Preoperative medication management turnkey order set for nonemergent adult cardiac surgery

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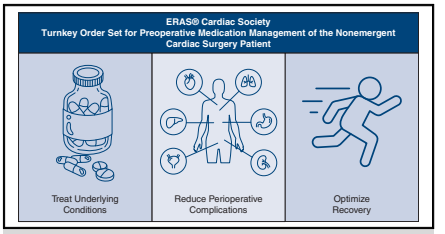
ABSTRACT

Objective: The management of preoperative medications is an essential component of perioperative care for the cardiac surgical patient. This turnkey order set is part of a series created by the Enhanced Recovery After Surgery Cardiac Society, first presented at the Annual Meeting of The American Association for Thoracic Surgery in 2023. Numerous guidelines and expert consensus documents have been published to provide guidance in preoperative medication management. Our objective is to integrate these documents into an evidence-based order set that will facilitate standardized implementation of best practices for preoperative medication management for nonemergent adult cardiac surgery.

Methods: Subject matter experts were consulted to translate existing guidelines and peer reviewed literature into a sample turnkey order set for the preoperative management of patients' medications. Orders derived from consistent Class I, IIA, or equivalent recommendations across referenced guidelines and consensus manuscripts appear in the order set in **bold** type. Selected orders that were inconsistently Class I or IIA, Class IIB, or supported by published evidence, were also included in *italicized* type.

Results: Holding antiplatelet and anticoagulant medications before nonemergent cardiac surgical procedures may reduce the risk of bleeding. Sodium-glucose co-transporter-2 inhibitors and glucagon-like peptide-1 agonists should also be discontinued to prevent acidosis and aspiration, respectively. Specific guidance for frequently used medications are complied within the manuscript, less frequently used medications are listed seperately.

Conclusions: Despite strong recommendations from major guidelines and consensus manuscripts, variation exists in preoperative medication orders, with limited availability of succinct implementation tools. This turnkey order set may facilitate standardized comprehensive preoperative medication management before nonemergent cardiac surgery. (JTCVS Open 2024;22:1-13)



Key aspects of preoperative medication management across perioperative phases of care.

CENTRAL MESSAGE

Integrating guideline recommendations and consensus statements into a turnkey order set may facilitate the implementation of preoperative medication management of nonemergent cardiac surgery patient.

PERSPECTIVE

Multiple professional societies have released evidence-based recommendations for preoperative medication management. Variation in practice still exists. The Enhanced Recovery After Surgery (ERAS) Cardiac Society has developed a "turnkey" order set to assist clinicians in adhering to best practices for preoperative medication management of the nonemergent adult cardiac surgery.

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Received for publication March 5, 2024; revisions received May 25, 2024; accepted for publication June 10, 2024; available ahead of print July 29, 2024.

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https://doi.org/10.1016/j.xjon.2024.06.009

Abbreviations and Acronyms

ACC = American College of Cardiology
AHA = American Heart Association
AmSECT = American Society of ExtraCorporeal Technology
ASA = American Society of Anesthesiologists
EACTS = European Association for Cardio-Thoracic Surgery
ERAS = Enhanced Recovery After Surgery
GLP-1 = glucagon-like peptide agonist
SABM = Society for the Advancement of Patient Blood Management
SCA = Society of Cardiovascular Anesthesiologists
SCAI = Society for Cardiac Angiography and Interventions
SGLT2i = sodium-glucose co-transporter-2 inhibitor
STS = Society of Thoracic Surgeons
TKO = "turnkey" order set

The management of preoperative medications requires a provider to weigh the risk to benefits of drug therapy versus the potential for increased complications before the surgical procedure. For example, holding anticoagulation to reduce the risk of bleeding must be weighed against the risk of increased thrombotic complications.[1] Similar risk-benefit decisions must be considered for all medications during the perioperative period. There are no current comprehensive resources incorporating recommendations for most medication classes before cardiac surgery. This work used published guidelines and consensus documents to develop a practical preoperative medication order set for all nonemergent adult cardiac surgery patients. This "turnkey" order set (TKO) is part of a continued series created by the Enhanced Recovery After Surgery (ERAS) Cardiac Society to aid in the comprehensive implementation of evidence based standardized care.

