Treatment and Prevention of Hair Loss

modified August 2025

The chart below provides information on common hair loss treatments, including efficacy, adverse effects, and dose or usage information. Data on treatment of drug-induced hair loss is limited. For patients interested in compounded, online products, advise sticking with accredited digital pharmacies (https://nabp.pharmacy/programs/accreditations/digital-pharmacy/accredited-digital-pharmacies/).

Agent	Regimen	Comments
Agents approved for hair loss treatment		
Baricitinib (Olumiant)	• 2 to 4 mg/day depending on extent of hair loss and response.[47,48] • Use the lowest effective dose.[47,48] • Moderate kidney impairment: 1 to 2 mg/day (Canada: 2 mg/day).[47,48]	• Approved for severe alopecia areata.[47,48] • In alopecia areata, the immune system attacks hair follicles. Baricitinib works by inhibiting Janus kinase, which is involved in inflammation.[47] • Discontinue if no response after 36 weeks.[47] • With strong OAT3 inhibitors, reduce dose by half (Canada: reduce 4 mg to 2 mg, but if the usual dose is 2 mg, avoid OAT3 inhibitors).[47,48] • Not recommended in severe liver impairment.[47,48] • See **footnote a** information on side effects and monitoring of janus kinase inhibitors.
Finasteride (oral)* (Propecia, generics) *See below in the "Agents used off-label for hair loss" section concerning use of topical finasteride.	• 1 mg/day, orally.[5,6] • Daily use for ≥3 months necessary for results.[5,6] Evidence for alternate dosing is lacking. • Benefits reverse within 12 months if treatment is discontinued.[5,6]	• Approved for treatment of androgenic alopecia in **men**.[5,6] • Inhibits the conversion of testosterone to dihydrotestosterone by inhibiting Type II 5-alpha-reductase.[6] Type II 5-alpha-reducase, which is present in the hair follicles as well as the prostate, and is the source of most circulating dihydotestosterone.[5,6] • Contraindicated in patients who are or may become pregnant.[5,6] Patients of childbearing potential should not handle crushed or broken tablets.[5,6] • Improvement in female pattern hair loss has been shown with a dose of 1.25 to 5 mg/day moderate improvement [Evidence level B-3].[7,8,19,20] ○ Finasteride can be tried for androgenic alopecia in transgender men.[7] • Common adverse effects: decreased libido, erectile dysfunction, and ejaculation disorder, which may resolve with continued treatment, or persist after discontinuation.[5,6,21] May also cause gynecomastia, depression, suicidality, anxiety, and muscle-related adverse effects.[5,21,24] • May reduce prostate-specific antigen (PSA) levels by up to 50% within three months.[25] • Combining with topical minoxidil may be more effective than monotherapy.[23] Avoid combining with topical finasteride; no data, and may cause more adverse effects.

Agent	Regimen	Comments
Agents approved for hair loss treatment, continued		
Minoxidil (topical) (Rogaine, generics): 2% solution 5% foam 5% solution (US)	• **2% solution**: apply 1 mL twice daily.[2,22] • **5% foam**: apply ½ capful once daily (females) or twice daily (men).[2,22] • **5% solution (males):** apply 1 mL twice daily.[22]	• Approved for treatment of androgenic alopecia.[1,2] There are separate products marketed for males and females. In Canada, only the foam is approved for females.[2] • Off-label uses with some evidence of benefit include scarring alopecia (adjunct), hair shaft disorders, acceleration of hair growth after chemo, and beard or eyebrow enhancement.[1] • For females, 2% minoxidil solution appears as effective as 5% minoxidil solution, and once-daily application of the 5% foam is as effective as twice daily application of the 2% solution but is better tolerated.[1,23] • Adverse effects include irritation/contact dermatitis (itching, scaling) (especially with the 5% solution due to its propylene glycol content), and growth of fine hair on the cheeks or forehead.[1,3,23] o Advise patients to thoroughly massage the **recommended amount** into the scalp to minimize unwanted non-scalp hair growth and systemic adverse effects.[2,23] o The foam (which is propylene glycol-free) dries quickly, is less likely to drip than the solution, and leaves little residue.[1,52] • Shedding may increase during the first two to six weeks of use while hair transitions from telogen (resting) to growth (anagen) phase.[2,23] Shedding will also increase if treatment is paused.[23] • Assess efficacy after six months.[23] • Combining with oral finasteride may be more effective than monotherapy.[23] Avoid combining with oral minoxidil; no data, and may cause more adverse effects.
Ritlecitinib (Litfulo)	50 mg once daily[49,50]	• Approved for severe alopecia areata.[49,50] • In alopecia areata, the immune system attacks hair follicles. Ritlecitinib works by inhibiting Janus kinase and the TEC family of tyrosine kinases, which are involved in inflammation.[49] • Discontinue if no response after 36 weeks.[49] • Use with strong CYP3A4 inducers is not recommended.[49,50] Ritlecitinib may increase levels of drugs that are substrates of CYP3A4, CYP1A2, and perhaps OCT1.[49,50] • Not recommended in severe hepatic impairment (Canada: contraindicated).[49,50]
Agents used off-label for hair loss		
Bicalutamide (Casodex, generics)	12.5 to 50 mg three to five times/**week**.[10]	• An androgen receptor inhibitor typically used for prostate cancer. • Limited data for female pattern hair loss.[10] • Known to causes less hepatotoxicity than flutamide (see row below for flutamide information) when used for other indications.[10]

Agent	Regimen	Comments
Agents used off-label for hair loss, continued		

Biotin	Limited data	• Biotin deficiency is rare, but hair thinning is a symptom of deficiency.[11]
		  ○ Adequate daily intake for adults: 30 mcg.[11]
		• Be aware that biotin supplementation can interfere with some thyroid function tests, causing falsely high or falsely low levels depending on the assay used.[11]
		  ○ Advise patients to hold biotin supplement of ≥5 mg/day for 72 hours pre-test.[11]
		• There are not enough data to support the use of biotin solely for hair loss, unless correcting a biotin deficiency.[11]

