Nourish

Clinical Reference Guide and Tx Pathway: Thyroid Disorders

Introduction

Definition

A clinical pathway is a tool used to define, standardize, and sequence the interventions specific to conditions treated. Clinical pathways are followed to optimize outcomes, reduce risk, and ensure quality care.

Purpose

Thyroid conditions have shown growth over the past 25 years in the United States, affecting predominantly elders, women, and non-Hispanic Whites (1). It is estimated that 20 million adults have a thyroid condition currently. A clinical pathway will serve to standardize care, while allowing for clinical judgment and individuality of counseling style.

Background: Treating Adult Thyroid Conditions

Current statistics in the United States from the American Thyroid Association indicate 12% of the population suffers from a thyroid condition, with 60% unaware. Undiagnosed thyroid disease may put patients at risk for certain serious conditions, such as cardiovascular diseases, osteoporosis, and infertility. Thyroid conditions are disproportionately found in women, as one in eight women will develop a thyroid condition in their lifetime and are five to eight times more likely than men to develop thyroid problems (1, 2).

The thyroid and thyroid hormone(s) impact every cell in the body. Consequently, dysfunction and disease affecting the thyroid can impact multiple systems in the body and have varied outcomes. The thyroid gland produces hormones that regulate metabolism, affecting energy levels, weight, and body temperature. These hormones also influence heart rate, growth and development, digestive function, and mental health. Proper thyroid function is essential for maintaining overall physiological balance and well-being.

People who have thyroid conditions are at increased risk for many serious diseases and health conditions:

- Anxiety
- Cardiovascular Disease
- Chronic fatigue

- Depression
- Developmental problems in infants
- Infertility
- Low energy
- Low quality of life
- Miscarriage
- Osteoporosis
- Preterm birth
- Weight gain

Pathophysiology

Thyroid conditions range from hypothyroidism to hyperthyroidism and can originate from a variety of triggers. "Hypo" and "hyper" are prefixes used in medical terminology to denote deficiency and excess, respectively. "Hypo" indicates a lower than normal level of a substance or activity, while "hyper" signifies a higher than normal level. In this case, hypothyroidism suggests that too little thyroid hormone is being produced, and hyperthyroidism would be the opposite, resulting in too much thyroid hormone being produced.

- Hypothyroidism: Characterized as a slow thyroid, usually detected by an elevated Thyroid Stimulating Hormone (TSH) which is signaling the thyroid gland to make more thyroid hormone.
- Hashimoto's Thyroiditis: The autoimmune disease where antibodies "attack" the thyroid gland.
- Hyperthyroidism: Characterized as a fast thyroid, with low TSH signaling the thyroid gland to make less thyroid hormone.
- Grave's Disease: Autoimmune disease of Hyperthyroidism

A well-functioning thyroid fulfills the demands of several essential processes:

1. Synthesis of thyroid hormone in thyroid gland
2. Peripheral conversion of thyroid hormone levothyroxine (T4) to its active form liothyronine (T3)
3. Cellular sensitivity to active T3 thyroid hormone

Phase 1: Thyroid Synthesis
Synthesis of T4 requires several cofactors:

- Amino Acid: Tyrosine
- Minerals: iodine, iron, zinc, magnesium, selenium
- Vitamins A, E, B2, B3, B6, C, and D

Phase 2: Peripheral Conversion:
The deiodinase enzyme is responsible for the conversion of T4 thyroid hormone into active T3 thyroid hormone. There are a variety of micronutrient cofactors for this enzymatic process. Micronutrients serve as essential cofactors for a wide range of physiological processes.

- T4 is synthesized in the thyroid gland, and must be converted to T3 to be metabolically active.

Phase 3: Cellular Sensitivity to Thyroid Hormone

The presence of metabolically active T3 alone cannot maintain homeostasis; additional cofactors are necessary to ensure target tissues' sensitivity.

Laboratory Values

Table 1.1: Thyroid Lab Ranges (1, 3)

Test	Typical Lab Range	Integrative Medicine Range
Thyroid Stimulating Hormone (TSH)	0.4-4.5mIU/L	0.3-2.0 mIU/L
Produced in the pituitary gland in response to amounts of T3. Higher levels of T3 decrease production of T4 in a negative feedback loop.		
Free T4	.8-1.8ng/dL or 9-23 pmol/L	1.1-1.8 ng/dL or 15-23 pmol/L
Unbound T4. Free T4 has direct tissue function in the body.		
Free T3	2.3-4.2 pg/mL or 3-7 pmol/L	5-7 pmol/L
Unbound T3, is the most active form of thyroid hormone. This form enhances the efficiency of energy production by increasing mitochondrial activity, promoting the breakdown of carbohydrates and fats, which ensures that cells have adequate energy to perform their functions efficiently.		
Thyroid Peroxidase Antibodies (TPOAbs)	<35 IU/mL	Prefer <2-9 IU/mL

Elevated in Hashimoto's and sometimes elevated in Grave's Disease		
Thyroglobulin antibodies (TgAbs)	<20 IU/mL	<2 IU/mL
Sometimes raised in Hashimoto's thyroiditis		
Reverse T3	8-25ng/dL	11-18 ng/dL
This is produced from T4 and is an inactive form of T3 produced under conditions of stress in an effort to conserve energy.		
Thyroid Stimulating Immunoglobulin	<140%	<125%
It is a stimulatory antibody and the one that causes an overactive thyroid gland. May be raised in Graves' disease.		

Table 1.2: Nutrition Labs Related to Thyroid Function: (4-6)

Nutrition Lab	Reference Range	Ideal Range for Thyroid Health
Vitamin B12 (4)	200–800 pg/mL	-
Ferritin (4, 7)	Female: 24–307 ng/mL Male: 24–336 ng/mL	70-90 ng/mL
RBC (2)	Female: 4.1–5.1 × 106 cells/mm3 Male: 4.5–5.9 × 106 cells/mm3	-
Magnesium, serum (4)	1.6–2.6 mg/dL	-
Vitamin D3 (4, 8) • 1,25-Dihydroxyvitamin D (1,25-dihydroxycholecalciferol) • 25-Hydroxyvitamin D (25-hydroxycholecalcif	• 15–60 pg/mL • 30–60 ng/mL	50-80 ng/mL

erol)		
Urinary Iodine (4)	Varies based on lab	-
Selenium (6)	120-160 µg/l	-
Methylmalonic Acid (4)	0.00–0.40 µmol/L	-

RD Scope

Clinical counseling focused on nutrient density and medication management is one of the key MNT strategies identified in support of patients who have thyroid conditions. Thyroid function is closely tied to vitamin and mineral status, and RDs are competent in assessing a patient's diet for micronutrient deficiencies. Furthermore, thyroid hormone treatment is highly sensitive to dietary factors, making dosage and timing relative to food intake essential
Individualized dietetic care for thyroid health at Nourish is provided via telehealth and is based on patient self-reported thyroid S/S and/or a referral from a provider who seeks thyroid support for their patients.

Nourish RDs follow the Nutrition Care Process, including nutrition assessment, diagnosis, intervention, and monitoring and evaluation. RDs should follow guidelines endorsed by the Academy of Nutrition and Dietetics for providing thyroid health MNT and education (1).

Interventions

There are multiple interventions and approaches to working with people who have thyroid conditions, some sequential, and many can be combined for greater efficacy. RDs at Nourish support lifestyle modification. As well, they should serve as advocates for their patients by recommending external referral to thyroid specialists when appropriate. The goal of any treatment for people with suboptimal thyroid function is an improvement in overall health and resolution of thyroid related disorders and/or symptomatology.

