Thyroid Disorders - Classes of medication

Thyroid Agents (HYPOthyroid)	
Levothyroxine (T4) *Synthroid®* *OR Eltroxin®*	Synthetically made T4 hormone (body then converts to T3 in peripheral tissues as needed) Identical to endogenously made T4 All adverse effects are rare May see signs of HYPERthyroidism with doses too high Dosed according to body weight, then adjusted according to TSH levels Takes 1-3 weeks for full therapeutic benefit
Other thyroid products	Liothyronine (synthetic T3) Desiccated thyroid (mixture of T3 & T4 obtained from dried thyroid glands of pigs) Both products have been largely replaced by levothyroxine
Anti-thyroid Agents (HYPERthyroid)	
Propylthiouracil	Inhibits synthesis of thyroid hormone, as well as conversion of T4 -> T3 Used to control thyroid function until surgery (short-term)
Methimazole	Inhibits synthesis of thyroid hormone, but does NOT inhibit conversion of T4 -> T3 Safer than propylthiouracil, but takes longer to work (could be months) Taken once a day A long-term option if patient has opted out of surgery

Thyroid Disorders - Classes of medication (cont)

Radioactive iodide	Iodine is taken up by only the thyroid Radioactivity destroys the thyroid gland – attempt to only destroy some of it, but many result in HYPOthyroid state Once/if they are HYPOthyroid, we replace thyroid hormone (likely levothyroxine) Can also treat thyroid cancer – there have been no known cases of cancer caused by 131I 2/3 of patients respond to one treatment – used when opposed to surgery Can take 3-6 months after 1 dose (3 months between doses) Tissue damage limited to thyroid gland only with no surrounding structures affected

Adverse effects

Levothyroxine	All adverse effects are rare May see signs of HYPERthyroidism with doses too high Avoid with minerals such as calcium, magnesium, aluminum – blocks absorption – separate by 2h
Propylthiouracil (PTU)	rash, symptoms of HYPOthyroidism, agranulocytosis, hepatotoxicity, many drug interactions (anticoagulants, digoxin) Must be taken multiple times a day (short t½) Can take up to 3 weeks to exert effect (does not affect hormone already released)
Metformin	nausea (take with food), diarrhea (transient), lactic acidosis (rare)

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Adverse effects (cont)	
Sulfonylureas	hypoglycemia, weight gain, nausea, rash, hepatotoxicity (don't take with alcohol) Can cause hypoglycemia on its own (most likely of all classes besides insulin) Avoid in elderly (more susceptible to hypoglycemia)
Replaglinide	hypoglycemia (less than sulfonylureas), weight gain Generally only cause hypoglycemia when combined with another hypoglycemic drug
Thiazolidinediones	edema and fluid retention, headache, weight gain Post-marketing surveillance: may increase risk of fractures, concern about ↑ cardiovascular events Not likely to cause hypoglycemia on its own
Acarbose	abdominal cramping, diarrhea, flatulence, malabsorption of vitamins/minerals or other drugs (separate by 2h); potential hepatotoxicity Does not cause hypoglycemia on its own IF hypoglycemic, and need to give sugar, must take glucose tabs, milk, or honey; NOT SUCROSE
DPP4 Inhibitors	hypoglycemia, cough, nasopharyngitis, rash, hypersensitivity, muscle aches, joint pain Not likely to cause hypoglycemia on its own Rare: pancreatitis (severe abdominal pain that may be accompanied by vomiting) Oral tablets taken once daily

