Thyroid Function Screening Tests

When a patient is suspected of having an underlying thyroid condition, there is a stepwise approach to ordering thyroid function tests. The initial screening test of choice is measurement of thyroid stimulating hormone, or TSH. Depending on the value determined, measurements of thyroid hormones (serum free T3 and free T4) may be taken, with the addition of a total T4 measurement to provide further evidence towards the underlying cause. Regardless of etiology, screening tests are not always reliable in a severely ill inpatient population, and special circumstances, like pregnancy, may alter the measured value of these tests.



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If TSH High

TSH-tissue and Up-arrow

If TSH is high, it may indicate either primary hypothyroidism, or subclinical hypothyroidism. Primary hypothyroidism occurs when the thyroid is releasing too little T3 and T4. Therefore, negative feedback does not occur, and TSH levels increase in the attempt to stimulate the thyroid to produce more thyroid hormones. Subclinical hypothyroidism, also called underactive thyroid or mild thyroid failure, means that although thyroid function is inadequate, increased TSH production is able to maintain normal levels of T3 and T4. To distinguish primary and subclinical hypothyroidism, a serum free T4 level is measured.

Free T4 (FT4)

Free Tea with (4) Fork

If TSH is elevated, serum free T4 levels should be measured. T4 is the primary hormone released by the thyroid gland; it is further modified while in circulation into T3, which has ten times the potency of T4. When serum free T4 is measured, it can help distinguish etiology, as well as measuring the degree of hypothyroidism.

If TSH Low

TSH-tissue and Down-arrow

If the level of TSH is low, it may indicate primary hyperthyroidism, or subclinical hyperthyroidism. Primary hyperthyroidism refers to overproduction of thyroid hormones by the thyroid gland, resulting in feedback inhibition of TSH production. Subclinical hyperthyroidism occurs when the anterior pituitary is producing too little TSH, but the thyroid gland itself is able to produce adequate levels of T3 and T4 despite very little stimulation from TSH.

Free T4 (FT4) and T3 (Triiodothyronine)

Free Tea with (4) Fork & Tea with (3) Tree

T4 is the primary hormone released by the thyroid gland; it is further modified while in circulation into T3, which has ten times the potency of T4. These hormones are measured to determine the etiology of an elevated or depressed level of TSH. Negative feedback by high levels of circulating T3 and T4 will inhibit release of TSH, while low levels of circulating thyroid hormones will trigger greater release of TSH.

Consider Serum Total T4 (Thyroxine)

Total Cereal with Tea (4) Fork

When free T4 is released into circulation by the thyroid gland, it is either converted into the more potent T3, or bound to the serum protein thyroxine-binding globulin (TBG) and measured as part of total T4. Therefore, less TBG means less total T4, and more TBG means more total T4, but in both cases free T4. Special circumstances, like pregnancy or hepatic dysfunction, can cause TBG levels to increase or decrease respectively.

Considerations

Only Total T4 Increases in Pregnancy

Total Tea with (4) Up-arrow with Pregnant-woman

Serum total T4 measures both free T4 and T4 bound to TBG (>99.9% bound). If TBG increases in circumstances, like pregnancy or oral contraceptive use, there will be a greater amount of TBG available to bind to free T4 in the bloodstream. If more TBG binds more free T4, there will be less T4, and this will stimulate the anterior pituitary to produce more TSH, and thus more T4 by the thyroid gland to bring the free T4 levels back up to normal. Only free thyroid hormones affect metabolism and other functions, so pregnant patients remain euthyroid even with an increased total T4.

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T4 is Converted to T3

Free Tea with (4) Fork & Tea with (3) Tree

While in systemic circulation, T4 is acted upon by the enzyme 5’-deiodinase to form T3, a hormone that has a much shorter half-life but much greater potency (10x) than T4. Propylthiouracil (PTU) is a medication used to treat hyperthyroidism, that inhibits 5’-deiodinase and prevents peripheral conversion of T4 to T3.

Avoid for Inpatient Screening

Avoid-sign On In-Screen-door

Inhospital patients, especially ones with severe illnesses, can have fluctuations in their protein and hormone levels that may seemingly alter the level of thyroid hormones, while not actually affecting function. Therefore, inpatient diagnosis of thyroid conditions should not solely rely on thyroid hormone measurements.

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