Hypothyroidism

Pharmacological Tx - Hypothyroidism

Thyroid hormone replacement is the gold standard treatment for hypothyroidism (9). The most common thyroid hormone replacement is levothyroxine, a synthetic form of T4 thyroid hormone, and is observed as the standard of care for the hypothyroid patient (9). However, synthetic liothyronine (T3) and desiccated or glandular prescription options, which contain a combination of T3 and T4 thyroid hormone, are also available.

The RD role in pharmacological management of thyroid medications should focus on timing of medications and how food can affect the absorption of thyroid hormone medications.

Table 1.3: Thyroid Hormone Replacement Therapy Options:

Active Hormone Rx	Brand Names	Details
Levothyroxine (T4)	Synthroid	Very common brand name option; gluten free; contains lactose
	Levoxyl	Another less common brand name; lactose free
	Generic Levothyroxine	Inexpensive option, popular but can be contaminated with gluten; most contain lactose
	Tirosint	Gel-capsule used for patients highly sensitive to dyes, food allergies, etc.
	Thyquidity	Liquid form of levothyroxine, best tolerated by patients with GI conditions or those who prefer to eat or drink after taking medication
Liothyronine (T3)	Cytomel	“Brand name”; commonly used when adding T3 to combination therapy; helpful if pt is struggling with deodinase activity
	Generic Liothyronine	Used in compounded formulations

Dessicated Thyroid Gland (T4/T3) • All are derived from pork or beef so not to be used for persons with beef or pork allergies. • Contains both active T4 and T3 thyroid hormone	Armour Thyroid /NP Thyroid	Utilizes standardized amounts of T4/T3 hormone in a 4 to 1 ratio, unlike the other options in this category; Lactose Free
Other Pharmacological Considerations	Compounded T3/T4 hormone	Offers personalized dosages, allergen-free options, various forms of administration, and potentially more consistent hormone levels for patients with specific needs
	LDN-Low Dose Naltrexone	• Used off label to assist with management of thyroid symptoms; believed to lower antibodies, though research has yet to show this to be possible (1, 11-13) • Doses of 1.5-4.5 mg per day are usually recommended and have been reported to enhance immune function by increasing the body's production of endorphins, also known as endogenous endorphin production. Recent research in fibromyalgia is being used to support this off-label use (1, 11-13)

Medication Management:

- Thyroid medications are usually taken once a day, ideally early morning on an empty stomach, at least 30 - 60 minutes before eating and/or drinking coffee, and 4 hours before taking calcium or iron supplements. Patients should also limit soy containing foods within 2 hours of taking thyroid medication.

- The RD should assess challenges to timing intake and medication and support with strategies accordingly.

Nutrient Deficiencies -Hypothyroidism

Addressing nutritional deficiencies in thyroid patients is critical to supporting the body's production of thyroid hormones and ensuring adequate cellular uptake.

Vitamins, minerals, and amino acids act as cofactors on a biochemical level to facilitate adequate production of thyroid hormone, conversion of thyroid hormone, and cellular uptake/sensitivity to thyroid hormone.

Clinicians should work to assess the following nutrients from both dietary and supplement intake to help the patient develop strategies for achieving nutrient adequacy. RDs are uniquely equipped to provide education on nutritional deficiencies and help co-create targeted plans to address nutritional deficiencies, whether through food and/or nutritional supplementation.

During the assessment, RDs should evaluate dietary intake for the following nutrients, using biomarker data when available. It is within the clinician's scope to recommend further labs if the RD is very familiar with lab interpretation and follows the Nourish SOP for Diagnostics. Lab testing can help assess certain nutrient deficiencies, but not all. While some lab tests for certain nutrients are well-established and scientifically validated, others may be considered less reliable or even pseudoscientific. The accuracy and clinical relevance of these tests depend on the biomarker being measured, the method used, and the context in which the tests are interpreted. It is essential to consult with a healthcare professional to determine which tests are appropriate and based on sound scientific evidence.

These following nutrients have an impact on thyroid function (3, 14):

1. *Synthesis of T4 requires several cofactors:*
   - ➔ Amino Acid: Tyrosine
   - ➔ Minerals: iodine, iron, zinc, magnesium, selenium
   - ➔ Vitamins A, E, B2, B3, B6, C, and D

2. *Peripheral Conversion of Thyroid Hormone:*
   - ➔ T4 is synthesized in the thyroid gland. It has low metabolic activity, so it must be converted to T3 to be metabolically active.

➔ Requires selenium and zinc

3. *Cellular Sensitivity to Thyroid Hormone*
   ➔ The presence of metabolically active T3 in and of itself is insufficient to maintain homeostatic balance. Additional cofactors are required to ensure the sensitivity of target tissues, including vitamin A and zinc.
      ◆ Cofactors Needed Daily (3, 14)

Nutrition and Dietary Considerations –Hypothyroidism

Table 1.4: Nutrition and Dietary Considerations for Hypothyroidism (1,3, 14-15)

Nutrient	Adequate Intake/RDA	Tolerable Upper Intake	Hypothyroidism
Vitamin B12, mcg/d	Adults, ages >18 y: 2.4 mcg	Not established	Need may be increased; assess anemia
Dietary sources include sardines, salmon, organ meats, mollusks, meat, dairy, fortified cereals, and yeast.			• No ideal dose has been identified; labs are best utilized to assess status • Use methylcobalamin if supplementing (16)
Iron, mg/d**	Men, ages >18 y: 8 mg Women, ages 19-50 y: 18 mg Women, ages >50 y: 8 mg	45 mg	Low iron storage can impair thyroid hormone synthesis; needs are increased
Dietary sources include red meat, oysters, clams, chicken, legumes and leafy greens.			May need 25-5 mg/d iron bisglycinate is best absorbed with less side effects (17). Take with vitamin C to increase absorption
Magnesium(Mg),	Men, ages	350mg	Required for T4 to T3

mg/d	19-30 y: 400 mg Women, ages 19-30 y: 310 mg Men, ages ≥31 y: 420 mg Women, ages ≥31 y: 320 mg		conversion
Dietary sources include: beans and other legumes; dark green leafy vegetables; nuts; seeds; and whole grains.			No consensus on supplementation needs in these disease states; use clinical judgment and lab results to address deficiencies. ● *Magnesium glycinate is well absorbed* ● *Supplementation must be 4 hours apart from thyroid hormone medications as Mg will inhibit absorption*
Copper, mcg/d	>19y: 900 mcg	10000 mcg	low
Dietary sources include:			2mg/day in Multivitamin (1)
Vitamin D3, IU	>19-70y: 600 IU >70: 800 IU	4000 IU	low
Dietary sources include fatty fish, fortified dairy, eggs, mushrooms, and sunlight (skin production of vitamin D depends on the season and latitude).			1000-5000 IU/day (18-19)
Iodine, mcg/d*	Adults, ages >19 y: 150 mcg	1100 mcg	low/high
Dietary sources include iodized salt, fish, dairy, grains, and sea vegetables.			Assess iodine intake and adjust on a case-by-case basis to meet and not exceed

			RDA.
Selenium, mcg/day • Important cofactor for the deiodinase enzyme to convert T4 into T3	Adults, ages >19 y: 55 mcg	400 mcg	can be low, supplementation can be beneficial (20-21)
Dietary sources include Brazil nuts (depending on size, about one to two nuts contain rough (200 µg), onions, meat, grains, tuna, crab, and lobster (1).			200 mcg daily
Zinc, mg/d • Transport of thyroid hormone, stimulation of the pituitary for TSH production, and conversion of T4 to T3	Men: >19: 11 mg Women, ages >19: 8 mg	40 mg	Low: needs are increased (22)
Dietary sources include shellfish, herring, legumes, milk, and wheat bran.			2 mg/day in Multivitamin (1)
Calcium (1) • Consuming calcium containing supplements within 4 hours of thyroid hormone medication will result in decreased thyroid	>19-50: 1000 mg 51-70+: 1200 mg	19-50: 2500 mg >51: 2000 mg	Calcium may be retained

hormone absorption.			
Dietary sources include dairy, fortified orange juice, sardines, tofu, salmon, fortified grains and leafy greens.			Not to exceed RDA.