METHODS

Leading multidisciplinary subject matter experts were consulted to analyze and translate existing guidelines and peer-reviewed literature into a sample TKO for preoperative medication management of the nonemergent cardiac surgery patient. Orders from consistent Class I, IIA, or comparable recommendations across referenced guidelines and consensus manuscripts appear in the TKO in bold type. Selected orders inconsistent with Class I or IIA, Class IIB, or supported by evidence published in peer-reviewed journals, are also included in italicized type. Table 1[2-5] provides a synopsis of existing Class I and IIA (or equivalent) recommendations from applicable guidelines and consensus statements. Table 2 translates the recommendations, guidelines, consensus statements, and peer-reviewed literature into a TKO, with less frequently used medication noted in Appendix E1. Notably, the intent was not to recapitulate the evidence base justifying existing recommendations, as this task was part of the original guidelines and consensus statements efforts. Decisions regarding order inclusion were made on the basis of estimated benefit, risk, cost, implementation complexity, and generalizability. These orders should be considered on the basis of local institutional priorities, resources, practices, and expertise. When variation was found in literature, we used expert consensus and strength of literature to determine order inclusion. This TKO does not include consideration for patients with renal and/or hepatic dysfunction; prescribers should use additional precautions and consult a pharmacist when treating these patients. Whenever prescribing or holding a medication, consideration should include risk versus benefit, need for bridging therapies, medication to medication interactions, allergies, and potential adverse reactions. Medication holding day definition example can be viewed in Figure 1.

Comparisons Across Existing Guidelines

Strong-, moderate-, and low-risk recommendations from multiple sources were used to create the TKO. The guidelines chosen for comparison were published by The European Association for Cardiothoracic Surgery (EACTS),[2] The American College of Cardiology/American Heart Association/Society for Cardiac Angiography and Interventions (ACC/AHA/SCAI),[3] The Society of Thoracic Surgeons/Society of Cardiovascular Anesthesiologists/American Society of ExtraCorporeal Technology/Society for the Advancement of Patient Blood Management (STS/SCA/AmSECT/SABM),[4] and American Society of Anesthesiologists (ASA)[5] (Table 1). The EACTS,[2] ACC/AHA/SCAI,[3] and STS/SCA/AmSECT/SABM[4] documents are guidelines, and the ASA[5] publication is an expert consensus document. The EACTS[2] and STS/SCA/AmSECT/SABM[4] guidelines focus exclusively on cardiac surgery, whereas the ACC/AHA/SCAI[3] and ASA[5] publications were intended for all surgical subspecialties.

Antithrombotic Agents

There is literature to support holding preoperative antithrombotic agents to reduce the risk of bleeding during cardiac surgery. EACTS and ACC/AHA/SCAI both support continuation of aspirin throughout the preoperative period for patients with coronary artery disease.[2,3] EACTS and STS/SCA/AMSECT/SABM both state that it is reasonable to stop aspirin 7 days before noncoronary cardiac surgery to reduce the risk of bleeding.[2,4] EACTS, ACC/AHA/SCAI, and STS/SCA/AmSECT/SABM all recommend ticagrelor should be held preoperatively for a minimum of 3 days, clopidogrel for 5 days, and prasugrel for 7 days before nonemergent surgery.[2,3,5-9] The half-life of ticagrelor is about 7 hours, and it inhibits platelet aggregation in a reversible manner. This is in contrast to other antiplatelet medications like clopidogrel, which irreversibly inhibit platelets for the lifetime of the platelet (7-10 days).[23,24] As the result of its relatively short half-life and reversible action, the antiplatelet effect of ticagrelor diminishes more quickly once the medication is stopped, allowing platelet function to recover in time for surgery, thereby reducing the risk of excessive bleeding. Although hold recommendations for cangrelor range from 1 to 6 hours, providers are now routinely holding the medication for 1 hour before surgery.[10] Providers may choose to be more conservative in high-risk cases, such as a redo sternotomy, multiple valve, and advanced aortic cases.