Adverse effects (cont)	
GLP-1 Agonists	nausea, diarrhea, hypoglycemia, infusion site reactions, pain in stomach area, decreased appetite, indigestion, burping, flatulence, joint and muscle pain, dizziness, headache, cough, rash, pancreatitis, dehydration, increases in heart rate Can cause hypoglycemia on its own Rare: anaphylactic reaction, nephrotoxicity, thyroid cancer
SGLT-2 Inhibitors	weight loss, diuretic effect, hypotension, polydipsia (thirst), increased rate of urinary tract infections, must have adequate kidney function Not likely to cause hypoglycemia on its own
Corticosteroids Local Administration adverse effects	
Opthalmic	Stinging, redness, tearing, burning, secondary infection Long-term: cataracts, glaucoma
Oral Inhalation	Thrush, hoarseness, dry mouth, dysphoria (change in voice), dysphagia (difficulty swallowing), taste disturbance
Nasal Inhalation	Rhinorrhea, burning, sneezing, dry mucous membranes, epistaxis, loss of smell
Topical	Burning, irritation, skin atrophy (thinning of skin), telangiectasia ( ) To Prevent: lowest dose possible, shortest duration possible, applying very thin layer of product only on affected area, do not apply to open skin
Adverse Effects of Corticosteroids Systemic Administration	
CNS	euphoria, insomnia, restlessness, increased appetite, altered mood (depression, mania, psychosis)
Eye	cataracts, glaucoma
Face/Trunk	redistribution of fat -> moon face, buffalo hump, protruding abdomen

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Adverse effects (cont)	
Heart	hypertension, enlarged heart
GI	stomach upset, may ↑ risk of ulcer
Blood	glucose intolerance -> diabetes; leukocytosis
Kidneys	fluid & water retention (if mineralocorticoid activity)
Growth inhibition	use in kids only if necessary (inhalers safe)
Muscle	wasting of muscle tissue (myopathy)
Bones	osteoporosis
Skin	easy bruising, poor wound healing, acne, striae
Prednisone	nausea, hypertension, hyperglycemia, insomnia, psychosis, redistribution of fat, osteoporosis, easy bruising, edema, infections, HPA-axis suppression
Contraception – Adverse Effects	
Estrogen	Nausea, Breast tenderness, Headache, Bloating, Thrombosis
Progestin	Irritability, Fatigue, Breast tenderness, Bloating, Withdrawal bleeding (cyclical), Headache, Adverse lipid alterations, “PMS-like symptoms”
Emergency Contra-ception	Nausea – if vomit within 2 hours of dose – take dose again; may give with anti-emetic (dimenhydrinate – Gravol®) Irregular bleeding – spotting after taking dose; regular menses may be off by a few days (early or late) Abdominal pain, cramping – use acetaminophen (not NSAID in case of pregnancy) Diarrhea, breast tenderness, fatigue, headache – all possible and transient

Adverse effects (cont)	
α1-Blo-ckers	Retrograde ejaculation, Dizziness, fatigue, rhinitis, Orthostatic hypotension, Syncope “first-dose syncope”
α-redu-ctase Inhibitors	Ejaculatory dysfunction, Loss of libido, Impotence, Gynecomastia,)All effects due to ↓ DHT levels) Can cause birth defects in male children
PDE-5 Inhibitors	: hypotension, headache, back and muscle pain, hearing loss, visual changes, priapism (erection > 4h)

Classes of Oral Hypoglycemics	
Metformin	A biguanide (only one in it’s class) Mechanism: Enhances tissue sensitivity to insulin -> reducing insulin resistance, Also decreases hepatic gluconeogenesis Often first drug prescribed
Sulfonylureas *Glyburide, gliclazide, glimepiride*	Enhance insulin secretion from the pancreas (aka insulin secretagogue) Also increase insulin sensitivity at target tissues (like metformin)
Repaglinide	A meglitinide Stimulate release of insulin from pancreas (insulin secretagogue) Requires presence of glucose to exert action, therefore MUST BE TAKEN BEFORE (within 30 mins) OR WITH A MEAL
Thiazolidine-diones *Rosiglitazone, pioglitazone*	Enhance insulin sensitivity at target tissues (similar to metformin) Food has no direct effect (can be taken with or without food)

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Classes of Oral Hypoglycemics (cont)