*Observationally, in practice, many patients are moving away from using iodized table salt, so it is important for the clinician to assess sodium sources in initial appointments.
**The clinician should assess ferritin, if possible, to determine overall iron status. Iron deficiency anemia can reduce the effectiveness of iodine supplementation; therefore, if testing indicates a need for iron supplementation, addressing the deficiency will enhance the benefits of iodine.

Other Dietary Considerations

- Balancing Blood Glucose/Anti-inflammatory Diet Pattern
- Adequate carbohydrate intake
    - Low carb diets such as the ketogenic diet, low-carb paleo, and the Atkins diet which can result in carbohydrate intake below RDA of 150 g/day are not recommended as thyroid hormone production may decrease (23).
- Increase Fiber
- Increase Protein
- Limit Soy Consumption (24)
- Gluten Free
    - Of all diet modifications, eliminating gluten has shown to have the greatest potential for positive effects towards patients with Hashimoto's. (25) There are several possible reasons shown in the research:
        - There is a correlation with Hashimoto’s and Celiac disease, with an estimated 1.2-15% of patients having both of these autoimmune conditions. The antibodies produced in celiac disease can cross-react with thyroid antibodies because they may share similar molecular structures (26).
        - Various research studies have shown a positive correlation with a gluten free diet and reduction in symptoms of hypothyroidism, as well as reduction in measurable antibodies (27).
        - Even if a patient does not have a Celiac’s diagnosis or an identified gluten sensitivity, exploring a gluten-free diet may benefit a patient who is still experiencing symptoms despite proper medication management.

- Possible nutrition considerations for following a gluten-free diet:
    - Following a gluten free diet can result in insufficient intake of folate, B12, fiber, magnesium, zinc, iron, and vitamin D3 (28)
- The recommended duration for following a gluten-free diet for improvement to thyroid function is at least 3 months, with 6 months being ideal. It is crucial for the patient to maintain a completely gluten-free diet during this period. Although the gluten molecule is excreted from the body within 48 hours, the immune response to gluten can persist for up to 4 months.

- Moderate Goitrogenic Foods (30)
    - Goitrogens suppress the thyroid gland through three mechanisms:
        - Suppressing the release of thyroid hormone
        - Changing the way thyroid hormone gets produced in the body
        - Suppressing the absorption of iodine via glucosinolate compounds.

      As a compensatory mechanism, the thyroid will enlarge with increases in production to accommodate low levels of thyroid hormone. This can lead to the formation of a goiter, also known as an enlarged thyroid gland.

Table 1.6: Goitrogenic Foods (31)

Arugula	Cassava Root	Kohlrabi	Pine Nuts	Spinach
Broccoli/ Broccoli Sprouts	Cauliflower	Millet	Radishes	Strawberries
Broccolini	Collard Greens	Mustard Greens	Rapini	Turnips
Brussels Sprouts	Horseradish	Peaches	Rutabaga	Wasabi
Cabbage	Kale	Peanuts	Soy Products	Watercress

        - Cooking, lightly steaming, or fermenting goitrogenic foods deactivates and breaks down the iodine-blocking glucosinolates and allows increased bioavailability of iron.
- Time-Restricted Eating/Circadian Rhythm

    - Many thyroid patients present with a desire to lose weight and often follow “intermittent fasting” styles of eating. However, this is not always recommended, as long periods of fasting may affect the conversion of T4 to T3, thus raising a patient’s TSH level (32-37). Clinical judgment is needed to determine if fasting is the correct approach for a patient with weight loss goals.

- The Autoimmune Diet Protocol (AIP) (1, 37-38)
    - The AIP Diet Protocol is a dietary approach designed to reduce inflammation and improve symptoms in individuals with autoimmune diseases, including autoimmune thyroid conditions like Hashimoto's thyroiditis. The AIP diet involves several key principles, including a reduction in inflammatory foods, inclusion of nutrient dense foods, a re-introduction phase where some foods may be placed back in the dietary patterns, and a focus on gut health.
        - Before considering the Autoimmune Protocol (AIP) diet, it is essential to thoroughly assess the patient's stress levels and overall health. Given the diet's extreme restrictions, weigh whether the psychological and physiological stress of adherence outweighs the potential benefits.
        - This diet is contraindicated for patients who are pregnant, underweight, malnourished, or have a history of disordered eating or eating disorders.
        - Ensure adequate nutritional intake is maintained; consider recommending a comprehensive multivitamin during the elimination phase.
    - The AIP diet is a two-phase elimination diet.
        - Phase One – "Elimination" – foods and ingredients that have been shown to trigger inflammation, allergies, or autoimmune flares and reactions are eliminated.
        - This phase is recommended to last for at least 30 days, with a 90-day trial being ideal.
            - Grains, including wheat, oats, rice, amaranth, barley, buckwheat, bulger, corn, millet, quinoa, rye, sorghum, and spelt, and products made from grains such as pasta, bread, cereals, crackers
            - Legumes
            - Beans, including soy, and soy products like tofu and tempeh
            - Nightshades vegetables like tomatoes, peppers, eggplant, and potatoes

- Goji berries
- Dairy – all forms, including butter and ghee
- Butter
- Eggs
- Coffee
- Chocolate
- Alcohol
- Nuts, including nut butters and peanut butter
- Seeds
- Seed-based spices, including allspice, anise, celery seed, cumin, fennel seed, sesame seeds, mustard, nutmeg, and poppy seeds
- Fruit and berry-based spices: allspice, anise, caraway, cardamom, juniper, peppercorn, sumac
- Sugar, including sugar substitutes like xylitol, mannitol, and stevia
- Refined and processed foods
- Refined oils and seed oils like canola oil, sesame oil, and sunflower oil
- Food additives, dyes, and thickeners
- Chlorella
- Spirulina

- Phase 2-During the "Reintroduction" phase, foods are gradually reintroduced in small quantities while monitoring symptoms to identify triggers.

Exercise Considerations - Hypothyroidism

The ideal exercise volume and type for hypothyroid patients will vary based on the patient, but generally exercise has been found to not have a significant impact on thyroid function (39-40). Given the thyroid's sensitivity to prolonged stress, providers may recommend low-intensity exercise combined with strength training to minimize stress hormone exposure and prevent decreases in T3, testosterone, and growth hormone (39). The type and amount of exercise should be individualized and take into account factors such as - risk of myopathy that can occur with hypothyroidism, achieving normal thyroid levels, and ability to consume adequate nutrition to fuel exercise. Dietitians play a crucial role in setting realistic exercise expectations for thyroid patients, given their extensive involvement in patient support.

Hyperthyroidism/Thyrotoxicosis

Hyperthyroidism is most often a result of biological causes like autoimmune Grave's disease, toxic adenoma, and toxic multinodular goiter, all of which are characterized as an over-productive thyroid gland resulting in high levels of T4 and/or T3(1). A less severe, non-biological cause is excessive iodine intake (41).