Cimetidine	300 mg five times a day, orally.[12]	• Evidence limited to case reports. • Blocks dihydrotestosterone from binding the follicle receptor.[4] • Because of the high doses needed to achieve hair growth, men should not take cimetidine to treat their hair loss due to possible feminizing effects.[4]
Dutasteride (Avodart, generics)	0.5 mg once daily, orally.[10]	• In Japan and South Korea, approved for male androgenic alopecia.[9] • Like finasteride, dutasteride inhibits the conversion of testosterone to dihydrotestosterone by inhibiting Type II 5-alpha-reductase.[10] • Likely more effective than finasteride, but is not first-line due to lack of approval for this indication.[10] • May reduce prostate-specific antigen (PSA) levels by up to 50% within three months.[25]
Estrogen, Oral contraceptives	Various	• Estrogens and progesterones increase sex hormone binding globulin (SHBG), thereby decreasing the amount of free testosterone.[13] • The role of estrogens in hair growth remains controversial.[14] • Oral contraceptive pills decrease ovarian production of androgens.[4] ○ May be combined with spironolactone, especially in premenopausal patients.[13] • More appropriate for patients with another indication for use (e.g., contraception, hormone replacement therapy).[14] • Newer generation oral contraceptives containing the least androgenic progestin (e.g., desogestrel, norgestimate, drospirenone) may be preferred due to fewer androgenic effects.[4,13]

Agent	Regimen	Comments
Agents used off-label for hair loss, continued		
Finasteride (topical) (available online [e.g., forhims.com, happyhead.com])	Limited data; regimens vary.	• Has been used alone or combined with other therapies in males and females.[15-17] • Better tolerated than oral finasteride.[10,28] However, systemic adverse effects have been reported (e.g., decreased libido, erectile dysfunction, depression, suicidality, anxiety).[51] Local reactions include itching, burning, and redness.[10] • Patients of childbearing potential should not handle the product, and care should be taken to avoid accidental transfer.[51] • Vehicle may affect efficacy.[18] • Males with androgenic alopecia: o topical finasteride 0.25% applied once daily may be as effective as oral finasteride 1 mg once daily with better tolerability [Evidence level B-1].[28] o topical finasteride 0.25% applied in the evening and topical minoxidil 5% applied in the morning may be more effective than minoxidil 5% twice daily [Evidence level B-1].[16] • In postmenopausal patients with androgenic alopecia: o topical finasteride 0.25% may be less effective than topical minoxidil.[26] o topical finasteride 0.5% combined with topical minoxidil 2% may be an option [Evidence Level B-3].[15] • Avoid combining with oral finasteride; no data, and may cause more adverse effects.
Flutamide	62.5 to 250 mg once daily.[10]	• Used off-label for female androgenic alopecia.[10] • Flutamide appears to have antiandrogenic action by inhibiting androgen uptake and/or by inhibiting nuclear binding of androgen in target tissues or both.[22] • Flutamide alone may be efficacious in treating female androgenic alopecia [Evidence level B-3].[29] • Note risk of increased liver enzymes associated with flutamide.[10]
Ketoconazole 2% shampoo (Nizoral, generics) Ketoconazole 1% shampoo (US only) (Nizoral)	Shampoo two to four times weekly.[30]	• Mechanism may involve a direct anti-inflammatory effect, an indirect anti-inflammatory effect by killing Malassezia yeast that colonizes the scalp, and/or an antiandrogenic effect.[30,31] • May be as effective as minoxidil 2% once daily for androgenic alopecia in males.[30] • Limited data show effectiveness in females using ketoconazole 2% (though it may work more slowly than topical minoxidil) [Evidence Level B-1].[32] • Generally used in combination with other treatments for androgenic alopecia.[4,31] • It is unclear if the 1% shampoo is as effective as the 2% shampoo.[4]

Agent	Regimen	Comments
Agents used off-label for hair loss, continued		
Minoxidil (oral)	• Females: 0.5 to 2.5 mg/day[34] • Males: 1.25 to 5 mg/day[34] • If needed, increase dose every three months.[34]	• Option for patients (male or female) unwilling or unable to use topical minoxidil due to inconvenience, cost, or skin irritation.[42] • Preliminary data suggests that minoxidil 1 mg once daily may be more effective than minoxidil 5% once daily for female pattern hair loss.[35] • Adverse effects include body hypertrichosis (typically mild, manageable, and reversible), lightheadedness, fluid retention (e.g., leg edema, periorbital edema, pericardial effusion), tachycardia, headache, insomnia, and initial hair shedding (usually resolves after four weeks).[10,33-35] o Dividing dose twice daily may improve tolerability in regard to hypotension.[22] • Consider a six-month trial.[34,35] • Avoid combining with topical minoxidil; no data, and may cause more adverse effects.
Rosemary oil	Limited data	• For alopecia areata, topical rosemary oil has only been evaluated in combination with other ingredients; its effect when used alone is unclear.[37] • For androgenic alopecia, preliminary evidence suggests that applying rosemary oil (Barij Essence Pharmaceutical Company) 1 mL to the scalp twice daily for 6 months is as effective as minoxidil 2% for increasing hair count.[38]
Saw palmetto[36]	Limited data	• Appears to noncompetitively inhibit 5 alpha-reductase types 1 and 2 and to prevent the conversion of testosterone to dihydrotestosterone *in vitro*.[36] • Limited data. In one study, saw palmetto 200 mg plus beta sitosterol 50 mg twice daily improved subjective scores of hair quantity and quality in males with androgenic alopecia. In another study, 320 mg daily was less effective than finasteride 1 mg daily.[36]
Spironolactone (Aldactone, generics)	25 to 200 mg once daily, orally.[10,39]	• Used off-label (alone or combined with other therapies) for female androgenic alopecia.[39] • Inhibits testosterone production and blocks dihydrotestosterone at androgen receptors.[10,22] • Rule out pregnancy prior to use due to risk of feminization of male fetus if pregnancy occurs while taking spironolactone.[22] o Often combined with oral contraceptives for effect and to prevent pregnancy.[40] • May cause postural hypotension, hyperkalemia, breast tenderness, and irregular menses.[10,22]
Zinc	Limited data	• Significant zinc deficiencies are rare in industrialized countries, but hair loss is a symptom of deficiency.[25] o Moderate zinc deficiency can be seen in patients with malabsorption syndromes, alcohol misuse, chronic kidney disease, and other chronic debilitating diseases.[41] o Recommended daily allowance: 8 mg (females ≥19 years of age); 11 mg (males ≥18 years).[41]