Acarbose	Inhibits α–glucosidase, which reduces the rate of absorption of carbohydrates from the GI tract, preventing hyperglycemia – therefore TAKE WITH MEALS
Dipeptidyl Dipeptidase 4 (DPP4) inhibitors *linagliptin, alogliptin, sitigliptin, saxagliptin*	Incretins are a group of hormones that tell the pancreas to release insulin (from pituitary); basal rate and elevated in response to food Drugs particularly target glucagon-like peptide 1 (an incretin) and others DPP-4 inhibitors inhibit the breakdown of incretins, which increases and prolongs their activity -> instructs pancreas to release more insulin for longer
Glucagon-like peptide 1 (GLP-1) agonists *exenatide, liraglutide, dulaglutide, semaglutide, lixisenatide*	GLP-1 agonists mimic endogenous GLP-1 (an incretin) Results in increased satiety, reduced gastric emptying, and greater insulin secretion GLP-1 agonists are resistant to degradation by DPP4 enzymes Given as SC injections 1st Gen are administered daily or BID; 2nd Gen are weekly Varying t ½ of 2.4 hours - 2 weeks
SGLT-2 Inhibitors *Canagliflozin, dapagliflozin, empagliflozin, ertugliflozin*	Increases excretion of glucose in the kidney by preventing glucose reabsorption, therefore reducing blood glucose levels

Diabetes medications and treatments

Glucose homeostasis factors	
Insulin	Released in response to HIGH blood sugar Promotes the uptake, utilization, and storage of glucose → lowers blood glucose concentration Suppresses endogenous glucose and Inhibits glucagon release Causes rapid uptake, storage, and use of glucose by insulin sensitive tissues (Muscle, liver, adipose (fat), brain)
	Basal release rate of 0.5 – 1.0 unit / hour
	Rate of release increases when blood glucose (BG) > 5.5mmol/L (in response to eating - bolus)
	Usual secretion: 25-50 units / day
Glucagon	Released in response to LOW blood sugar Increases the hepatic glucose output → increases blood glucose concentration
Diabetes Mellitus	A metabolic disorder characterized by the presence of hyperglycemia due to defective insulin secretion, insulin action, or both
Type 1	due to defective insulin secretion An autoimmune destruction of pancreatic β–cells, causing an absolute lack of insulin secretion
Type 2	due to insulin resistance, eventually leading to defective insulin secretion
Hyperglycemia	HYPERglycemia would occur if a patient did not have enough insulin FPG > 7.0mmol/L

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Diabetes medications and treatments (cont)	
Hypoglycemia	HYPOglycemia would occur if: too much insulin, improper timing of insulin, or patient skipped a meal FPG < 4mmol/L
Insulin Treatment	Insulin preparations vary by: Onset of action, Time to peak glycemic effect, Duration of action, Appearance
Long-Acting Insulin Analogues (LAIA)	
Insulin detemir (Levemir)	After injection, the molecules self-associate and bind to albumin slowly released from subcut-aneous tissue into blood stream at a slow, predic-table rate
Insulin degludec (Tresiba)	Forms multihexamers following SC injection, leading to a depot delayed absorption from SC tissue and also binding to albumin leads to longer time profile
Insulin glargine (Lantus)	An acidic (pH of 4) product in the vial, and once injected subcutaneously, the acidic solution is neutralized, and forms micro-precipitates these slowly dissolve over at a slow, predictable rate
Insulin Routes of Administration	
Subcutaneously	most common
With an insulin pump	continuous subcutaneously
Inhaled dry powder	not yet approved in Canada
Intravenous	only regular (R or Toronto) for emergencies
Mixing Insulins	Important note regarding administration: not all insulins can be mixed ALWAYS CHECK
R/Toronto + N/NPH	may be pre-mixed and stored together
RAIA + N/NPH	may mix, but administer immediately (do not store mixed)
LAIA	do not mix in same syringe with any other insulins – due to specific mechanism of action and pH

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