Hyperthyroidism is ten times more common in women than in men. Autoimmune hyperthyroidism often follows a stress trigger, leading to immune system hyperactivity. In hyperthyroidism, the thyroid gland produces excess thyroid hormones, which can significantly affect the cardiovascular system. One of the common symptoms of hyperthyroidism is an elevated heart rate (tachycardia) due to the overstimulation of the heart by these excess hormones(1, 41). This may require some patients to be on Beta Blockers that block the effects of catecholamines on beta-adrenergic receptors in the heart. This reduces heart rate, decreases the force of heart muscle contraction, and lowers blood pressure.

Patients with hyperthyroidism often present with symptoms such as goiter, infrequent periods in women, increased appetite, exophthalmos (protrusion of the eyes due to inflammation), eye bulging, increased BMR, loose bowel movements, unintentional weight loss, heat intolerance, lowered cholesterol, anxiety, and increased heart rate. The main concerns with untreated hyperthyroidism include bone loss, cardiovascular damage, and ocular damage, which can lead to blindness. Many patients delay seeking treatment because the initial weight loss and boost in energy can mask symptoms of concern, making them harder to recognize.

Registered dietitians play a crucial role in supporting hyperthyroid patients by addressing their increased energy needs (40 kcal/kg) and higher nutrient requirements, as well as managing increased fluid needs (3-4 L per day) when there are no renal or cardiac concerns (1).

Hyperthyroidism can escalate into a life-threatening thyroid storm, necessitating close monitoring and medication management by an endocrinologist or specialized physician.

A "thyroid storm," also known as a thyrotoxic crisis, is a severe and life-threatening condition that occurs when hyperthyroidism is left untreated or inadequately managed. It is characterized by an extreme overproduction of thyroid hormones, leading to a rapid and dramatic increase in metabolism. Symptoms of a thyroid storm include:

- High fever

- Rapid heart rate (tachycardia)
- High blood pressure
- Severe agitation or delirium
- Profuse sweating
- Nausea, vomiting, or diarrhea
- Severe weakness or muscle wasting
- Confusion or loss of consciousness

A thyroid storm requires immediate medical attention and hospitalization. Treatment typically involves medications to reduce thyroid hormone production and manage symptoms, as well as supportive care to stabilize the patient's condition.

Pharmacological Tx-Hyperthyroidism

Table 1.7: Medical Management Hypothyroidism-Pharmaceutical/Surgical

	Treatments	**Details**
Medications	Methimazole/Tapazole	• First line medication to treat hyperthyroidism; taken once daily • Full efficacy at 4-6 weeks • Category D; has strict regulatory control and carry a pregnancy warning • Fewer side effects than other treatments
	Propylthiouracil	• Used when Methimazole is contraindicated • Used in the first trimester of pregnancy • Dosage is given 2-3x/day, resulting in greater difficulty with patient adherence
Thyroid Destruction	Radioactive Iodine Ablation	• Damages/destroys thyroid cells and shrinks the thyroid gland, thus decreasing the excess hormone production.

		• Results in hypothyroidism • Pregnancy should be avoided for 6-12 months post treatment • Medically managed as hypothyroid post ablation
	Surgical Removal	• Full removal of thyroid gland • Risk of damaging the parathyroid glands resulting in hypoparathyroidism • Medically managed as hypothyroid post surgery

Nutrition and Dietary Considerations–Hyperthyroidism

Medical Nutrition Therapy (1, 41-43):

- Support Blood Glucose balance with balanced meals
    - Glycogen stores can be low due to hypermetabolic rate, leading to blood glucose fluctuations.
    - Insulin resistance is common with thyrotoxicosis (44).
    - Caloric intake is often too low in the hypermetabolic state; thus the RD can support patient needs by focusing on balanced meals meeting 40 kcal/kg per day to prevent unwanted weight loss.
- Adequate protein intake
    - 1-1.75g/kg accounting for activity level and amount of muscle mass lost while hyperthyroid
- Adequate minerals for bone health due to frequency of bone demineralization from increased metabolic rate (45)
    - Ensure adequate calcium, phosphorus, and vitamin D to 100% Daily Value.
        - Dairy is a common source of these nutrients, as one cup can meet those daily needs, but dairy sensitivities are common in patients with thyroid disorders. Therefore, it is recommended to supplement up to 100% of the daily value for each nutrient category when facing dairy allergies/sensitivities (1).
- Assess dietary iodine intake and counsel on avoiding excessive iodine intake above the RDA of 150 mcg/day (44, 46).

    - This may result in using non-iodized salt with home cooking and limiting MVI with iodine to allow for fewer dietary restrictions from food (See Table 1.5 for iodine rich foods).
- Monitor digestion.
    - More frequent bowel movements are a common complaint in the hyperthyroid state.
- Multivitamin Use:
    - Hyperthyroid patients run the risk of low B vitamins (16, 47-48). A multivitamin can help correct deficiencies that diet alone cannot address. Furthermore, it can also address the mineral concerns identified above as well. *It is important to choose one without iodine, as referenced above*.
- Excess goitrogen intake (41)
    - Goitrogenic vegetables can potentiate the efficacy of medications used to treat hyperthyroidism. Recommend a maximum of two cups of goitrogenic vegetables. See Table 1.6 for a list of high goitrogenic foods.
- Supporting elevated heart rate
    - Minimize stimulants, as patients facing hyperthyroidism can have an increased heart rate.
        - RDs may need to counsel patients on decreasing or eliminating caffeine to help manage symptoms.
    - Magnesium can be helpful to slow heart rate (50). See Table 1.

Table 1.4: Nutrition/Dietary Considerations for Hyperthyroidism (1,3, 14-15)

Nutrient	**Adequate Intake/RDA**	**Tolerable Upper Intake**	**Hyperthyroidism**
Vitamin B12, mcg/d	Adults, ages >18 y: 2.4 mcg	Not established	Needs are increased
Dietary sources include sardines, salmon, organ meats, mollusks, meat, dairy, fortified cereals, and nutritional yeast.			-No ideal dose has been identified; labs are best utilized to assess status -Use methylcobalamin if supplementing (16)
Magnesium(Mg), mg/d	Men, ages 19-30 y: 400 mg Women, ages	350 mg	-Deficiency is common -needs are increased with elevated heart rate

	19-30 y: 310 mg Men, ages ≥31 y: 420 mg Women, ages ≥31 y: 320 mg		
Dietary sources include: beans and other legumes; dark green leafy vegetables; nuts; seeds; and whole grains.			No consensus on supplementation; use clinical judgment and lab results to address deficiencies. ● *Magnesium glycinate is highly bioavailableMagnesium supplementation should be taken at least 4 hours apart from thyroid hormone medications, as magnesium can inhibit their absorption.*
Vitamin D3, IU	>19-70y: 600 IU >70: 800 IU	4000 IU	Needs are increased
Dietary sources include fatty fish, fortified dairy, eggs, mushrooms, and sunlight (skin production of vitamin D depends on the season and latitude).			2000 IU/day
Vitamin E, mg	>14y: 15mg	14-18: 800 mg >18: 1000 mg	Needs are higher due to increased amounts of Vitamin E lost from excessive free radical generation
Dietary sources include sunflower seeds, almonds, fortified cereals, hazelnuts, and peanut butter.			Assess intake from food; supplementation has been shown to have benefits, but dosages have not been well studied.(49)
Iodine, mcg/d*	Adults, ages >19 y: 150 mcg	1100 mcg	Levels may be high; excess iodine >500 mcg/day may *induce* hyperthyroidism (1);
Dietary sources include iodized salt, fish, dairy, grains, and sea vegetables.			Assess iodine intake and adjust to meet and not exceed RDA.
Selenium, mcg/day	Adults, ages >19	400 mcg	Only supplement when deficient

• Important cofactor for the deiodinase enzyme to convert T4 into T3	y: 55 mcg		and if antithyroid antibodies are deficient.
Dietary sources include Brazil nuts (depending on size, about one to two nuts contain roughly 200 µg), onions, meat, grains, tuna, crab, and lobster.1			200 mcg
Zinc, mg/d • Transport of thyroid hormone, stimulation of the pituitary for TSH production, and conversion of T4 to T3	Men: >19: 11 mg Women, ages >19: 8 mg	40mg	Deficiency can be common
Dietary sources include shellfish, herring, legumes, milk, and wheat bran.			2 mg in multivitamin is recommended
Calcium (1) • Consuming calcium containing supplements within 4 hours of thyroid hormone medication will result in decreased thyroid hormone absorption.	>19-50: 1000 mg 51-70+: 1200 mg	19-50: 2500 mg >51: 2000 mg	Needs are increased to prevent bone loss, which is greater in this disease state

Dietary sources include dairy, fortified orange juice, sardines, tofu, salmon, fortified grains and leafy greens.	Goal should be to consume up to the RDA.