EACTS and a clinical recommendation from the American College of Chest Physicians recommend holding non-vitamin K antagonist oral anticoagulants for 2 to 4 days. The range depends on the medication and guidelines differ slightly on recommended time to hold before surgery.[2,8] EACTS recommends abciximab to be held for 24 hours and eptifibatide tirofiban, 4 hours before surgery.[2] Warfarin is recommended to be held for 5 days before surgery and to check an international normalized ratio.[2,8] Intravenous heparin is recommended to be held 6 hours and low molecular weight heparin held 1 day before surgery.[2,8] Patients should be assessed for need of bridging therapy with either intravenous short-acting anticoagulation or antiplatelet medications.

TABLE 1. Summary of Class I/IIa or equivalent recommendations

Recommendation	EACTS[2] 2017	ACC/AHA/SCAI[3] 2021	STS/SCA/AmSECT/SABM[4] 2021	ASA[5] 2023
Antithrombotic management				
Aspirin	√	√	√	
DAPT	√	√	√	
GPIIb/IIIa inhibitors	√	√		
Vitamin K antagonists	√			
NOAC/DOAC	√			
Renin-angiotensin aldosterone system inhibitors				
ACE/ARB	√			
Beta-blockers				
Beta-blocker	√			
Statins				
Statin	√			
Glucose management				
Oral hypoglycemics and long-acting subcutaneous insulin	√			
GLP-1 agonists				√

A "√" indicates class I/IIA or equivalent recommendations for preoperative medication for nonemergent **adult cardiac surgery**. *EACTS*, European Association for Cardiothoracic Surgery; *ACC/AHA/SCAI*, The American College of Cardiology American Heart Association, Society for Cardiac Angiography and Interventions; *STS/SCA/AmSECT/SABM*, Society of Thoracic Surgeons, Society of Cardiovascular Anesthesiologists, American Society of ExtraCorporeal Technology, Society for the Advancement of Patient Blood Management; *ASA*, American Society of Anesthesiologists; *DAPT*, dual antiplatelet therapy; *GPIIb/IIa*, glycoprotein IIb/IIIa; *NOAC*, non-vitamin K antagonist oral anticoagulant; *DOAC*, direct-acting oral anticoagulant; *ACE-I*, angiotensin-converting-enzyme inhibitor; *ARB*, angiotensin receptor blocker; *GLP-1*, glucagon-like peptide 1.

Endocrine Agents

There has been increasing use of glucagon-like peptide (GLP-1) agonists and sodium-glucose co-transporter-2 inhibitors (SGLT2i), as benefits outside the treatment of diabetes have now been demonstrated.[25] There are concerns for increased risk of aspiration as the result of delayed gastric emptying associated with the use of GLP-1 medications. A recent consensus statement from the ASA recommends holding daily dosed GLP-1 agonists the day of surgery and weekly dosed GLP-1 agonists for 7 days before surgery to theoretically reduce the potential for aspiration with induction of anesthesia.[5,11,12] Other adverse events that have been reported with the use of GLP-1 medications include gastrointestinal disorders, gallbladder-related disorders (mostly cholelithiasis), cardiovascular and psychiatric disorders, and malignant neoplasm.[26]

SGLT2i are recommended to be held 3 days before surgery, except ertugliflozin, which should be held 4 days before surgery because of its long half-life and increased risk of euglycemic diabetic ketoacidosis.[7,11-18] All other oral hypoglycemics are recommended to be held the day of surgery. If metformin is co-prescribed with an SGLT2i, it should be held for 3 days before surgery.[7,11-16]

Short-acting insulin is recommended to be held the day of surgery. For long-acting insulin, 75% of the dose is commonly taken the day before surgery and 50% of the dose on the day of surgery.[7,11-13,15] The EACTS recommendation does not include specific medication classes and states that antidiabetics and long-acting subcutaneous insulin should be omitted the day before surgery.[2]

