to a lesser degree, the free T_4 index.[9] However, none of the currently available free T_4 tests actually measure free T_4 directly; rather, they estimate it.[10]

Commercial laboratories can provide a direct free T_3 estimate, but it may be less reliable than total T_3. If serum T_3 measurement is indicated, serum total T_3 is usually measured. However, total T_3 measurement is rarely indicated for patients with hypothyroidism because it usually remains within the normal reference range.[11] Nevertheless, serum total T_3 measurement could be useful in patients with T_3 toxicosis and in those who are acutely ill.

Accordingly, in acutely ill hospitalized patients like ours, measuring serum TSH using a third-generation assay and free T_4 is essential to assess thyroid function. Many clinicians also measure serum total T_3.

On hospital days 3 and 4, he had 2 episodes of focal atrial tachycardia

CASE CONTINUED: LOW TSH, LOW-NORMAL FREE T_4, LOW TOTAL T_3

The attending physician ordered serum TSH, free T_4, and total T_3 measurements, which

TABLE 3

Clinical causes of decreased D1 activity

Condition or drug	Comment
Low caloric intake, malnutrition	The most common inhibitory factor of type 1 iodothyronine deiodinase (D1)
Nonthyroid illness	Even if it is mild
Drugs	
Propylthiouracil	Not methimazole
Glucocorticoids	Eg, 4 mg of dexamethasone decreases total T_3 by 30% in several days
Beta-adrenergic antagonists	Propranolol, metoprolol, atenolol, and alprenolol (not nadolol or sotalol)
Oral cholecystographic agents (eg, sodium ipodate)	Not available in United States
Amiodarone	Could compete with thyroxine (T_4) for the deiodinative site
Liver disease	Liver tissue expresses high levels of D1
Selenium deficiency	D1 is a selenoprotein
Neonatal period	Especially in premature and low-birth-weight infants

yielded the following:

- TSH 0.1 mU/L (0.5–5.0)
- Total T_3 55 ng/dL (80–180)
- Free T_4 0.9 ng/dL (0.9–2.4).

2 Which best explains this patient's abnormal thyroid test results?

- ☐ His acute illness
- ☐ Central hypothyroidism due to pituitary infarction
- ☐ His albuterol therapy
- ☐ Subclinical thyrotoxicosis
- ☐ Hashimoto thyroiditis

What could account for his low TSH, low-normal free T_4, and low total T_3 levels?

Since euthyroid patients with an acute illness may have abnormal thyroid test results (**Table 2**),[5–7] thyroid function testing is not recommended unless there is a strong indication for it, such as new-onset atrial fibrillation, atrial flutter, or focal atrial tachycardia.[1] In such patients, it is important to know whether the test abnormalities represent true thyroid disorder or are the result of a nonthyroidal illness.

In healthy people, T_4 is converted to T_3 (the principal active hormone) by type 1 deiodinase (D1) mainly in the liver and kidneys, whereas this reaction is catalyzed by type 2 deiodinase (D2) in the hypothalamus and pituitary. Type 3 deiodinase (D3) converts T_4 to reverse T_3, a biologically inactive molecule.[12] D1 also mediates conversion of reverse T_3 to diiodothyronine (T_2) (**Figure 1**).

Several conditions and drugs can decrease D1 activity, resulting in low serum T_3 concentrations (**Table 3**). In patients with nonthyroidal illness, decreased D1 activity can be observed as early as the first 24 hours after the onset of the illness and is attributed to increased inflammatory cytokines, free fatty acids, increased endogenous cortisol secretion, and use of certain drugs.[13,14] In addition, the reduced D1 activity can decrease the conversion of reverse T_3 to T_2, resulting in elevated serum reverse T_3. Increased D3 activity during an acute illness is another mechanism for elevated serum reverse T_3 concentration.[15]