Exercise Considerations-Hyperthyroidism

Exercise can be beneficial for hyperthyroid patients to manage symptoms, but caution is warranted due to common cardiovascular concerns and skeletal weakness. Therefore, it is crucial to prioritize nutritional support and proper medication management before encouraging physical activity(1, 50). Achieving normal thyroid lab results is essential, and patients should be cleared by their primary care physician or thyroid specialist before starting or increasing exercise.

Additional Considerations for Treatment of Hypothyroidism and Hyperthyroidism

Person-Centered Approach

Shared decision making and patient-driven goal setting are foundational to Nourish's Clinical Philosophy.

Patient-centered care focuses on the patient and the individual's particular healthcare needs. The goal of patient-centered healthcare is to empower patients to become active participants in their care. Evidence-supported principles guiding care at Nourish include:

- Establishing a positive dietitian-patient relationship
- Displaying humanistic behaviors
- Using effective communication skills
- Individualizing and adapting care and frequency of dismissal of thyroid patients health concerns.

Thyroid patients often express frustration when their lab results do not support their symptoms of poor health. Subclinical thyroid issues are gaining more attention from healthcare providers. Dietitians play a unique and important role in offering empathy, ensuring patients feel heard, and supporting them in making lifestyle changes to improve thyroid function.

Motivational Interviewing

While not required of every RD in every session, Motivational Interviewing (MI) is a foundational counseling technique employed by Nourish RDs.
Most RDs at Nourish have had extensive education and experience with the tools of MI including:

- Open-ended questions
- Rolling with Resistance (or avoiding the righting reflex)
- Expressing empathy
- Developing discrepancy (or exploring ambivalence), and supporting self-efficacy, among others.

MI is a collaborative, goal-oriented style of communication with particular attention to the language of change. It is designed to strengthen personal motivation for and commitment to a specific goal by eliciting and exploring the person's own reasons for change within an atmosphere of acceptance and compassion.The fundamentals of MI are identifying what the patient would like to accomplish, and through exploring ambivalence (15).
MI is practiced with an underlying spirit or way of being with people, including:

- **Partnership**. MI is a collaborative process. The MI practitioner is an expert in helping people change; people are the experts of their own lives.
- **Evocation**. People have within themselves the resources and skills needed for change. MI draws out the person's priorities, values, and wisdom to explore reasons for change and support success.
- **Acceptance**. The MI practitioner takes a nonjudgmental stance, seeks to understand the person's perspectives and experiences, expresses empathy, highlights strengths, and respects a person's right to make informed choices about changing or not changing.
- **Compassion**. The MI practitioner actively promotes and prioritizes clients' welfare and wellbeing in a selfless manner.

Evidence-Based Care

Evidence-based practice (EBP) in dietetics involves providing holistic, quality care based on the most up-to-date research and knowledge rather than traditional methods, advice from colleagues, or personal beliefs/bias (52).

EBP is an approach to health care wherein health practitioners use the best evidence possible, i.e., the most appropriate information available, to make decisions for individuals, groups, and populations.

EBP values, enhances and builds on clinical expertise, knowledge of disease mechanisms, and pathophysiology. It involves complex and conscientious decision making based not only on the available evidence but also on client characteristics, situations, and preferences. It recognizes that healthcare is individualized, dynamic, and inherently involves uncertainties and probabilities.

EBP incorporates successful strategies that improve client outcomes and is derived from various sources of evidence, including research, national guidelines, policies, consensus statements, systematic analysis of clinical experience, quality improvement data, specialized knowledge, and the skills of experts. Evidence-based Medicine (EBM) has been built on the cornerstone of eliminating bias (45).

It is the expectation of Nourish RDs that they evaluate and utilize the latest research studies, systematic reviews, and meta-analyses related to nutrition and dietetics. This evidence forms the foundation for making informed decisions about dietary interventions for Nourish patients.

Clinical Pathway

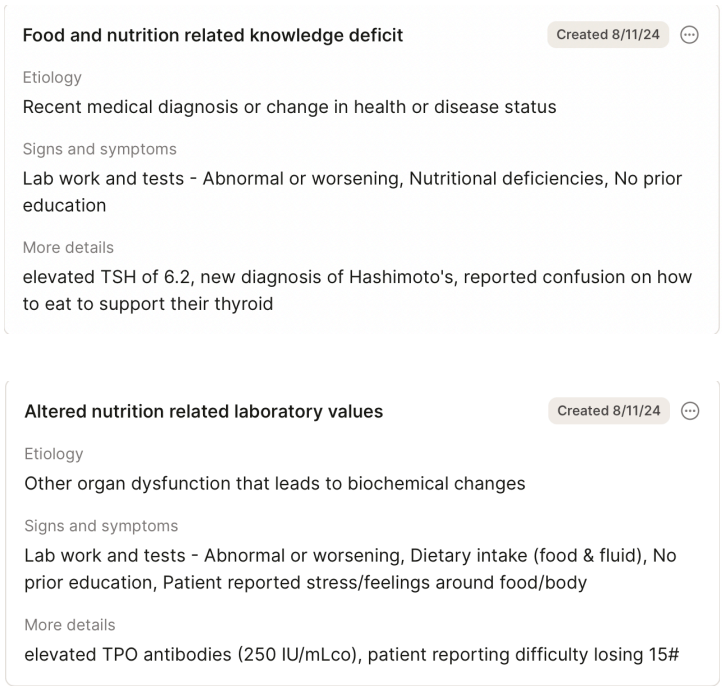
Clinical pathways are structured, evidence-based plans that guide healthcare professionals through the delivery of care for specific conditions or goals. Below is a clinical pathway to direct dietitian clinical practice for working with patients with a thyroid disorder. Keep in mind that this is a general guideline for the management of thyroid disorders*. Individual patient needs may vary.

This Clinical Pathway aims to provide a structured and comprehensive approach to supporting patients in achieving thyroid disease management while addressing individual needs and promoting long-term success.

The number of sessions presented represents a recommendation based on thyroid literature. Individual patient preference, learning style, magnitude of behavior change, and insurance limitation must be considered.

Pre	**Referral and Assessment** In advance of appt with the patient, review the information that the patient shared in their signup flow/intake form. Review referral from the healthcare provider indicating the patient's heart health goals or a patient self-referral, as well as any uploaded medical documentation and records.
1.0 Sessions 1 - 2	**Complete the Assessment** During the initial session for a patient seeking nutrition support for thyroid concerns, RD will capture a complete health history (including weight history and labs), determine eligibility for outpatient counseling, review biochemical data, medical tests, and procedures, then set the stage for goal setting. Documentation in the relevant section of the Nourish chart note is required.