Cardiac Agents

β-blockers are recommended to be continued until surgery.[2,3,7,18-21] Angiotensin-converting enzyme inhibitors and angiotensin receptor blockers are commonly held the day before cardiac surgery to reduce the risk of vasoplegia.[2,7,18] In contrast, it is reasonable to continue vasodilators such as hydralazine and nitroglycerin.[7,18] Statin therapy is frequently continued before cardiac surgery.[2,7,21]

There are no large studies, guidelines, or recommendations regarding other cardiac agents. Although not addressed by guidelines or consensus manuscripts, diuretics and direct renin inhibitors are generally held the day of surgery because of concern for adverse effects on renal function in the setting of volume depletion and/or hypotension.[7,18] phosphodiesterase type 5 inhibitors (ie, sildenafil and tadalafil) are frequently held 72 hours before surgery when used for erectile dysfunction as the result of concerns related to vasodilation and hypotension.[7,18,22] When phosphodiesterase type 5 inhibitors are used for pulmonary hypertension or cardiac optimization, they are regularly continued, as they have been shown to decrease inotropic support and ventilator hours in patients with right ventricular failure and pulmonary hypertension.[7,18,22,27] Calcium channel blockers and antiarrhythmics are generally continued.[2,3,7,18]

Future Research

There are insufficient publications to guide the use of cannabis before surgery. The use of delta-9-tetrahydrocannabinol, or THC, should be disclosed to the anesthesiologist.[28] Herbal supplements are another area in which the literature is inconsistent, with some resources recommending discontinuation of all supplements and herbal medications for 7 days, whereas others recommend 2 weeks before surgery.[7,29] Further research and publications are needed. Additional research is needed to study how best to educate patients and assist with consistent safe multidisciplinary preoperative medication guidance. This can include formal multidisciplinary education and introducing materials through multiple platforms, including web-based or personal phone-based applications.[30]

CONCLUSIONS

Literature exists to guide practitioners in evidence-based best practice for most preoperative medications used by adult cardiac surgical patients. However, the availability of a centralized single reference of up-to-date

TABLE 2. Orders

Medication class	Medication example(s)	Recommendation
Antiplatelet agents		
In the absence of platelet function studies	**Aspirin**	**Hold 7 d before surgery (patients without CAD or other strong indication)**[2-4,6,7] *Continue for patients with CAD*[2,3,6-8]
	Dipyridamole	*Hold 2 d before surgery*[7]
	Cilostazol	*Hold 5 d before surgery*[7]
	Clopidogrel	**Hold 5 d before surgery**[2-4,6-9]
	Prasugrel	**Hold 7 d before surgery**[2-4,6-8]
	Ticagrelor	**Hold 3 d before surgery**[2-4,7-9]
	Cangrelor	**Hold 1-6 h before surgery**[2,10]
	Eptifibatide **Tirofiban**	**Hold 4 h before surgery**[2,3,6]
	Abciximab	**Hold 24 h before surgery**[2,3,6]
Anticoagulants		
	Warfarin	**Hold 5 d before surgery and check an INR**[2,8]
	Heparin IV	**Hold 6 h before surgery**[2,8]
	LMWH	**Hold 1 d before surgery**[2,8]
Anticoagulants-NOAC		
	Apixaban	**Hold 2-4 d before surgery;** consider renal impairment when holding[2,4,8]
	Dabigatran	**Hold 2-4 d before surgery;** consider renal impairment when holding[2,4,8]
	Edoxaban	**Hold 2-4 d before surgery;** consider renal impairment when holding[2,4,8]
	Rivaroxaban	**Hold 2-4 d before surgery;** consider renal impairment when holding[2,4,8]
Endocrine agents		
GLP-1 agonists (daily dosing)	**Exenatide** **Liraglutide** **Lixisenatide** Semaglutide	**Hold the day of surgery**[5,11,12]
GLP-1 agonists (weekly dosing)	**Dulaglutide** **Exenatide extended release** **Semaglutide**	**Hold 7 d before surgery**[5,12]
Dipeptidyl peptidase-4 inhibitors *Secretogogues* *Thiazolidinediones*	*Glyburide* *Glipizide* *Glimepiride* *Pioglitazone* *Saxagliptin* *Linagliptin* *Vildagliptin* *Sitagliptin* *Alogliptin*	*Hold the day of surgery*[7,11-15]
Oral hypoglycemics-biguanides	*Metformin*	*Hold metformin for 1 d before surgery, if co-prescribed with an SGLT-2, then hold 3 d before*[7,11-16]