Thyroid function testing in patients with nonthyroidal illness usually shows low serum total T_3, normal or low serum TSH, and normal, low, or high serum free T_4. However, transient mild serum TSH elevation can be seen in some patients during the recovery period.[16] These abnormalities with their mechanisms are shown in **Table 2**.[5–7] In several commercial kits, serum direct free T_4 can be falsely decreased or increased.[8]

THE DIFFERENTIAL DIAGNOSIS

Our patient had low serum TSH, low-normal serum direct free T_4, and low serum total T_3. This profile could be caused by a nonthyroidal illness, "true" central hypothyroidism, or his glucocorticoid treatment. The reason we

use the term "true" in this setting is that some experts suggest that the thyroid function test abnormalities in patients with acute nonthyroidal illness represent a transient central hypothyroidism.[17] The clinical presentation is key in differentiating true central hypothyroidism from nonthyroidal illness.

In addition, measuring serum cortisol may help to differentiate between the 2 states, as it would be elevated in patients with nonthyroidal illness as part of a stress response but low in patients with true central hypothyroidism, since it is usually part of combined pituitary hormone deficiency.[18] Of note, some critically ill patients have low serum cortisol because of transient central adrenal insufficiency.[19,20]

The serum concentration of reverse T_3 has been suggested as a way to differentiate between hypothyroidism (low) and nonthyroidal illness (high); however, further studies showed that it does not reliably differentiate between the conditions.[21]

GLUCOCORTICOIDS AND THYROID FUNCTION TESTS

By inhibiting D1, glucocorticoids can decrease peripheral conversion of T_4 to T_3 and thus decrease serum total T_3. This effect depends on the type and dose of the glucocorticoid and the duration of therapy.

In one study,[22] there was a significant reduction in serum total T_3 concentration 24 hours after a single oral dose of dexamethasone 12 mg in normal participants. This effect lasted 48 hours, after which serum total T_3 returned to its pretreatment level.

In another study,[23] a daily oral dose of betamethasone 1.5 mg for 5 days did not significantly reduce the serum total T_3 in healthy volunteers, but a daily dose of 3 mg did. This effect was more pronounced at a daily dose of 4.5 mg, whereas a dose of 6.0 mg had no further effect.

Long-term glucocorticoid therapy also decreases serum total T_4 and total T_3 by lowering serum thyroid-binding globulin.[24]

Finally, glucocorticoids can decrease TSH secretion by directly inhibiting thyrotropin-releasing hormone.[25,26] However, chronic hypercortisolism, whether endogenous or exogenous, does not cause clinically central hypothyroidism, possibly because of the negative feedback mechanism of low thyroid hormones on the pituitary and the hypothalamus.[27]

Other drugs including dopamine, dopamine agonists, dobutamine, and somatostatin analogues can suppress serum TSH. As with glucocorticoids, these drugs do not cause clinically evident central hypothyroidism.[28] Bexarotene, a retinoid X receptor ligand used in the treatment of cutaneous T-cell lymphoma, has been reported to cause clinically evident central hypothyroidism by suppressing TSH and increasing T_4 clearance.[29]

BETA-BLOCKERS, BETA-AGONISTS AND THYROID FUNCTION

While there is general agreement that beta-adrenergic antagonists (beta-blockers) do not affect the serum TSH concentration, conflicting data have been reported concerning their effect on other thyroid function tests. This may be due to several factors, including dose, duration of therapy, the patient's thyroid status, and differences in laboratory methodology.[30]

In studies of propranolol, serum total T_4 concentrations did not change or were increased with daily doses of 160 mg or more in both euthyroid participants and hyperthyroid patients[31–33]; serum total T_3 concentrations did not change or were decreased with 40 mg or more daily[34]; and serum reverse T_3 concentrations were increased with daily doses of 80 mg or more.[31] It is most likely that propranolol exerts these changes by inhibiting D1 activity in peripheral tissues.