	Components of the thyroid assessment include: ● Health history ● Adult weight hx ● Assessing patient's current stress level via the Nutritional Intake Form ● Current intake (24-hour recall) / Current dietary habits ● Calculate estimated dietary intake (kcal and macros) ● Physical activity levels ● Previous and current labs (including assessing the need for obtaining more recent labs if it's been >1 year and the need for testing antibodies if labs are not present)

1.1 Sessions 1 -2	**Determine Eligibility** 1. Nourish provides MNT for thyroid conditions for patients based on patient shared goals, symptoms, and exclusion criteria. The patient shares the goal of thyroid management on the sign up flow and/or during the initial session. 2. If your clinical judgment indicates that the patient has other medical conditions that should be prioritized over thyroid management, use clinical judgment and the patient's goals to reprioritize and transfer if needed.
1.3	**Complete diagnosis (PES) Examples**:  **Food and nutrition related knowledge deficit** Created 8/11/24 Etiology Recent medical diagnosis or change in health or disease status Signs and symptoms Lab work and tests - Abnormal or worsening, Nutritional deficiencies, No prior education More details elevated TSH of 6.2, new diagnosis of Hashimoto's, reported confusion on how to eat to support their thyroid **Altered nutrition related laboratory values** Created 8/11/24 Etiology Other organ dysfunction that leads to biochemical changes Signs and symptoms Lab work and tests - Abnormal or worsening, Dietary intake (food & fluid), No prior education, Patient reported stress/feelings around food/body More details elevated TPO antibodies (250 IU/mLco), patient reporting difficulty losing 15#

Sessions 1 -2 (with regular revisitation)	**Establish Patient Goals:** ● Collaborate with the patient to set realistic and achievable behavioral goals. ● Follow S.M.A.R.T goal format. ● Consider individual factors such as age, medical conditions, and lifestyle. Consider the need for the patient to follow up with MD if updated labs are needed or the patient reports symptoms and/or medication management beyond RD's scope of practice.
1.5 Sessions 1 -2 (with regular revisitation)	**Develop Intervention** Food and/or Nutrient Delivery ● Develop an individualized dietary plan/pattern/approach considering individual macronutrient and micronutrient needs. ○ Calculate Energy needs - Resting Metabolic Rate (RMR) using the Mifflin-St Jeor equation based on age, actual weight, height, and gender (in Provider Portal). ○ Determine Total Daily Energy Expenditure (TDEE) by multiplying RMR by Activity Factor (AF) to get TDEE (in Provider Portal). ○ Adjust for desired weight gain or loss ○ Balanced macronutrient distribution ■ Carbohydrates: 45-65% of total daily calories ■ Protein: 10-35% of total daily calories ■ Fat: 20-35% of total daily calories ○ Prioritize nutrient Density (EN/Kcal) ○ Address nutrient deficiencies if identified. ○ Focus on identifying possible sources of inflammation for patients and work on creating an anti-inflammatory diet to support thyroid health. ○ Consider exploring a gluten free diet or AIP if determined appropriate after assessing the patient. ○ Consider cultural and personal food preferences.

	Note: RDs will use discretion on whether to share specifics on energy estimations and nutrients needs with the patient.
	
	Nutrition Education
	
	• Provide individualized education after assessing nutrition knowledge deficits and identifying relevant topics.
	• Possible education topics:
	  ○ Medication timing in relation to food intake and supplementation
	  ○ Vitamin and mineral considerations for thyroid conditions
	  ○ Sources of goitrogenic foods
	  ○ Anti-Inflammatory foods/AIP Diet
	  ○ Managing digestive concerns
	  ○ Other Lifestyle factors that contribute to inflammation (e.g. stress, sleep)
	
	Nutrition Counseling
	
	• Motivational interviewing to identify and set behavior-change goals.
	• Cognitive-behavioral strategies to address emotional eating or food triggers.

1.6 Sessions 3 - 12+	**Share evidence-based tools for healthy eating to support thyroid health, including:** ▪ Portion awareness tools (visuals, cups, food scale) ▪ Meal Plans or idea lists ▪ Food first approach/culinary medicine ▪ Food prep skills & exercises ▪ Food journaling/tracking ▪ Symptom tracking ▪ Activity journaling/tracking ▪ Nutrition label reading ▪ Hydration strategies ▪ Strategies for dining out ▪ Strategies for incorporating activity ▪ Stress management techniques (meditation, yoga, breathing exercises) ▪ Mindful eating

	■ Behavior contracts ■ Stimulus control ■ Social support ■ Visualization ■ Gratitude ■ Tobacco cessation (if appropriate) ■ Medication Compliance ■ Self-weighing (if appropriate and if weight gain or loss is desired) RDs are to use clinical and behavior change judgment to select from the available tools with Nourish to support patients with thyroid disorders.
1.8 Sessions 3 - 12+	**Physical Activity Integration** • Encourage physical activity for, per Academy Evidence Analysis Library. • Consider recommending low-intensity exercise combined with strength training to promote T4 to T3 conversion (8). • Refer to a fitness professional and qualified fitness programming source to incorporate a personalized exercise plan if appropriate.
1.9 Sessions 1 - 12+	**Additional charting requirements** • With each session, complete all relevant outcomes including general health.

2.0 Session 1-12+	**Regular Monitoring and Follow-Up** • Schedule regular follow-up appointments to monitor progress. • Adjust the dietary plan and goals as needed. • Address any challenges or concerns the patient may encounter. • Provide ongoing behavioral support to help the patient overcome barriers. • Encourage self-monitoring through food diaries, symptom tracking, and/or mobile apps (e.g. MyTherapy, Boost Thyroid, Thyroid Tracker, ThyForLife, Symple Symptom Tracker). • Discuss strategies for managing social and environmental influences on eating behavior • Be mindful of the mental health implications of thyroid disease. • Review new thyroid labs every 3 months. • Assess GI function regularly for slow or hyper motility and address as appropriate.
2.1 Session 12+	**Transition to Maintenance** • Gradually transition the patient to a plan that promotes thyroid stability once goals and symptoms have been addressed. • Provide guidance on maintaining thyroid health. • Recommend ongoing support through periodic check-ins • Explore with the patient whether there are other nutrition interests / goals with which you might be able to help.

2.2 Session 1-12+	**Multidisciplinary Collaboration** ● Collaborate with other healthcare professionals as available, such as physicians and psychologists, to ensure comprehensive and coordinated care. ● Communicate regularly with the healthcare team to address any medical or psychological concerns ● Consider encouraging patients to obtain thyroid labs if their most recent results are >1 year old.
2.3 Session 12 or completion of program	**Evaluation** ● Evaluate the effectiveness of the intervention based on lab results, reduction in symptoms, outcome graph trends, and improvements in overall health. ● Collect patient feedback for continuous quality improvement.

Professional Development and Education

As the scientific and medical landscape for treating people with thyroid disorders is changing rapidly, Nourish encourages RDs to remain up to date with professional education. To support this, Nourish provides full-time RDs a $300 education stipend.

The following are credible, authoritative sources for ongoing professional education. Research in the field of nutrition and dietetics is always changing, so it is important to stay up to date on new developments.

Academy of Nutrition and Dietetics (AND):

- AND offers a variety of professional development opportunities, including webinars, workshops, and conferences related to thyroid treatment and nutrition.

Endocrine Society:

- The Endocrine Society hosts conferences and educational events that may include sessions on thyroid function and its impact on endocrine health.

Online Platforms and Courses:

- Explore online platforms like Coursera, edX, and others for courses on thyroid management and related topics. Universities and institutions often offer online courses that provide CME credits.

Medical Journals:

- Stay updated with reputable medical journals that publish articles on thyroid and nutrition. Journals like The American Journal of Clinical Nutrition, and others can be valuable sources.

