

Understanding Hypothyroidism and Hyperthyroidism

The thyroid gland produces and secretes hormones that regulate metabolism and body temperature, as well as promote normal growth and development in children. Disorders of thyroid function are common in primary care and a contributing factor in critical illness and psychiatric disease. Both hypothyroidism and hyperthyroidism can be transient or permanent, depending on the underlying cause.

Pathophysiology

The thyroid gland is part of the hypothalamus-pituitary-thyroid axis and is controlled by a negative feedback loop. The hypothalamus secretes thyroid-releasing hormone (TRH), which stimulates the anterior pituitary gland to secrete thyroid-stimulating hormone (TSH), which in turn stimulates the thyroid to release thyroid hormones, thyroxine (T₄) and triiodothyronine (T₃). These hormones control how the body uses energy, so they affect nearly every organ in your body. When blood levels of thyroid hormones increase, TRH and TSH are inhibited.

Hypothyroidism

Hypothyroidism is a state of low circulating thyroid hormones. Primary causes for this condition, which affect the thyroid gland directly, impair its ability to make enough hormone. Rarely, there is a secondary cause, such as a pituitary gland tumor, which blocks the pituitary production of TSH. Hypothyroidism results in the slowing down of many physical and mental processes. Myxedema coma, the decompensated severe form of hypothyroidism, is a medical emergency that warrants immediate treatment with thyroid hormone and intensive care unit admission (Ross, 2024a).

Causes of Hypothyroidism

- Primary Hypothyroidism
 - Hashimoto disease (autoimmune thyroiditis)
 - Iodine deficiency
 - Surgical removal of the thyroid gland
 - Thyroid ablation with radioactive iodine
 - External radiation
 - Temporary inflammation of the thyroid gland
 - Too little thyroid medication
 - Exposure to some pharmacologic agents (i.e., amiodarone, lithium, thalidomide)
- Secondary Hypothyroidism
 - Pituitary-based deficiencies of TRH-stimulating or TRH-releasing hormone
 - Rare disorders related to impaired stimulation of the thyroid gland by the pituitary
 - Pituitary adenoma

Signs and Symptoms of Hypothyroidism (Surks, 2024)

- General loss of energy
- Slowed metabolism resulting in fatigue, slow movement and speech, cold intolerance, hypothermia, slowed deep tendon reflexes

- Skin: cool, pale, sweating, coarse hair, hair loss, brittle nails, nonpitting edema (myxedema)
- Eyes: periorbital edema and Graves' eye disease (eyes appear to bulge out)
- Neck: enlarged thyroid gland, hoarse voice
- Hematology: anemia
- Cardiovascular: bradycardia, decreased cardiac output
- Respiratory: shortness of breath on exertion, rhinitis
- Gastrointestinal: constipation, decreased taste sensation, weight gain
- Hypercholesterolemia
- Reproductive: menstrual irregularities/infertility in women, decreased libido
- Neurologic: mild cognitive impairment, Hashimoto encephalopathy, myxedema coma
- Musculoskeletal: weakness, cramps, myalgias
- Stunted growth in children

Treatment of Hypothyroidism

Thyroid replacement, using a form of T₄ (levothyroxine sodium), is the preferred treatment that requires only once-a-day dosing. Thyroid replacement should be tailored for each patient, as small changes in dose can quickly cause an imbalance. Patients should be monitored closely until stable. After TSH is stabilized, maintenance therapy should be continued with annual or semiannual TSH testing. Effective treatment should improve or resolve most signs and symptoms.

Clinical Considerations

- Inform patient that thyroid replacement treatment will likely continue for life.
- Recheck the patient's TSH level if the brand of medication changes.
- Advise patient that medication should be taken at the same time each day on an empty stomach (at least one hour before other medications).
- When switching to intravenous (IV) levothyroxine, reduce the dose to 70% of the oral dose.
- Teach patient that reduced absorption can occur when taken with calcium, iron, vitamins, antacids, colestipol (or other medications that bind bile acids), and fiber supplements.
- Screen patients with depression, anxiety, and cognitive problems for thyroid disease.
- Manage constipation with laxatives and dry skin with moisturizer.

Hyperthyroidism

Hyperthyroidism is a state of high circulating thyroid hormones due to overproduction by the thyroid gland or other sources. Thyrotoxicosis is the clinical syndrome that results from excess thyroid hormone, with thyroid storm being the most severe form. Thyroid storm, a rare diagnosis, can occur in patients with or without preexisting hyperthyroidism and is usually triggered by factors such as trauma, myocardial infarction, surgery (including thyroid surgery for hyperthyroidism), or infection. Thyroid storm is a medical emergency, warranting immediate administration of medications to block the production and release of thyroid hormone and management of systemic illness (Ross, 2024b).