Agent	Regimen	Comments
		• Most data indicate zinc is NOT effective for various types of alopecia.[41]
Devices used to treat or prevent hair loss		
Cooling caps or scalp cooling systems (e.g., Paxman System, DigniCap system, Arctic Cold Cap*s*)	Varies per product and chemotherapy regimen.	• Cooling is thought to cause scalp vasoconstriction and slowing of hair follicle metabolism which reduces uptake and impact of chemotherapy on the follicle.[42] • Cooling can be provided by cooling caps (typically rented by the patient and brought to the center on dry ice) or a cooling system located at the cancer center.[44] • Generally, cooling starts 30 to 50 minutes pre-chemo, and caps are changed about every 25 minutes to maintain scalp temperature.[42,44] Optimum post-infusion cooling time is unclear and may depend on the pharmacokinetics of the chemotherapeutic agent (e.g., half-life of agent or its active metabolites), and may range from 20 minutes to five hours.[42,44] • National Comprehensive Cancer Network guidelines state that scalp cooling can be considered for breast cancer patients.[43] • Most taxane-treated women retain more than half their hair with cooling systems.[44] Results are not as good with anthracyclines.[43,44] • Some insurers will cover cooling costs.[44]
Low-level laser therapy (helmet-like-device or comb; e.g., Capillus Ultra, iRestore, LaserCap, Theradome, HairMax combs)	Varies (e.g., eight to 30 minutes, daily to twice weekly).[45]	• Low-level laser light is thought to stimulate mitochondrial production of energy and activation of redox-mediated pathways, leading to hair follicle stem cell differentiation and a shift from telogen to anagen phase.[45] • Over 80 products are cleared by the FDA.[45] • Efficacy varies by product. Low-level laser light therapy can increase hair growth by 6 to 25.7 hairs per cm^2.[45]
Procedures used to treat or prevent hair loss		

Hair follicle transplantation	Varies	• Hair follicles are taken from areas of the scalp that are resistant to androgen (e.g., occipital area) and transplanted into areas that are androgen sensitive.[46]
		  ○ Results are generally evident within six to 12 months.[46]
		  ○ Effectiveness varies based on patient and scalp health, quality of donor hair, and cause of alopecia.[46]
		• Minoxidil should be held one week before transplant. Starting five to seven days post-transplant, minoxidil 5% can be applied twice daily to the donor and transplanted areas.[46]

Agent	Regimen	Comments
		○ Oral finasteride and low-level laser therapy can also be used to maximize results.[46]
Procedures used to treat or prevent hair loss, continued		
Microneedling	Varies	• Microneedling uses multiple fine needles, usually on a roller, to make tiny skin punctures to increase blood flow and release growth factors, resulting in new hair follicles and hair growth from existing follicles.[45] • Results from studies vary. However, microneedling may increase penetration of topical drugs into the scalp, thereby promoting effectiveness.[45] • No microneedling devices have been FDA-cleared for hair loss, but have been cleared for other uses (e.g., treatment of wrinkles or scars).[45]
Platelet-rich plasma	Limited data, regimens vary.	• Used for androgenetic alopecia.[27] • Platelet-rich plasma (PRP) increases blood flow to the hair follicles and provides growth factors that stimulate stem cells in the follicles.[27] • PRP is prepared using the patient's own blood. The fraction containing platelets is separated and concentrated. The concentration of platelets in the finished product is supraphysiologic. A platelet activator may be added to enhance release of growth factors.[27] • Small volumes of PRP (e.g., 2 to 15 mL) are injected into the scalp at various intervals (e.g., 2 weeks, 3 months).[27] • Protocols are not standardized, and studies have had conflicting results.[27]

Abbreviations: ALC = absolute lymphocyte count; ANC = absolute neutrophil count

a. Janus kinase inhibitor side effects and monitoring: Screen for tuberculosis, viral hepatitis, and other infections before starting.[47-50] Ensure vaccinations are up-to-date before starting.[47-50] Avoid live vaccines while on treatment.[47-50] Serious side effects include malignancy, thromboembolism, hepatotoxicity, and myopathy or creatine phosphokinase elevations.[47-50] Counsel patients on skin cancer prevention and need for periodic skin examination.[47-50]
Baricitinib-monitoring: Monitor complete blood count and kidney function at baseline and according to routine patient management (Canada: baseline, four to eight weeks after initiation and periodically).[47,48] Check liver function tests at baseline and according to routine patient management.[47,48] Assess lipids 12 weeks after initiation, then as appropriate.[47,48] Hold treatment/do not start if ANC <1,000 cells/mm^3 (<1 x 10^9 cells/L), ALC <500 cells/mm^3 (<0.5 x 10^9 cells/L), or hemoglobin <8 g/dL (<80 g/L).[47,48]
Ritlecitinib monitoring: Check liver function tests at baseline and according to routine patient management (US).[50] Check platelets and lymphocytes at baseline, four weeks after initiation, and according to routine patient management.[49,50] Discontinue treatment if platelet count is <50,000/mm^3 (<50 x 10^9 cells/L) or ALC <500 cells/mm^3 (<0.5 x 10^9 cells/L)(can restart if ALC rises to >500 cells/mm^3 [>0.5 x 10^9 cells/L]).[49]

Users of this resource are cautioned to use their own professional judgment and consult any other necessary or appropriate sources prior to making clinical judgments based on the content of this document. Our editors have researched the information with input from experts, government agencies, and national organizations. Information and internet links in this article were current as of the date of publication.

Levels of Evidence

In accordance with our goal of providing Evidence-Based information, we are citing the **LEVEL OF EVIDENCE** for the clinical recommendations we publish.

Level	Definition	Study Quality
A	Good-quality patient-oriented evidence.*	1. High-quality randomized controlled trial (RCT) 2. Systematic review (SR)/Meta-analysis of RCTs with consistent findings 3. All-or-none study
B	Inconsistent or limited-quality patient-oriented evidence.*	1. Lower-quality RCT 2. SR/Meta-analysis with low-quality clinical trials or of studies with inconsistent findings 3. Cohort study 4. Case control study
C	Consensus; usual practice; expert opinion; disease-oriented evidence (e.g., physiologic or surrogate endpoints); case series for studies of diagnosis, treatment, prevention, or screening.	