(Continued)

TABLE 2. Continued

Medication class	Medication example(s)	Recommendation
Sodium-glucose co-transporter-2 inhibitors (SGLT2i)	*Canaglifozin*	*Hold 3 d before surgery except*[7,11-13,15-18]
	Dapagliflozin	**Ertugliflozin should be held 4 d before surgery*[12,13,18]
	Empagliflozin	
	*Ertugliflozin**	
Insulin, long-acting	*Detemir*	*Take 75% of dose day before surgery, take 50% of dose day of surgery*[11,13,15]
	Glargine	
Insulin, short-acting	*Lispro*	*Hold the day of surgery*[11,13,15]
	Aspart	
	Regular	
Cardiac medications		
ACE-I	*Benazapril*	*Hold the day before surgery*[2,7,18]
ARB	*Lisinopril*	
	Enalapril	
	Ramipril	
	Captopril	
	Perindopril	
	Losartan	
	Valsartan	
	Candesartan	
	Irbesartan	
	Sacubitril/valsartan	
	Olmesartan	
	Telmisartan	
	Azilsartan	
	Eprosartan	
Antiarrhythmics	*Amiodarone*	*Continue*[2,3,7,18]
	Dronaderone	
	Digoxin	
Beta blocker	*Metoprolol*	*Continue*[2,3,7,18-21]
	Carvedilol	
Calcium channel blockers	*Amlodipine*	*Continue*[7,18]
	Diltiazem	
	Felodipine	
	Isradipine	
	Nicardipine	
	Nifedipine	
	Verapamil	
Diuretics	*Bumetanide*	*Hold the day of surgery*[7,18]
	Furosemide	
	Hydrochlorothiazide	
	Triamterene	
	Torsemide	
	Spironolactone	
Phosphodiesterase type 5 inhibitors	*Sildenafil*	*Hold 72 h before surgery when used for the indication of erectile dysfunction for pulmonary hypertension continue*[7,18,22]
	Tadalafil	
	Vardenafil	

CAD, Coronary artery disease; *INR*, international normalize ratio; *IV*, intravenous; *LMWH*, low-molecular-weight heparin; *NOAC*, non-vitamin K antagonist oral anticoagulant; *GLP-1*, glucagon-like peptide 1; *SGLT-2*, sodium/glucose cotransporter 2; *ACE-I*, angiotensin-converting-enzyme inhibitor; *ARB*, angiotensin receptor blocker; *MAOI*, monoamine oxidase inhibitor.

recommendations is lacking. We have combined these resources and guidelines to provide a referenced practical TKO reference for clinicians caring for nonemergent adult cardiac surgery patients.

Conflict of Interest Statement

A.R.: Speaker's Bureau for Edwards Lifesciences; R.S.: consulting/advisory relationships with Zimmer Biomet, AtriCure, La Jolla, Terumo, Encare, and Edwards