Causes of Hyperthyroidism

- Graves' Disease

- Thyroid tumor/nodule
- Excessive intake of thyroid hormones
- Abnormal secretion of TSH
- Thyroiditis
- Excessive iodine intake or iodine-containing medications such as amiodarone

Signs and Symptoms of Hyperthyroidism (Ross, 2024c)

- Neck: Goiter (enlarged thyroid) may or may not be present; thyroid gland may or may not be tender
- Skin: warm, sweaty, hyperpigmentation, pruritus, hives, loose and soft nails, thinning or loss of hair
- Eyes: lid lag, exophthalmos, impairment of eye muscles, periorbital and conjunctival edema
- Hematology: immune thrombocytopenia, pernicious anemia, increased prothrombotic factors (factors VIII, IX, fibrinogen, plasminogen activator inhibitor-1)
- Cardiovascular: tachycardia, hypertension, widened pulse pressure, atrial fibrillation
- Respiratory: dyspnea and dyspnea on exertion
- Gastrointestinal: weight loss, increased metabolic rate, vomiting, diarrhea, dysphagia
- Metabolic: bone density loss, osteoporosis, hyperglycemia, low serum cortisol
- Genitourinary: urinary frequency, nocturia
- Reproductive: amenorrhea
- Neuropsychiatric: anxiety, nervousness, restlessness, irritability, emotional lability, insomnia, psychosis, agitation, depression, confusion, poor concentration
- Musculoskeletal: tremors in the hands, weakness
- Heat intolerance

Treatment of Hyperthyroidism

Hyperthyroid treatment includes the following:

- **Medications:**
 - Beta-blockers: alleviate symptoms (palpitations, tachycardia, tremors, anxiety)
 - Thionamides (antithyroid drugs): methimazole and propylthiouracil reduce thyroid hormone synthesis; and may suppress white blood cell production
- **Radioactive iodine:** one-time oral treatment ablates the hyperactive gland
 - A major complication of this treatment is permanent hypothyroidism.
- **Surgery** to remove the thyroid tissue that is producing the excessive thyroid hormone.
 - A major complication is disruption of the surrounding tissue, including accidental removal of the parathyroid glands, resulting in low calcium levels requiring calcium replacement.

Clinical Considerations

- Monitor vital signs, especially temperature, heart rate, and blood pressure (all increased in hyperthyroidism).
- Monitor for chest pain.
- Obtain ECG for any abnormal rate or rhythm.

- Use antipyretics and a cooling blanket for fever as needed.

Special Populations

Pregnancy

Thyroid dysfunction in pregnancy is associated with preeclampsia, spontaneous abortion, abnormal fetal brain development, and fetal mortality. In general, increased dosage requirements of thyroid replacement medications should be anticipated, especially during first and second trimesters.

Children

Thyroid hormones play a critical role in neurologic development in children. Low or absent levels of thyroid hormone may result in cretinism, and neonatal hypothyroidism accounts for the most preventable cause of intellectual disability.

Elderly

Signs and symptoms of hypothyroidism may be very subtle and mistakenly attributed to normal aging changes. Taking a careful history is important to make the correct diagnosis and helps to avoid erroneous diagnoses of heart failure, dementia, or depression.

Thyroid Function Tests (TFTs) (Ross, 2023c)

Thyroid function tests (TFTs) are used to screen thyroid activity. TSH is the gold standard for evaluating thyroid function.

When screening for thyroid dysfunction:

- If the TSH is normal, no further testing is required.
- If the TSH is high, check free T₄ to determine the degree of hypothyroidism.
- If the TSH is low, check free T₄ and T₃ to determine the degree of hyperthyroidism.
- If pituitary or hypothalamic disease is suspected, check both serum TSH and free T₄.
- If TSH is normal, but patient has convincing symptoms of thyroid dysfunction, check free T₄.

Normal Thyroid Test Values	
Laboratory Test	Normal Range (Adult)
TSH	0.4 to 5.0 mU/L
Total T ₄	4.6 to 11.2 mcg/dL
Free T ₄	Varies with methodology used.
Total T ₃	75 to 195 ng/dL
Free T ₃	Varies among laboratories.

Note: TSH levels peak in the evening and are at their lowest in the afternoon. Also, levels may vary with severe stress, illness, trauma, and low energy intake.

References:

Mathew P, Kaur J, Rawla P, et al. (2023, March 19). Hyperthyroidism (Nursing) *StatPearls*. Treasure Island (FL): StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK568782/>

Patil N, Rehman A, Anastasopoulou C, et al. (2024, February 18). Hypothyroidism (Nursing) *StatPearls*. Treasure Island (FL): StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK568746/>

Ross, D. (2024a, May 9). Myxedema coma. *UpToDate*. <https://www.uptodate.com/contents/myxedema-coma>

Ross, D. (2024b, July 5). Thyroid storm. *UpToDate*. <https://www.uptodate.com/contents/thyroid-storm>

Ross, D. (2024c, October 10). Overview of the clinical manifestations of hyperthyroidism in adults. *UpToDate*. <https://www.uptodate.com/contents/overview-of-the-clinical-manifestations-of-hyperthyroidism-in-adults>

Ross, D. (2023, December 6). Laboratory assessment of thyroid function. *UpToDate*. <https://www.uptodate.com/contents/laboratory-assessment-of-thyroid-function>

Surks, M.I. (2024, April 20). Clinical manifestations of hypothyroidism. *UpToDate*. <https://www.uptodate.com/contents/clinical-manifestations-of-hypothyroidism>