***Outcomes that matter to patients** (e.g., morbidity, mortality, symptom improvement, quality of life).
[Adapted from Ebell MH, Siwek J, Weiss BD, et al. Strength of Recommendation Taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. Am Fam Physician 2004;69:548-56. https://www.aafp.org/pubs/afp/issues/2004/0201/p548.html.]

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Managing Erectile Dysfunction

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Erectile dysfunction (impotence) is defined as persistent (> three months) or recurrent failure to maintain a penile erection that allows for satisfactory sexual experience.[1,2] It can impact psychosocial health, well-being, and quality of life for the patient and their partner.[3] Prevalence increases as men age, affecting up to 80% of males >70 years.[1,3] This FAQ answers common questions about erectile dysfunction, including risk factors and management.

Question	Answer/Pertinent Information
What **causes** erectile dysfunction**?**	• Erectile dysfunction (ED) has many potential causes:[1,3] ○ vascular (most common): e.g., peripheral vascular disease, atherosclerosis, hypertension, diabetes, dyslipidemia, obesity, metabolic syndrome, sedentary lifestyle, smoking ▪ may be an early warning sign for the development of CVD; however, NOT an independent risk factor of CVD.[3] ○ neural: common after injuries (e.g., spinal cord, groin), stroke, surgery, or radiation therapy. ○ endocrine (hormonal): conditions that lower testosterone levels and decrease libido (e.g., hypogonadism).[1] ○ psychogenic factors (generalized or situational):[1,3] ▪ can be related to psychosocial stress, performance anxiety, and/or mental illness ▪ seen more often in younger patients ○ medications (may exacerbate or contribute to ED) (e.g., antidepressants, diuretics, anticholinergics, dopamine antagonists, antiandrogens, digoxin, ketoconazole, CNS depressants, beta-blockers, clonidine, finasteride, dutasteride, gemfibrozil, opioids, others).[1,3,13,22] ○ can result from conditions associated with excessive alcohol intake (e.g., androgen deficiency, peripheral neuropathy, chronic liver disease).[1]
What is the **role of non-drug measures** for erectile dysfunction?	• The modification and optimal management of potential causes (discussed above) and lifestyle changes may correct erectile dysfunction for some patients.[1,3] • Modifications to lifestyle factors should include:[1,3] ○ increased exercise and physical activity, with weight loss if the patient is overweight or obese ○ smoking cessation ○ reduced alcohol and cannabis intake ○ dietary changes (e.g., low cholesterol) • Referral to a mental health professional and/or sexual counseling is recommended for patients with erectile dysfunction if psychogenic factors are suspected.[2,3]

Question	Answer/Pertinent Information

What is the **role of supplements** and **alternative therapies** for erectile dysfunction?	• Several supplements and alternative medications (e.g., panax ginseng, nitric oxide synthase substrates [l-arginine, citrulline]) have been promoted and investigated for erectile dysfunction.
	  o These treatments are not generally recommended due to a lack of evidence of efficacy.[3,4]
	• Some products marketed for erectile dysfunction contain volatile substances (e.g., alcohol) that evaporate to create local cooling and warming sensations which stimulate nerve endings, inducing erection.[20]
	  o For example, *Eroxon* is a non-medicated topical gel which has been FDA-cleared as an OTC device for the treatment of erectile dysfunction.[20] Evidence of efficacy is very limited.[21]

Can patients with **CV risk factors** take medications to manage erectile dysfunction?	• Avoid the use of medications to treat erectile dysfunction in patients with **high** CV risk.[1] • Guidelines recommend that patients with **intermediate** CV risk have treadmill testing to stratify them as either high- or low-CV risk.[1] • Sexual intercourse and orgasm require the equivalent cardiac workload needed to vigorously walk up two flights of stairs or to walk 1.5 km.[1]

What is the **role of phosphodiesterase 5 (PDE5) inhibitors** for erectile dysfunction?	• PDE5 inhibitors are considered **first line** for patients with erectile dysfunction [Evidence Level A-2].[1-3,5]
	• The efficacy (60% to 70%), onset, safety, and tolerability are similar between the different PDE5 inhibitors.[1,3]
	• Tadalafil has the longest duration of effect (~36 hours), compared to other PDE5 inhibitors (~4 to 5 hours).[3]
	  o can be taken once-daily or used as needed (max: once daily), based on patient preference [Evidence Level A-2].[6]
	• Common adverse effects of PDE5 inhibitors include:[2,3,7]
	  o headache, nasal stuffiness, nausea, dizziness
	  o flushing (lowest with tadalafil)
	  o dyspepsia (lowest with avanafil)
	  o myalgias (lowest with vardenafil and avanafil)
	  o visual impairment (e.g., blurred vision, impaired color perception, color tinge to vision) (highest with sildenafil)
	• Concomitant use of PDE5 inhibitors and nitrates is **contraindicated**, due to risk of life-threatening hypotension.[7]
	• Use PDE5 inhibitors with caution with meds that can lower blood pressure (e.g., alpha blockers, antihypertensives) or in patients who ingest excessive amounts of alcohol.[7]
	• Dose adjustment of PDE5 inhibitors should be considered or is recommended in patients with kidney or liver impairment, older than 65 years, or taking moderate to strong 3A4 inhibitors.[3,7]
	• Patients taking PDE5 inhibitors should be aware that:[3]
	  o sexual stimulation is required to achieve an erection.
	  o they may need to try a dose more than once to determine efficacy.
	  o the dose may need to be titrated to balance adverse reactions and efficacy.
	  o disintegrating films and tablets do not require water to swallow.