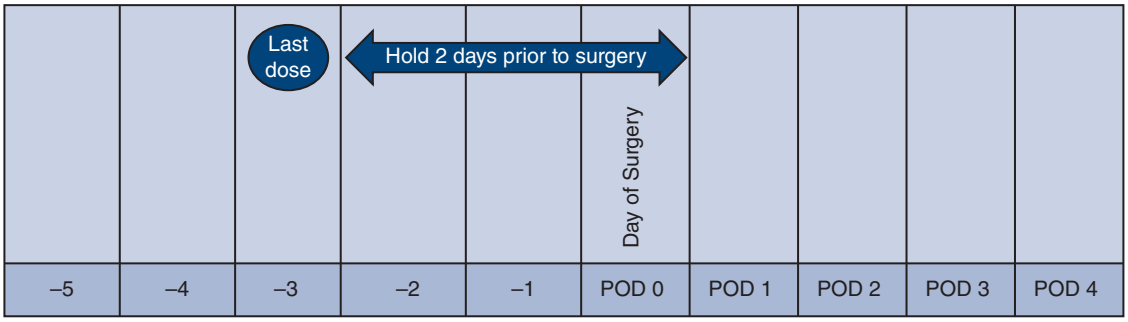

FIGURE 1. Holding day definition: day dosing does not include surgery day (ex: "hold 2 days before surgery" if Wednesday is surgery day, last dose should be taken Sunday).

Lifesciences. R.C.A.: honoraria from Edwards Lifesciences and HLS Therapeutics. In addition, he has function on an Ad Board for Renibus Therapeutics Inc. A.J.G.: speaker and advisory activities for Edwards Lifesciences. V.M.B.: Speaker's Bureau Edwards Lifesciences. D.T.E.: Device Safety Monitoring Board: Edwards Lifesciences Transcatheter Valves; Trial Steering Committees: Renibus, Alexion, Cardiorenal Systems, Genentech; Medical Advisory Boards: Medela, Arthrex, and AtriCure. S.C.: served on advisory boards for Edwards Lifesciences, La Jolla Pharmaceutical Company, Baxter Healthcare, and Eagle Pharmaceuticals. K.W.L.: consultant for Abiomed, Alexion, Medela, Medtronic, and Renibus. G.M.: consultant for Edwards Lifesciences. S.R.: advisor and speaker for 3M. All other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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Key Words: preop medication, turnkey order set, cardiac surgery, perioperative, medication management

APPENDIX E1. MEDICATIONS BY CLASS

Class	Example	Recommendation
Acetylcholinesterase inhibitors	*Donazepil* *Galantamine* *Rivastigmine* *Tacrine*	*Continue*[7]
Alpha blocker	*Alfuzosin* *Doxazosin* *Phenoxybenzamine* *Phentolamine* *Prazosin* *Silodosin* *Tamsulosin* *Terazosin*	*Continue*[7,12,18]
Alpha 2 agonists—central-acting	*Clonidine* *Guanfacine*	*Continue*[7,18]
Aminosalicylates	*Mesalamine* *Sulfasalazine* *Azathioprine*	*Hold 1 d before surgery*[7,31] *Hold the day of surgery*[31]
ACE-I *ARB*	*Benazapril* *Lisinopril* *Enalapril* *Ramipril* *Captopril* *Perindopril* *Losartan* *Valsartan* *Candesartan* *Irbesartan* *Sacubitril/valsartan* *Olmesartan* *Telmisartan* *Azilsartan* *Eprosartan*	*Hold the day before surgery*[2,7,18]
Anorectics	*Phentermine*	*Hold for 7 days before surgery*[32]
Antiarrhythmics	*Amiodarone* *Dronaderone* *Digoxin*	*Continue*[2,3,18]
Antibiotic prophylaxis	*Mupirocin*	*Continue*[2]
Anticonvulsants	*Carbamazepine* *Felbamate* *Gabapentin* *Levetiracetam* *Lamotrigine* *Oxcarbazepine* *Phenytoin* *Pregabalin* *Primidone* *Tiagabine* *Topiramate* *Valproic acid* *Zonisamide*	*Continue*[7]