Hospital Grand Rounds and Workshops:

- Participate in hospital grand rounds, workshops, and seminars that focus on thyroid management and related topics. These events often offer CME credits.

References

(1) Anziani, N. (2020). The Health Professional's Guide to Nutrition Management of Thyroid Disease. http://books.google.ie/books?id=uv-VzQEACAAJ&dq=Nutrition+Management+of+Thyroid+and+Disease&hl=&cd=1&source=gbs_api
(2) General Information/Press Room." *American Thyroid Association*, https://www.thyroid.org/media-main/press-room/. Accessed 13 August 2024.
(3) Noland, Diana, et al., editors. *Integrative and Functional Medical Nutrition Therapy: Principles and Practices*. Springer International Publishing, 2020.
(4) "ABIM Laboratory Test Reference Ranges–January 2024." *ABIM*, https://www.abim.org/Media/bfijryql/laboratory-reference-ranges.pdf. Accessed 13 August 2024.
(5) "REFERENCE VALUES FOR COMMON LABORATORY TESTS1." *ACCP*, https://www.accp.com/docs/sap/Lab_Values_Table_PSAP.pdf. Accessed 13 August 2024.
(6) Wimmer, I et al. "Selenium levels in patients with autoimmune thyroiditis and controls in lower Austria." *Hormone and metabolic research = Hormon- und Stoffwechselforschung = Hormones et metabolisme* vol. 46,10 (2014): 707-9. doi:10.1055/s-0034-1377029
(7) Rushton, D. H. (2002). Nutritional factors and hair loss. *Clinical and Experimental Dermatology*, *27*(5), 396–404. https://www.researchgate.net/publication/11196756_Nutritional_factors_and_hair_loss
(8) Holick, M. F., Binkley, N. C., Bischoff-Ferrari, H. A., Gordon, C. M., Hanley, D. A., Heaney, R. P., Murad, M. H., & Weaver, C. M. (2011). Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice

Guideline. *The Journal of Clinical Endocrinology & Metabolism*, *96*(7), 1911–1930. https://doi.org/10.1210/jc.2011-0385

(9) Jonklaas J, Bianco AC, Bauer AJ, et al. Guidelines for the treatment of hypothyroidism: prepared by the American Thyroid Association Task Force on Thyroid Hormone Replacement. Thyroid. 2014;24(12):1670-1751.doi:10.1089/thy.2014

(10) Raknes, G., & Småbrekke, L. (2020). No change in the consumption of thyroid hormones after starting low dose naltrexone (LDN): a quasi-experimental before-after study. *BMC Endocrine Disorders*, *20*(1). https://doi.org/10.1186/s12902-020-00630-4

(11) Raknes, G., & Småbrekke, L. (2020b). No change in the consumption of thyroid hormones after starting low dose naltrexone (LDN): a quasi-experimental before-after study. *BMC Endocrine Disorders*, *20*(1). https://doi.org/10.1186/s12902-020-00630-4

(12) McDermott, M. T. (2019). Low-Dose naltrexone treatment of Hashimoto's thyroiditis. In *Springer eBooks* (pp. 317–326). https://doi.org/10.1007/978-3-030-22720-3_24

(13) Yang, J., Shin, K., Do, A., Bierle, D. M., Dabrh, A. M. A., Yin, Z., Bauer, B. A., & Mohabbat, A. B. (2023). The Safety and Efficacy of Low-Dose Naltrexone in Patients with Fibromyalgia: A Systematic Review. *Journal of Pain Research*, *Volume 16*, 1017–1023. https://doi.org/10.2147/jpr.s395457

(14) Babiker A, Alawi A, Al Atawi M, Al Alwan I. The role of micronutrients in thyroid dysfunction. Sudan J Paediatr. 2020;20(1):13-19. doi: 10.24911/SJP.106-1587138942. PMID: 32528196; PMCID: PMC7282437.

(15) Dietary Reference Intakes Tables and Applications. The National Academies of Sciences Engineering and Medicine Health and Medicine Division website. Accessed August 7, 2024. https://www.nationalacademies.org/our-work/summary-report-of-the-dietary-reference-intakes

(16) Koyama, K., Usami, T., Takeuchi, O., Morozumi, K., & Kimura, G. (2002). Efficacy of methylcobalamin on lowering total homocysteine plasma concentrations in haemodialysis patients receiving high-dose folic acid supplementation. *Nephrology Dialysis Transplantation*, *17*(5), 916–922. https://doi.org/10.1093/ndt/17.5.916

(17) Bumrungpert, A., Pavadhgul, P., Piromsawasdi, T., & Mozafari, M. R. (2022). Efficacy and safety of ferrous bisglycinate and folinic acid in the control of iron deficiency in pregnant women: a randomized, controlled trial. *Nutrients*, *14*(3), 452. https://doi.org/10.3390/nu14030452

(18) Holick, M. F., Binkley, N. C., Bischoff-Ferrari, H. A., Gordon, C. M., Hanley, D. A., Heaney, R. P., Murad, M. H., & Weaver, C. M. (2011b). Evaluation, Treatment, and Prevention of Vitamin D Deficiency: an Endocrine Society Clinical Practice Guideline. *The Journal of Clinical Endocrinology & Metabolism*, *96*(7), 1911–1930. https://doi.org/10.1210/jc.2011-0385

(19) Vieth, R., Kimball, S., Hu, A., & Walfish, P. G. (2004). Randomized comparison of the effects of the vitamin D3adequate intake versus 100 mcg

(4000 IU) per day on biochemical responses and the wellbeing of patients. *Nutrition Journal*, *3*(1). https://doi.org/10.1186/1475-2891-3-8

(20) Harris C. Thyroid disease and diet: nutrition plays a part in maintaining thyroid health. Today's Dietitian. 2012;14(7):40. Accessed August 12, 2024. www.todaysdietitian.com/newarchives/070112p40.shtml

(21) Gartner R, Gasnier BC, Dietrich JW, Krebs B, Angstwurm MW. Selenium supplementation in patients with autoimmune thyroiditis decreases thyroid peroxidase antibodies concentrations. J Clin Endocrinol Metab. 2002;87:1687-1691. doi:10.1210/jcem.87.4.8421 https://academic.oup.com/jcem/article/87/4/1687/2374966

(22) Agnew, U. M., & Slesinger, T. L. (2022, December 11). *Zinc toxicity*. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK554548/

(23) United States Institute of Medicine (2005) Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington, DC: National Academies Press.

(24) Bashar, M., & Begam, N. (2020). Role of dietary factors in thyroid disorders: Current evidences and way forwards. *Thyroid Research and Practice*, *17*(3), 104. https://doi.org/10.4103/trp.trp_7_20

(25) Piticchio T, Frasca F, Malandrino P, Trimboli P, Carrubba N, Tumminia A, Vinciguerra F, Frittitta L. Effect of gluten-free diet on autoimmune thyroiditis progression in patients with no symptoms or histology of celiac disease: a meta-analysis. Front Endocrinol (Lausanne). 2023 Jul 24;14:1200372. doi: 10.3389/fendo.2023.1200372. PMID: 37554764; PMCID: PMC10405818.

(26) Sategna-Guidetti C, Volta U, Ciacci C et al. Prevalence of thyroid disorders in untreated adult celiac disease patients and effect of gluten withdrawal: an Italian multicenter study. *The American Journal of Gastroenterology*. 2001;96(3):751-757. doi:10.1111/j.1572-0241.2001.03617.x.