Acute illness can alter thyroid test results by several mechanisms

Furthermore, a significant decrease in serum total T_3 concentrations was observed in hyperthyroid patients treated with atenolol 100 mg daily, metoprolol 100 mg daily, and alprenolol 100 mg daily, but not with sotalol 80 mg daily or nadolol (up to 240 mg daily).[35,36]

On the other hand, beta-adrenergic agonists have not been reported to cause significant changes in thyroid function tests.[37]

SUBCLINICAL THYROTOXICOSIS OR HASHIMOTO THYROIDITIS?

Our patient's thyroid function test results are more likely due to his nonthyroidal illness and glucocorticoid therapy, as there is no clinical evidence to point to a hypothalamic-pituitary

disorder accounting for true central hypothyroidism.

The other options mentioned in question 2 are unlikely to explain our patient's thyroid function test results.

Subclinical thyrotoxicosis is characterized by suppressed serum TSH, but both serum free T_4 and total T_3 remain within the normal reference ranges. In addition, the serum TSH level may help to differentiate between thyrotoxicosis and nonthyroidal illness. In the former, serum TSH is usually suppressed (< 0.01 mU/L), whereas in the latter it is usually low but detectable (0.05– 0.3 mU/L).[38,39]

Hashimoto thyroiditis is a chronic autoimmune thyroid disease characterized by diffuse lymphocytic infiltration of the thyroid gland. Almost all patients with Hashimoto thyroiditis have elevated levels of antibodies to thyroid peroxidase or thyroglobulin.[40] Clinically, patients with Hashimoto thyroiditis can either be hypothyroid or have normal thyroid function, which is not the case in our patient.

CASE CONTINUED

After illness, normalization of thyroid test results can take weeks or months

An endocrinologist, consulted for a second opinion, agreed that the patient's thyroid function test results were most likely due to his nonthyroidal illness and glucocorticoid therapy.

3 In view of the endocrinologist's opinion, which should be the next step in the management of the patient's thyroid condition?

- ☐ Start levothyroxine (T_4) therapy
- ☐ Start liothyronine (T_3) therapy
- ☐ Start *N*-acetylcysteine therapy
- ☐ Start thyrotropin-releasing hormone therapy
- ☐ Remeasure thyroid hormones after full recovery from his acute illness

It is not clear whether the changes in thyroid hormone levels during an acute illness are a pathologic alteration for which thyroid hormone therapy may be beneficial, or a physiologic adaptation for which such therapy would not be indicated.[41]

However, current data argue against thyroid hormone therapy using T_4 or T_3 for patients with nonthyroidal illness syndrome (also called euthyroid sick syndrome).[42] Indeed, several randomized controlled trials showed that thyroid hormone therapy is not beneficial in such patients and may be detrimental.[41,43]

Therapies other than thyroid hormone have been investigated to ameliorate thyroid hormone abnormalities in patients with nonthyroidal illness. These include *N*-acetylcysteine, thyrotropin-releasing hormone therapy, and nutritional support.

Some studies showed that giving *N*-acetylcysteine, an antioxidant, increased serum T_3 and decreased serum reverse T_3 concentrations in patients with acute myocardial infarction.[44] Nevertheless, the mortality rate and length of hospitalization were not affected. Further studies are needed to know whether *N*-acetylcysteine therapy is beneficial for such patients.

Similarly, a study using a thyrotropin-releasing hormone analogue along with growth hormone-releasing peptide 2 showed an increase in serum TSH, T_4, and T_3 levels in critically ill patients.[45] The benefit of this therapy has yet to be determined. On the other hand, early nutritional support was reported to prevent thyroid hormonal changes in patients postoperatively.[46]

Measuring thyroid hormone levels after full recovery is the most appropriate next step in our patient, as the changes in thyroid hormone concentrations subside as the acute illness resolves.[47]

CASE CONTINUED

The patient continued to improve. On hospital day 6, he was feeling better but still had mild respiratory distress. There had been no further episodes of arrhythmia since day 4. His blood pressure was 136/86 mm Hg, heart rate 88 beats per minute and regular, respiratory rate 18 breaths per minute, and oral temperature 37.1°C. His oxygen saturation was 92% on room air.