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Class	Example	Recommendation
Antigout agents	*Allopurinol* *Colchicine* *Febuxostat* *Probenecid*	*Continue*[7]
Antihistamines	*Loratadine* *Diphenhydramine* *Cetirizine* *Chlorpheniramine*	*Continue*[7]
Antimetabolites *Antirheumatics*	*Methotrexate** *Leflunomide** *Hydroxychloroquine** *Sulfasalazine*	*Continue*[7,33-36] **Methotrexate is recommended to be continued preoperatively in patients with normal renal function, but held for 2 wk before surgery in patients with renal impairment.* **Leflunomide stopped 2 wk before surgery.* **Hydroxychloroquine—insufficient evidence for recommendation of cardiac surgery*
Antimigraine agents—triptans	*Almotriptan* *Eletriptan* *Frovatriptan* *Naratriptan* *Rizatriptan* *Sumatriptan* *Zolmitriptan*	*Hold the day before surgery*[7]
Antipsychotics	*Haloperidol* *Risperidone* *Olanzapine*	*Continue*[7,37]
Antispasmodic	*Oxybutynin* *Darifenacin* *Tolterodine*	*Continue*[7,38]
Antivirals *Antiretrovirals*	*Non-nucleoside reverse transcriptase inhibitor* *Protease inhibitors, Integrase inhibitors (would be too many to list individually)*	*Continue*[7,36]
Appetite suppressant	*Phentermine*	*Hold 7 d before surgery*[7]
Benzodiazepines	*Alprazolam* *Chlordiazepoxide* *Diazepam* *Clonazepam*	*Continue*[7,37]
Beta blocker	*Metoprolol* *Carvedilol*	*Continue*[2,3,7,18-21]
Biologic agents (including any applicable biosimilars)	*Adalimumab* *Etanercept* *Golimumab* *Infliximab* *Abatacept* *Certolizumab* *Rituximab* *Tocilizumab* *Anakinra* *Secukinumab*	*Hold timing for end of dosing cycle 2-8 wk pending medication*[33-35]

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Class	Example	Recommendation
Biologic disease-modifying agents	*Interferon beta* *Glatiramer acetate* *Siponimod* *Fingolimod* *Ustekinumab* *Belimumab* *Tofacitinib** *Upadacitinib** *Baricitinib**	*General should be stopped at end of dosing cycle but should be discussed with prescribing team.* **Should be stopped 7 d before surgery*[33,35,36]
Bisphosphonates and antiosteoporosis agents	*Alendronate* *Ibandronate* *Risedronate* *Zoledronic acid* *Denosumab* *Calcitonin-salmon*	*Hold the day of surgery*[7,12]
Calcium channel blockers	*Amlodipine* *Diltiazem* *Felodipine* *Isradipine* *Nicardipine* *Nifedipine* *Verapamil*	*Continue*[7,18]
Cannabis		*No guidance at this time, but should be disclosed to the anesthesiologist*[28]
Central nervous system depressant	*Zolpidem*	*Continue*[37]
Central nervous system stimulants	*Dextroamphetamine* *Lisdexamfetamine* *Dexmethylphenidate* *Methylphenidate*	*Hold the day of surgery*[7,37]
Cox-2 inhibitors	*Celecoxib*	*Hold 3 d before surgery*[7]
Direct renin inhibitors	*Aliskiren and combination products*	*Hold the day before surgery*[7]
Diuretics	*Bumetanide* *Furosemide* *Hydrochlorothiazide* *Triamterene* *Torsemide* *Spironolactone*	*Hold the day of surgery*[7,18]
Dopamine agonist	*Ropinirole* *Pramipexole* *Carbidopa/Levodopa*	*Continue*[7,12]
Glucocorticoids	*Budesonide* *Dexamethasone* *Hydrocortisone* *Methylprednisolone* *Prednisolone* *Prednisone*	*Continue*[7,31,36]
Histamine H2 blockers	*Cimetidine* *Famotidine* *Ranitidine* *Nizatidine*	*Continue*[7,22]