Question	**Answer/Pertinent Information**		
What **phosphodiesterase 5 (PDE5) inhibitors** are available for erectile dysfunction?	**Drug**	**Strengths/Cost**[a]	**Usual Adult Dose**[b] (Note: max of **one dose/day** for all products.)[7]
	Avanafil (*Stendra*, generics) (US only)	• 50 mg, 100 mg, 200 mg tablets • $56/tablet (all strengths)	• Initial dose:[8] 100 mg ~15 minutes prior to sexual activity. • Dose range:[8] 50 to 200 mg orally ~15 to 30 minutes before sexual activity.
	Sildenafil (*Viagra*, generics)	• 25 mg, 50 mg, 100 mg tablets • **US**: $0.25 (25 mg), $0.30 (50 mg), $0.30 (100 mg) • **Canada**: ~$3 (all strengths) • 50 mg oral disintegrating film (ODF)(Canada) • **Canada**: $10.50/film	• Dose:[9,10] 50 mg (range: 25 mg to 100 mg) • Take dose ~30 to 60 minutes (up to 4 hours) before sexual activity.[9,10] • For a 100 mg dose of ODF (Canada only), allow initial 50 mg film to dissolve completely on the tongue, then repeat with the second 50 mg film. • Tablets and oral disintegrating films are not interchangeable; however, to switch between forms, start with a mg-to-mg conversion.[17,18]
	Tadalafil (*Cialis*, generics)	• 2.5 mg, 5 mg, 10 mg, 20 mg tablets • **US**: $0.30/tablet (2.5mg), $0.35 (5 mg), $0.70 (10 mg), $0.85 (20 mg) • **Canada**: $13/dose (10 mg, 20 mg) OR $120/month (2.5 mg, 5 mg)	• Dose:[11,12] 10 mg (20 mg Canadian labeling) (range 5 to 20 mg) at least 30 minutes prior to sexual activity. • Consider daily dosing (2.5 to 5 mg) for men who take two or more doses per week.[7,11,12]
	Vardenafil (*Levitra*, *Staxyn*, generics)	*Levitra*: • 2.5 mg (US only), 5 mg, 10 mg, 20 mg tablets • **US**: ~$15/tablet (all strengths) • **Canada**: $10 (5 mg), $11 (10 mg), $13 (20 mg) *Staxyn*: • 10 mg oral disintegrating tablet (ODT) • **US**: ~$30/tablet • **Canada**: $6.50/tablet	*Levitra*:[14,15] • Dose:[14,15] 10 mg (range 5 to 20 mg) ~1 hour (US labeling), or 25 to 60 minutes (range of 15 minutes to 8 to 10 hours) (Canadian labeling) before sexual activity. *Staxyn*:[16,17] • 10 mg dissolved on the tongue without liquids ~1 hour (US labeling) or 45 to 90 minutes (Canadian labeling) before sexual activity.

Question	Answer/Pertinent Information
How do you **switch between PDE5 inhibitors?**	• To switch from one PDE5 inhibitor to another, consider the following as comparable doses (based on dosage ranges and available strengths):[7] o sildenafil 50 mg o vardenafil 10 mg ▪ onset of action for oral tablets and oral disintegrating tablets is similar;[18] however, these formulations are not bioequivalent and not interchangeable.[17] Formulations can be converted on mg-to-mg basis.[18] o tadalafil 10 mg o avanafil 100 mg
What is the **role of alprostadil** for erectile dysfunction?	• Alprostadil **intracavernosal injection** (*Caverject*, *Edex* [US only]) may be considered second-line.[1-3] o highly effective and generally well-tolerated; 95% can achieve a functional erection.[3] o adverse effects: pain at the injection site, bruising, pain, scarring/curvature, priapism.[3] o Some experts suggest a combination of alprostadil with papaverine and phentolamine (compounded as *Trimix*, which is not FDA- or Health Canada-approved).[2,3] ▪ may provide improved efficacy with fewer adverse effects.[3] ▪ atropine is also sometimes used in these mixtures.[2] o Requires manual dexterity and adequate teaching to ensure proper injection technique and dose titration.[3]
What is the **role of testosterone** for erectile dysfunction?	• Testosterone monotherapy is NOT recommended for management of erectile dysfunction, even if the patient has low serum testosterone levels.[3,19] o Note that treating **testosterone deficiency syndrome** (low testosterone level **plus symptoms of testosterone deficiency**) can improve overall sexual function and sexual quality of life.[3] • Some evidence supports testosterone plus a PDE5 inhibitor if a PDE5 inhibitor alone was not effective, especially if serum testosterone is low [Evidence Level B-2].[2,3,19] o For availability and dosing of testosterone formulations, see our chart, *Comparison of Testosterone Products*.
What is the **role of other interventions** for erectile dysfunction?	• Vacuum erection devices (VEDs) may be recommended second-line, particularly if there is an intolerance or contraindication to medications and/or surgery.[1-3] o mechanism: negative pressure promotes blood flow, then trapped in the penis by a constriction ring.[3] o may be cumbersome and labor-intensive; however, up to 90% of patients may achieve functional erections.[2,3] o may be associated with numbness, bruising, pain, and painful ejaculation.[3] o can be combined with PDE5 inhibitors.[3] • Surgery may be considered if patients fail first- and second-line therapies.[2] • There is no evidence of efficacy for experimental therapies (e.g., stem cell therapy, platelet-rich plasma).[2]

Abbreviations: CNS = central nervous system; CVD = cardiovascular disease; ED = erectile dysfunction; ODF = oral disintegrating film; ODT = oral disintegrating tablet; PDE = phosphodiesterase.

a. Pricing is based on average wholesale acquisition cost (WAC), for generic when available. US medication pricing by Elsevier, accessed November 2024.
b. The usual adult dose provided assumes normal kidney and liver function. Lower doses should be considered or used with some PDE5 inhibitors in patients ≥65 years, taking CYP3A4 inhibitors (especially ritonavir) or alpha-blockers, severe kidney impairment, or liver impairment. Consult product labeling for dose adjustment recommendations.

Users of this resource are cautioned to use their own professional judgment and consult any other necessary or appropriate sources prior to making clinical judgments based on the content of this document. Our editors have researched the information with input from experts, government agencies, and national organizations. Information and internet links in this article were current as of the date of publication.

Levels of Evidence

In accordance with our goal of providing Evidence-Based information, we are citing the **LEVEL OF EVIDENCE** for the clinical recommendations we publish.

Level	Definition	Study Quality
A	Good-quality patient-oriented evidence.*	1. High-quality randomized controlled trial (RCT) 2. Systematic review (SR)/Meta-analysis of RCTs with consistent findings 3. All-or-none study
B	Inconsistent or limited-quality patient-oriented evidence.*	1. Lower-quality RCT 2. SR/Meta-analysis with low-quality clinical trials or of studies with inconsistent findings 3. Cohort study 4. Case control study
C	Consensus; usual practice; expert opinion; disease-oriented evidence (e.g., physiologic or surrogate endpoints); case series for studies of diagnosis, treatment, prevention, or screening.	