(27) Woderyelesh Kassa, Raafia Memon, Kashif M. Munir, The Gluten- Grave's Connection: Is There One?, Endocrine and Metabolic Science, Volume 1, Issues 1–2, 2020, 100048, ISSN 2666-3961, https://doi.org/10.1016/j.endmts.2020.100048. (https://www.sciencedirect.com/science/article/pii/S2666396120300029)

(28) Tondt J, Yancy WS, Westman EC. Application of nutrient essentiality criteria to dietary carbohydrates. *Nutrition Research Reviews*. 2020;33(2):260-270. doi:10.1017/S0954422420000050

(29) Lund F, Hermansen MN, Pedersen MF, Hillig T, Lavant E, Valtonen-André C, Sölétormos G. Decrease by 50% of plasma IgA tissue transglutaminase antibody concentrations within 2 months after start of gluten-free diet in children with celiac disease used as a confirming diagnostic test. Scand J Clin Lab Invest. 2016;76(2):128-32. doi: 10.3109/00365513.2015.1124449. Epub 2016 Jan 12. PMID: 26878876.

(30) Babiker, A., Alawi, A., Atawi, M., & Alwan, I. (2020). The role of micronutrients in thyroid dysfunction. *Sudanese Journal of Paediatrics*, 13–19. https://doi.org/10.24911/sjp.106-1587138942

(31) Eastman, C. J., & Zimmermann, M. B. (n.d.). *Table 5, Dietary Goitrogens - Endotext - NCBI Bookshelf*.

https://www.ncbi.nlm.nih.gov/books/NBK285556/table/tyd-iodine-deficienc.goitrogenm/

(32) Belal MM, Youssef AR, Baker H, Elalaky NA, Marey AA, Quaisy MA, Rabea EM. Effect of Ramadan fasting on thyroid functions in hypothyroid patients taking levothyroxine: a systematic review and meta-analysis. Ir J Med Sci. 2024 Apr;193(2):741-753. doi: 10.1007/s11845-023-03526-z. Epub 2023 Sep 21. PMID: 37733226; PMCID: PMC10961289.

(33) Belal, M. M., Youssef, A. R., Baker, H., Elalaky, N. A., Marey, A. A., Quaisy, M. A., & Rabea, E. M. (2023). Effect of Ramadan fasting on thyroid functions in hypothyroid patients taking levothyroxine: a systematic review and meta-analysis. *Irish Journal of Medical Science (1971 -)*, *193*(2), 741–753. https://doi.org/10.1007/s11845-023-03526-z

(34) Elsherbiny, T. M. (2022). Impact of fasting on thyrotropin and thyroid status during Ramadan in 292 previously well controlled hypothyroid patients. IFTAR study. *Endocrine*, *79*(3), 484–490. https://doi.org/10.1007/s12020-022-03242-1

(35) Akasheh, R. T., Kroeger, C. M., Trepanowski, J. F., Gabel, K., Hoddy, K. K., Kalam, F., Cienfuegos, S., & Varady, K. A. (2020). Weight loss efficacy of alternate day fasting versus daily calorie restriction in subjects with subclinical hypothyroidism: a secondary analysis. *Applied Physiology Nutrition and Metabolism*, *45*(3), 340–343. https://doi.org/10.1139/apnm-2019-0554

(36) Kim, B. H., Joo, Y., Kim, M. S., Choe, H. K., Tong, Q., & Kwon, O. (2021). Effects of intermittent fasting on the circulating levels and circadian rhythms of hormones. *Endocrinology and Metabolism*, *36*(4), 745–756. https://doi.org/10.3803/enm.2021.405

(37) Chandrasekaran, A., Molparia, B., Akhtar, E., Wang, X., Lewis, J. D., Chang, J. T., Oliveira, G., Torkamani, A., & Konijeti, G. G. (2019). The autoimmune protocol diet modifies intestinal RNA expression in inflammatory bowel disease. *Crohn S & Colitis 360*, *1*(3). https://doi.org/10.1093/crocol/otz016

(38) Abbott, R. D., Sadowski, A., & Alt, A. G. (2019). Efficacy of the autoimmune protocol diet as part of a multi-disciplinary, supported lifestyle intervention for Hashimoto's thyroiditis. *Cureus*. https://doi.org/10.7759/cureus.4556

(39) Klasson, C. L., Sadhir, S., & Pontzer, H. (2022). Daily physical activity is negatively associated with thyroid hormone levels, inflammation, and immune system markers among men and women in the NHANES dataset. *PLoS ONE*, *17*(7), e0270221. https://doi.org/10.1371/journal.pone.0270221

(40) Duñabeitia, I., González-Devesa, D., Varela-Martínez, S., Diz-Gómez, J. C., & Ayán-Pérez, C. (2023). Effect of physical exercise in people with hypothyroidism: systematic review and meta-analysis. *Scandinavian Journal of Clinical and Laboratory Investigation*, *83*(8), 523–532. https://doi.org/10.1080/00365513.2023.2286651

(41) Ross, Douglas S., et al. "2016 American Thyroid Association Guidelines for Diagnosis and Management of Hyperthyroidism and Other Causes of Thyrotoxicosis." *Thyroid*, vol. 26, no. 10, Oct. 2016, pp. 1343–1421, www.liebertpub.com/doi/10.1089/thy.2016.0229, https://doi.org/10.1089/thy.2016.0229.

(42) *Nutrient Lists from Standard Reference Legacy (2018) | National Agricultural Library*. (n.d.). https://www.nal.usda.gov/human-nutrition-and-food-safety/nutrient-lists-standard-reference-legacy-2018
(43) Academy of Nutrition and Dietetics. eNCPT: Nutrition Care Process Terminology [online publication]. Academy of Nutrition and Dietetics; 2017.
(44) Eom, Y. S., Wilson, J. R., & Bernet, V. J. (2022). Links between Thyroid Disorders and Glucose Homeostasis. *Diabetes & Metabolism Journal*, *46*(2), 239–256. https://doi.org/10.4093/dmj.2022.0013
(45) Dhanwal, D. (2011). Thyroid disorders and bone mineral metabolism. *Indian Journal of Endocrinology and Metabolism*, *15*(6), 107. https://doi.org/10.4103/2230-8210.83339
(46) National Institutes of Health Office of Dietary Supplements. Iodine. Accessed August 13, 2024. https://ods.od.nih.gov/factsheets/Iodine-HealthProfessional/
(47) Drill, V. A., & Overman, R. (1941). INCREASED REQUIREMENTS OF PANTOTHENIC ACID AND VITAMIN B6 DURING EXPERIMENTAL HYPERTHYROIDISM. *American Journal of Physiology-Legacy Content*, *135*(2), 474–477. https://doi.org/10.1152/ajplegacy.1941.135.2.474
(48) Alperin, J. B., Haggard, M. E., & Haynie, T. P. (1970). A study of vitamin B12 requirements in a patient with pernicious anemia and thyrotoxicosis: Evidence of an increased need for vitamin B12 in the presence of hyperthyroidism. *Blood*, *36*(5), 632–641. https://doi.org/10.1182/blood.v36.5.632.632
(49) Marcocci, C., Leo, M., & Altea, M. A. (2012). Oxidative stress in Graves disease. *European Thyroid Journal*, *1*(2), 80–87. https://doi.org/10.1159/000337976
(50) McAllister, R. M., Delp, M. D., & Laughlin, M. H. (1995). Thyroid status and exercise tolerance. *Sports Medicine*, *20*(3), 189–198. https://doi.org/10.2165/00007256-199520030-00005
(51) Magnesium fact sheet for health professionals. National Institutes of Health, US Department of Health and Human Services website. Updated June 2, 2022. Accessed August 13, 2024. https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional
(52) *EAL*. (n.d.). Retrieved August 13, 2024, from https://www.andeal.org/evidence-based-practice