Before discharge, he was encouraged to quit smoking. He was offered behavioral counseling and medication therapy, but he only said that he would think about it. He was discharged on oral cefixime for 4 more days and was instructed to switch to a long-acting bronchodilator along with his other home

medications and to return in 1 week to have his thyroid hormones checked.

One week later, his laboratory results were:

- TSH 11.2 mU/L (reference range 0.5–5.0)
- Free T_4 1.2 ng/dL (0.9–2.4)
- Total T_3 92 ng/dL (80–180).

Clinically, the patient was euthyroid, and examination of his thyroid was unremarkable.

4 Based on these last test results, which statement is correct?

- ☐ Levothyroxine therapy should be started
- ☐ His serum TSH elevation is most likely transient
- ☐ Thyroid ultrasonography is strongly indicated
- ☐ A radioactive iodine uptake study should be performed
- ☐ Measurement of thyroid-stimulating immunoglobulins is indicated

During recovery from nonthyroidal illness, some patients may have elevated serum TSH levels that are usually transient and modest (< 20 mU/L).[48] Normalization of the thyroid function tests including serum TSH may take several weeks[49] or months.[50] However, a systematic review found that the likelihood of permanent primary hypothyroidism is high in patients with serum TSH levels higher than 20 mU/L during the recovery phase of their nonthyroidal illness.[51]

Ultrasonography is useful for evaluating patients with thyroid nodules or goiter but is of little benefit for patients like ours, in whom the thyroid is normal on examination.

Similarly, a radioactive iodine uptake study is not indicated, as it is principally used to help differentiate between types of thyrotoxicosis. (Radioactive iodine is also used to treat differentiated thyroid cancer.)

Thyroid-stimulating immunoglobins are TSH receptor-stimulating antibodies that cause Graves disease. Nevertheless, measuring them is not routinely indicated for its diagnosis. However, their measurement is of significant help in the diagnosis of Graves disease if a radioactive iodine uptake study cannot be performed (as in pregnancy) and in atypical presentations such as euthyroid Graves ophthalmopathy.[52] Other indications for thyroid-stimulating immunoglobin measurement are beyond the scope of the article. Our patient's test results are not consistent with hyperthyroidism, so measuring thyroid-stimulating immunoglobins is not indicated.

CASE CONCLUSION: BETTER, BUT STILL SMOKING

The patient missed his 1-month clinic follow-up, but he visited the clinic for follow-up 3 months later. He was feeling well with no complaints. Test results including serum TSH, free T_4, and total T_3 were within normal ranges. His COPD was under control, with an FEV_1 88% of predicted.

He was again encouraged to quit smoking and was offered drug therapy and behavioral counseling, but he declined. In addition, he was instructed to adhere to his annual influenza vaccination.

KEY POINTS

- In patients with acute illness, it is recommended that thyroid function not be assessed unless there is a strong indication.
- If thyroid function assessment is indicated for critically ill patients, serum TSH and free T_4 concentrations should be measured. Some clinicians also measure serum total T_3 level.
- Thyroid function testing in critically ill patients usually shows low serum total T_3, normal or low serum TSH, and normal or low serum free T_4.
- Many drugs can alter thyroid hormone levels.
- Thyroid hormone therapy is not recommended for critically ill patients with low T_3, low T_4, or both.
- During recovery from nonthyroidal illness, some patients may have mild elevation in serum TSH levels (< 20 mU/L).
- Thyroid hormone levels may take several weeks or months to return to normal after the acute illness.
- Patients with serum TSH levels higher than 20 mU/L during the recovery phase of their nonthyroidal illness are more likely to have permanent primary hypothyroidism. ■

3 months later, he was feeling well; he had no complaints, and his free T_4, TSH, and total T_3 were normal

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