***Outcomes that matter to patients** (e.g., morbidity, mortality, symptom improvement, quality of life).

[Adapted from Ebell MH, Siwek J, Weiss BD, et al. Strength of Recommendation Taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. Am Fam Physician 2004;69:548-56. https://www.aafp.org/pubs/afp/issues/2004/0201/p548.html.]

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Perioperative Management of Diabetes

This chart provides information regarding management of home antidiabetic regimens in preparation for and after surgery or procedures, including oral agents, injectables, subcutaneous insulin, and insulin pumps. Treatment of glucose excursions is also reviewed. Information to help with management of special populations or situations is also covered, including emergency surgery and carbohydrate loading. Links to our resources on diabetes management in bariatric surgery and colonoscopy are provided. Keep in mind that there is **little high-quality evidence** upon which to base decisions; most information is based on expert opinion and experience.

OPTIONS FOR MANAGING GLUCOSE CONTROL BEFORE AND AFTER SURGERY	
NON-INSULIN ANTIDIABETIC AGENTS: • Concerns with use of these agents perioperatively include inability to respond quickly to changing patient glycemic control, safety issues, and paucity of efficacy data in this population.[1] • Individualize. Consider blood glucose control, comorbidities, and type of surgery. • Diabetes Canada generally recommends holding metformin, insulin secretagogues (i.e., sulfonylureas and meglitinides), and SGLT2 inhibitors in the event of reduced oral intake or dehydration.[23] • ERAS protocols promote normal oral intake, which in turn allows patients to resume their home meds quickly, thus reducing risk of iatrogenic harm.[8] For patients unable to restart oral meds post-op, see "Treatment of Perioperative Glucose Excursions" section, below.	
Drug or Drug Class	**Pertinent Information or Suggested Approach**
Metformin	• **Concern**: surgery- or contrast media-associated renal insults may put patient at risk of lactic acidosis.[6] • Generally hold the morning of surgery.[10] Consider giving morning dose on day of surgery if eGFR ≥60 mL/min/1.73 m^2 and if no contrast media will be administered.[18] • Restart post-op when patient is stable, eating and drinking regularly, kidney function normalizes (e.g., eGFR improves to ≥45 mL/min/1.73m^2), and no further tests or procedure are scheduled.[6,19,18] ○ If the patient has received iodinated contrast media, hold/resume metformin per institution protocol.[6] American College of Radiology guidelines suggest holding metformin for 48 hours post-imaging with non-gadolinium contrast media in patients with severe renal impairment or undergoing arterial studies that might cause emboli to the renal arteries.[12]
Sulfonylureas and meglitinides (e.g., glyburide, repaglinide)	• **Concern**: potential for hypoglycemia in fasting patient.[23] • Hold the morning of surgery.[10] If surgery is in the afternoon, a meglitinide could be taken in the morning if patient eats breakfast.[8] • Restart post-op when the patient is stable and eating regularly, and no further tests or procedures are scheduled.[6]

OPTIONS FOR MANAGING GLUCOSE CONTROL BEFORE AND AFTER SURGERY	
Drug or Drug Class	**Pertinent Information or Suggested Approach**
SGLT2 Inhibitors (bexagliflozin, canagliflozin, dapagliflozin, empagliflozin, ertugliflozin)	• **Concern**: euglycemic ketoacidosis and dehydration in surgery patients.[24] • US labeling recommends stopping at least three days prior to surgery (at least four days for ertugliflozin).[15] • To help prevent ketoacidosis, for patients using insulin at home, ensure adequate insulin dosage (e.g., try not to stop insulin entirely; reduce dose cautiously, and avoid sliding scale insulin alone).[24] Monitor patients closely while fasting (e.g., monitor urine for ketones).[24] For more information on prevention, identification, and treatment of SGLT2 inhibitor ketoacidosis, see our FAQ, *Hyperglycemia in the Hospital*. • Restart post-op when patient is stable and eating and drinking regularly, no further tests or procedures are scheduled, and any other risk factors for ketoacidosis have resolved **(e.g., infection)**.[6,24]
DPP-4 Inhibitors (alogliptin, linagliptin, saxagliptin, sitagliptin)	• Can generally be continued.[18] Consider risk/benefit in patients with gallbladder disease due to unclear association with pancreatitis.[9] • DPP-4 inhibitors alone or in combination with basal insulin provides glycemic control similar to that of basal-bolus insulin without increasing the risk of hypoglycemia or prolonging hospital stay [Evidence level B-1].[1,22] • Ensure dose is adjusted for kidney function. • Consider discontinuing saxagliptin or alogliptin in patients who develop heart failure.[10] • Restart post-op when the patient is stable and eating regularly, and no further tests or procedures are scheduled.[6]
Thiazolidinediones (pioglitazone)	• **Concern**: edema and heart failure.[6] • Generally continue.[17] Hold for emergency surgery.[17] • Restart post-op when the patient is stable and eating regularly, and no further tests or procedures are scheduled.[6]
Acarbose, miglitol (US)	• Mechanism of action is inhibition of dietary carbohydrate breakdown and absorption in the intestine.[3] It can be taken in the morning of surgery if the patient eats breakfast.[8] • Restart post-op when patient has adequate oral intake (i.e., is eating meals).[3,17]

GLP-1 Agonist (dulaglutide, exenatide, liraglutide, lixisenatide, semaglutide)	• **Concern**: gastrointestinal side effects (nausea and vomiting) could impair recovery (e.g., due to reduced oral intake), cause surgical complications (e.g., vomiting post-coronary bypass), be mistaken for an acute problem (e.g., ileus), or cause aspiration during anesthesia due to delayed gastric emptying.[7,13,21]
	• Consider holding on the day of surgery, or for a week before surgery for patients on weekly dosing (dulaglutide, exenatide extended release, semaglutide).[21]
	  ○ Consider delaying surgery if the patient is having gastrointestinal side effects.[21]
	  ○ If the patient has no gastrointestinal symptoms but did not hold their dose, follow "full stomach" precautions. Consider using ultrasound to assess gastric volume to guide decision to proceed or delay.[21]

OPTIONS FOR MANAGING GLUCOSE CONTROL BEFORE AND AFTER SURGERY

INSULIN:

- For elective surgery, try to schedule insulin-treated patients first to minimize the duration of the fast.[14]
- Avoid sliding scale regimen for optimal control.[1]
- **Post-op**, ERAS protocols promote normal oral intake, which in turn allows patients to resume their home meds, thus reducing risk of harm.[8] If oral intake is insufficient, reduce insulin dose(s) accordingly.[6] Consider a 20% to 25% reduction for safety.[19]

Insulin	Pertinent Information or Suggested Approach
Basal insulin (e.g., glargine, detemir, degludec, NPH)	**Evening before surgery**: • Consider giving 80% to 100% (type 1 diabetes) or 75% (type 2 diabetes) of the usual evening basal insulin dose.[10,14,18] Consider a 25% to 50% dose reduction for NPH.[18] Also consider a 50% dose reduction of other basal insulins if the basal insulin dose comprises >60% of the total daily insulin dose, especially in patients with liver or kidney insufficiency or malnutrition.[14] **Morning of surgery** • **Type 1**: Consider giving 75% to 80% (100% if the patient has no history of hypoglycemia with prolonged fasting) of the usual morning basal insulin dose.[10,14] Consider a 50% dose reduction for NPH.[10,14] Also consider 50% dose reduction for other basal insulins if the basal insulin dose may be inappropriately high*.[14] • **Type 2**: o NPH: consider giving 50% of the usual morning dose.[10,14] o Other basal insulins: consider giving 50%,[14] or as much as 75% to 80% [10]of the usual morning dose. ***Possible indicators of inappropriately high basal insulin dose:** basal insulin comprises >60% of the total daily insulin dose; history or overnight hypoglycemia or need for bedtime snack to prevent hypoglycemia; glucose drops >40 mg/dL overnight)[14] **General considerations**: • Dose reduction may be especially prudent if patient's surgery is scheduled for later in the day.[6] • It is imperative that patients with type 1 diabetes continue their basal insulin to prevent ketoacidosis.[14] • Consider managing patients with type 2 diabetes as type 1 if they have type 1-like features (e.g., severe hyperglycemia or ketoacidosis with little provocation, recurrent hypoglycemic episodes, labile control, small changes in insulin dose lead to big changes in glucose levels, need for multiple daily insulin doses with very high glucose in response to a missed dose).[14]
Premixed insulin	• Patient can take usual dose the evening before surgery, but omit pre-mix dose the morning of surgery.[6] • The morning of surgery, give 50% of the basal component as NPH or, if blood glucose is >200 mg/dL (11.1 mmol/L), 50% of the usual morning dose of premix can be given.[14]
Prandial insulin	• Omit bolus doses while patient is NPO.[14]

OPTIONS FOR MANAGING GLUCOSE CONTROL BEFORE AND AFTER SURGERY	
Insulin	**Pertinent Information or Suggested Approach**
Insulin pump	--Consider use of protocols that allow patients to self-manage pump when appropriate, for patient safety and satisfaction.--[5] The following is **sample guidance** based on the anticipated duration of the surgery. • **At arrival/admission**: o Document type of pump, type of insulin (designate U-100 vs U-500), and insulin dose (basal rate, carbohydrate to insulin ratio, insulin sensitivity factor), and infusion site.[5,18] Do this at the pre-op visit, if applicable.[5] Enter in electronic medical record in a place accessible to all caregivers.[5] o Consult endocrinology if the patient is likely to require admission post-op.[18] Do this at pre-op visit, if applicable.[18] o Confirm basal rate with patient.[18] Consider a 20% to 25% reduction.[10] o Check insertion site for swelling or leaking.[18] Document date of insertion.[18] o Check glucose using point-of-care testing.[18] Treat symptomatic hypoglycemia or glucose ≤70 mg/dL (3.9 mmol/L) by stopping pump and giving 12.5 to 25 mL of D50W intravenously.[18] Re-check in five minutes.[18] • For non-cardiac **procedures lasting <1 hour** (and perhaps up to 2 hours[14]) (inclusive of pre-op sedation, procedure, and recovery): o Pre-op, if glucose is above target, patient can self-treat per usual (assuming sedatives have not yet been given).[18] If pre-op blood glucose is >300 mg/d, consider switching to an intravenous insulin infusion.[18] Check for problems with the pump or infusion site.[5] o Continue basal rate for most patients.[5] If MRI, x-ray, or defibrillation anticipated, disconnect pump and secure outside operating room.[18] o Do not use the pump intraoperatively if patients may become hemodynamically unstable, or the infusion site is close to the surgical field.[14] In these cases, switch to intravenous insulin infusion.[14] • For non-cardiac **procedures lasting one to three hours** (inclusive of pre-op sedation, procedure, and recovery): o Pre-op, if glucose is within target range, patient can self-administer (assuming sedatives have not yet been administered) one hour's worth of basal insulin as a bolus.[18] Hold bolus if glucose ≤110 mg/dL (6.1 mmol/L). If above glucose target, patient can self-treat per usual.[18] o Disconnect pump and secure outside operating room.[18] o If pre-op blood glucose is >300 mg/dL (16.6 mmol/L), major blood loss is anticipated, or fluid or temperature shifts are anticipated, consider intravenous insulin infusion (see dosing, below).[18] o Post-op, check glucose before re-connecting pump.[18] • For non-cardiac **procedures lasting >3 hours** (inclusive of pre-op sedation, procedure, and recovery): o Disconnect pump.[18] o Start intravenous insulin infusion within one hour of stopping pump.[18]
Continued…	