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Class	Example	Recommendation
IgG monoclonal antibody	*Brodalumab* *Guselkumab* *Risankizumab* *Secukinumab* *Tildrakizumab* *Ustekinumab*	*Agents are recommended to be stopped before surgery and that surgery is scheduled at the end of the dosing cycle*[33,36]
Immunosuppressive agents	*Mycophenolate* *Mofetil* *Cyclosporine* *Tacrolimus* *Azathioprine* *Prednisone*	*Continue*[7,33-36]
Inhaled pulmonary agents	*Budesonide* *Fluticasone* *Montelukast* *Prednisone* *Tiotropium* *Albuterol* *Albuterol/ipratropium* *Formoterol/budesonide* *Formoterol/mometasone* *Ipratropium* *Levalbuterol* *Salmeterol* *Salmeterol/fluticasone*	*Continue*[7,18]
MAOI	*Isocarboxazid* *Moclobemide* *Phenelzine* *Tranylcypromine*	*Continue unless unable to provide MAOI-safe anesthetic, then discontinue under psychiatric guidance 2 wk before the procedure*[7,37]
Mood stabilizers	*Lithium** *Carbamazepine* *Lamotrigine* *Oxcarbazepine* *Valproic acid*	*Continue* **Hold for 72 h*[37]
Non-statin lipid-lowering agents	*Cholestyramine* *Colestipol* *Ezetimibe* *Fenofibrate* *Gemfibrozil* *Niacin*	*Hold the day before surgery*[7]
Nonsteroidal anti-inflammatory agents	*Short-acting* *Ibuprofen,* *Diclofenac* *Etodolac* *Indomethacin* *Intermediate-acting* *Naproxen* *Meloxicam* *Oxaprozin*	*Hold 7 d before surgery*[7,36,39]

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Class	Example	Recommendation
Opioid agonists	*Codeine* *Fentanyl* *Hydromorphone* *Methadone* *Morphine* *Oxycodone* *Oxymorphone* *Tramadol*	*Continue in perioperative period, with some considerations*[38,40]
Opioid antagonists	*Buprenorphine* *Naltrexone**	*Continue* **Intramuscular naltrexone should be held 24-30 d after the last injection; oral naltrexone should be held 3-4 d*[37,39,41]
Phosphodiesterase type 5 inhibitors	*Sildenafil* *Tadalafil* *Vardenafil*	*Hold 72 h before surgery when used for the indication of erectile dysfunction for pulmonary hypertension continue*[7,18,22]
Postmenopausal hormone therapy, oral contraceptive(s)	*Estrogens (oral)*	*Hold 6 wk before surgery*[7]
Proton pump inhibitors	*Esomeprazole* *Lansoprazole* *Omeprazole* *Pantoprazole* *Rabeprazole*	*Continue*[7,22]
Pulmonary agents	*Theophylline*	*Hold the day before surgery*[7,22]
Selective estrogen receptor modulators	*Tamoxifen* *Raloxifene*	*Hold the day of surgery*[7,12]
Selective serotonin reuptake inhibitors *Serotonin and norepinephrine reuptake inhibitor* *Aminoketone*	*Fluoxetine* *Citalopram* *Escitalopram* *Duloxetine* *Desvenlafaxine* *Duloxetine* *Levomilnacipran* *Milnacipran* *Venlafaxine* *Bupropion* *Hydrochloride*	*Continue*[7,37]
Skeletal muscle relaxants	*Cyclobenzaprine* *Metaxalone* *Tizanidine* *Methocarbamol*	*Continue*[7]
Statin	*Atorvastatin*	*Continue*[2,7,21]
Supplements, herbals		*Discontinue all supplements and herbals 7 d before surgery*[7,29] (2 wk)
Thyroid agents	*Levothyroxine* *Methimazole* *Propylthiouracil*	*Continue*[7,12]
Triazolopyridines		*Continue*[37]

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Class	Example	Recommendation
Tricyclic antidepressant	*Amitriptyline* *Nortriptyline* *Clomipramine* *Doxepin* *Imipramine*	*Continue*[7,37]
Tyrosine kinase inhibitors (oncologic indications only)	*Acalabrutinib* *Dasatinib* *Imatinib* *Erlotinib* *Everolimus* *Nintedanib*	*Hold 7 d before surgery in coordination with the patient's prescribing physician*[42]
Vasodilators	*Hydralazine* *Isosorbide dinitrate* *Isosorbide Mononitrate* *Minoxidil*	*Continue*[7,18]

ACE-I, Angiotensin-converting enzyme inhibitors; *ARB*, angiotensin II receptor blockers; *MAOI*, monoamine oxidase inhibitor.