OPTIONS FOR MANAGING GLUCOSE CONTROL BEFORE AND AFTER SURGERY	
Insulin	**Pertinent Information or Suggested Approach, continued**
Insulin pump, continued	○ If pump basal rate was <1 unit/hour, start insulin infusion at 0.5 unit/hour.[18] If pump basal rate was >1 unit/hour, start insulin infusion at 2/3 the pump basal rate.[18] ○ Follow institution's insulin infusion algorithm for adjustments.[18] ○ Post-op management depends upon whether the patient is stable, and competent to manage pump and record carbohydrate intake.[18] ▪ If patient is stable and competent, start insulin pump 30 minutes before stopping intravenous insulin infusion.[18] ▪ If patient is not stable and competent, continue as per intraoperative management, or switch to basal subcutaneous insulin.[18] Continue infusion for one to two hours after administration of basal subcutaneous insulin.[6]
TREATMENT OF PERIOPERATIVE GLUCOSE EXCURSIONS	
Target	• Intensive glucose control (i.e., near-normal glucose) should be avoided perioperatively due to the risk of hypoglycemia [Evidence level A-2].[4] • Consider a glucose target of 100 to 180 mg/dL (5.6 to 10 mmol/L) within four hours of surgery (ADA).[10] • A goal of 110 to 140 mg/dL (6.1 to 7.8 mmol/L) may be appropriate for critically ill postsurgical patients or cardiac surgery patients if it can be achieved without significant hypoglycemia (ADA).[10] • Some experts target a range of 140 to 180 mg/dL (7.8 to 10 mmol/L) intra- and postoperatively.[18] • Diabetes Canada recommends a goal of 5 to 10 mmol/L for most surgical patients (6 to 10 mmol/L if critically ill), and a goal of 5.5 to 11.1 mmol/L during coronary artery bypass grafting.[2]
Test	• Check blood glucose at least every two to four hours while NPO (ADA) (Diabetes Canada: every four to six hours).[2,10] Consider checking blood glucose every one to two hours for patients on continuous intravenous insulin or who are critically ill.[2]
Treat	• In critical care areas, coronary artery bypass surgery, prolonged surgery in patients with type 1 diabetes, or very high glucose levels, use an intravenous insulin infusion per institutional protocol.[2,10,14] • For other post-op patients, consider basal/bolus insulin if patient is not restarted on their oral diabetes meds.[2,10] ○ Example: patients requiring only oral agents at home could be switched to basal insulin 0.25 units/kg once daily, reduced to 0.15 units/kg/day if ≥70 years of age or SCr ≥2 mg/dL (176.8 umol/L).[1,6] • Treat excursions above target with rapid-acting or regular insulin.[10] • Do not give any pre-op boluses unless glucose >200 mg/dL (11.1 mmol/L) AND >3 hours pre-op.[11] **--Do not use sliding scale insulin**.[2,10]—

OPTIONS FOR MANAGING GLUCOSE CONTROL BEFORE AND AFTER SURGERY	
TRANSITION FROM INPATIENT INSULIN REGIMEN TO HOME REGIMEN (i.e., preparation for discharge)	
Insulin infusion to subcutaneous insulin	The following is **sample guidance** based on ADA standards and published protocols: • Give first dose of basal insulin two to three hours before intravenous insulin is discontinued.[2,10] Consider a dose equal to 60% to 80% of the daily infusion dose (daily infusions dose = requirement in the last six to eight hours extrapolated to 24 hours).[2,10] Give the remainder as prandial insulin, if applicable.[2] • Also take into consideration the patient's **home insulin regimen**, if applicable. Reduce the patient's home total daily dose by 20% to 25% and give as basal insulin if the patient is NPO or has limited caloric intake.[19] Alternatively, start 0.3 to 0.5 units/kg/day (total daily insulin dose), with 50% given as basal.[20] • If the patient was **not on home insulin**, and using ≤1 unit/hour with glucose running <140 mg/dL (7.8 mmol/L), consider stopping insulin.[20] For patients needing higher doses and/or glucose levels are running >140 mg/dL (7.8 mmol/L), provide basal insulin as above.[20] • Monitor glucose at least four times daily, and provide subcutaneous corrective coverage (not sliding scale) if needed.[20]
Switching back to oral diabetes meds.	• Try to get patients switched back to oral agents at least one to two days before discharge.[10]
SPECIAL POPULATION OR SITUATION	
Clinical Situation	**Pertinent Information**
Emergency surgery	• No short-acting bolus before surgery.[11] • Check blood glucose every 30 to 60 minutes during surgery.[11] • Start intravenous insulin infusion if glucose >200 mg/dL (11.1 mmol/L).[11]
Long or complex surgery	• Insulin infusion, especially for type 1 diabetes, coronary artery bypass grafting, or severe hyperglycemia.[14,17] Check glucose every one to two hours.[14] • Alternatively, give rapid-acting insulin every two hours as needed to control glucose.[14]
Carbohydrate loading	• As part of ERAS protocols, patients with diabetes often receive a carbohydrate-containing beverage a few hours before surgery.[16] However, there is little safety and efficacy data for this practice in patients with diabetes. There are anecdotal reports of surgical cancellations due to this practice.[16] • Until more data is available, experts suggest that diabetes patients not receive these drinks.[16]
Pre-colonoscopy	• See our Toolbox, *Improving Diabetes Outcomes*.
Bariatric Surgery	• See our chart, *Bariatric Surgery and Medication Use*.

Abbreviations: ADA = American Diabetes Association; DPP-4 =dipeptidyl peptidase-4; ERAS = enhanced recovery after surgery; eGFR = estimated glomerular filtration rate; GLP-1 = glucagon-like peptide-1; NPO = nothing by mouth; SGLT2 = sodium/glucose cotransporter-

Users of this resource are cautioned to use their own professional judgment and consult any other necessary or appropriate sources prior to making clinical judgments based on the content of this document. Our editors have researched the information with input from experts, government agencies, and national organizations. Information and internet links in this article were current as of the date of publication.

Levels of Evidence

In accordance with our goal of providing Evidence-Based information, we are citing the **LEVEL OF EVIDENCE** for the clinical recommendations we publish.

Level	Definition	Study Quality
A	Good-quality patient-oriented evidence.*	1. High-quality randomized controlled trial (RCT) 2. Systematic review (SR)/Meta-analysis of RCTs with consistent findings 3. All-or-none study
B	Inconsistent or limited-quality patient-oriented evidence.*	1. Lower-quality RCT 2. SR/Meta-analysis with low-quality clinical trials or of studies with inconsistent findings 3. Cohort study 4. Case control study
C	Consensus; usual practice; expert opinion; disease-oriented evidence (e.g., physiologic or surrogate endpoints); case series for studies of diagnosis, treatment, prevention, or screening.	

***Outcomes that matter to patients** (e.g., morbidity, mortality, symptom improvement, quality of life).

[Adapted from Ebell MH, Siwek J, Weiss BD, et al. Strength of recommendation taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. Am Fam Physician. 2004 Feb 1;69(3):548-56. https://www.aafp.org/pubs/afp/issues/2004/0201/p548.html.]

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