Peri-Procedure Management of Anticoagulants

Disclaimer: *This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.*

TABLE OF CONTENTS

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PRESENTATION

(Inpatient or Outpatient)

Patient on anticoagulant scheduled for procedure[1]

(The primary care team will determine whether the procedure can be done safely while the patient is on an anticoagulant after discussion with the patient regarding the overall risk of bleeding)

EVALUATION

Regional anesthesia (neuraxial and peripheral nerve procedures including lumbar puncture)

or

Interventional spine and pain procedures

or

Neurosurgery procedures

MANAGEMENT PRE- AND POST-PROCEDURE

- If urgent or emergent procedure, consider anticoagulant reversal if indicated (see Appendix B)
- If possible, delay elective procedures for 1 month after acute VTE or ischemic stroke[2]
- In patients with new onset atrial fibrillation/atrial flutter who have been on anticoagulation for < 1 month, recommend TEE to rule out cardiac thrombus prior to holding anticoagulant therapy
- See Appendix C for management of anticoagulants for regional anesthesia (neuraxial and peripheral nerve procedures including lumbar puncture)
- See Appendix D to determine bleeding risk and for management of anticoagulants based on bleeding risk for interventional spine and pain procedures
- See Appendix E to determine bleeding risk and for management of anticoagulants based on bleeding risk for neurosurgery procedures

Other procedures → Low bleeding risk procedure[3]?

Yes → Continue current anticoagulant

No → Urgent/ emergent procedure?

Yes →
- Consider anticoagulant reversal if indicated (see Appendix B)
- In patients with new onset atrial fibrillation/atrial flutter who have been on anticoagulation for < 1 month, consider TEE to rule out cardiac thrombus prior to holding anticoagulant therapy

→ For restart recommendations, refer to management based on anticoagulant:
- Parenteral agents, see Appendix F
- Warfarin, see Appendix G
- DOACs, see Appendix H

No →
- If possible, delay elective procedures for 1 month after acute VTE or ischemic stroke[2]
- In patients with new onset atrial fibrillation/atrial flutter who have been on anticoagulation for < 1 month, recommend TEE to rule out cardiac thrombus prior to holding anticoagulant therapy

→ Patient with low thromboembolic risk[4]?

Yes →
- Interrupt anticoagulant[5]
- Do NOT bridge if patient is on warfarin
- Do NOT bridge if patient is on DOAC

No →
- Interrupt anticoagulant[5]
- Bridge if patient is on warfarin
- For moderate risk bleeding procedures, do NOT bridge if patient on DOAC
- For high risk bleeding procedures, bridge if patient on DOAC[6]. Consult Benign Hematology for assistance in management.

DOACs = direct oral anticoagulants
TEE = transesophageal echocardiogram
VTE = venous thromboembolism

[1] For patients on antiplatelet therapy, see Peri-Procedure Management of Antiplatelet Therapy algorithm
[2] For patients with recent ischemic stroke, consult Neurology for further recommendations as indicated
[3] See Appendix A for Procedural Bleeding Risks based on type of procedure
[4] See Appendix I for Thromboembolic Risks
[5] If patient is on parenteral anticoagulant, see Appendix F; if on warfarin, see Appendix G; if on DOACs, see Appendix H
[6] Refer to Transitioning Between Anticoagulants (for internal use only) to assist with transitioning DOAC to a parenteral anticoagulant

Department of Clinical Effectiveness V5
Approved by the Executive Committee of the Medical Staff on 10/19/2021

APPENDIX A: Procedure Bleeding Risk

Note: For patients who have other risk factors for bleeding (*e.g.*, recent bleeding event, thrombocytopenia) consider utilizing the management recommendations for high risk bleeding procedures.

High Bleeding Risk	Moderate Bleeding Risk	Low Bleeding Risk
General Procedures		
• Regional anesthesia (neuraxial and deep peripheral nerve procedures) including lumbar puncture (see Appendix C)	• Bone marrow aspiration and biopsy • Venous port placement	• Ommaya reservoir puncture
Breast Surgical and Breast Radiology Procedures		
• All OR Breast Surgical procedures	• Biopsy and fine needle aspiration of breast, axillary nodal basins, internal mammary, and/or supraclavicular lymph nodes • Image guided pre-operative localization of the breast	• Breast punch biopsy in clinic
Cardiology Procedures		
• Coronary intervention • Endomyocardial biopsy • Implantable cardioverter-defibrillator/pacemaker lead extraction • Left atrial appendage occlusion device • Pericardiocentesis	• Diagnostic coronary angiography via femoral access • Electrophysiology testing and/or ablation • Pacemaker or defibrillator placement • Right heart catheterization • Supraventricular tachycardia ablation • Transvenous atrial fibrillation ablation	• Arterioventricular node ablation • Coronary artery angiography (radial approach) • Internal cardiac defibrillator implantation battery change • Permanent pacemaker implantation battery change
Dental Procedures[1]		
• Alevolar surgery (bone removal) • Apicoectomy (root removal) • Complex dental procedure/multiple tooth extraction • Reconstructive dental procedures	• Endodontic (root canal) procedures • Peridontal surgery, abscess incision • Up to 2 tooth extractions	• Dental hygiene • Minor dental procedures
Dermatologic Procedures		
N/A	N/A	• Dermatologic procedures • Mohs Center procedures

[1] For moderate risk of bleeding dental procedures in patients on vitamin K antagonists (VKA), either continue VKA in combination with a pro-hemostatic mouthwash or hold VKA 2-3 days prior to procedure

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Peri-Procedure Management of Anticoagulants

APPENDIX A: Procedure Bleeding Risk - continued

Note: For patients who have other risk factors for bleeding (*e.g.*, recent bleeding event, thrombocytopenia) consider utilizing the management recommendations for high risk bleeding procedures.

High Bleeding Risk	Moderate Bleeding Risk	Low Bleeding Risk
Gastroenterology Procedures		
• Biliary or pancreatic sphincterotomy and/or dilation • Cystogastrostomy • Endoscopic hemostasis • Endoscopic submucosal dissection (ESD), endoscopic mucosal resection (EMR) or other polypectomy • Endoscopic ultrasound with fine needle aspiration • Full thickness resection • Percutaneous endoscopic gastrostomy (PEG) placement • Pneumatic or bougie dilation • Therapeutic balloon-assisted enteroscopy • Treatment of varices • Tumor ablation by any technique	• Barrett's esophagus ablation • Colonoscopy with biopsy • Diagnostic balloon-assisted enteroscopy • Endoscopic retrograde cholangiopancreatography (ERCP) with stent and/or biopsy • Esophageal or enteral stent • Gastroscopy with biopsy • Sigmoidoscopy with biopsy	• Capsule endoscopy • Colonoscopy without biopsy • Diagnostic esophagogastroduodenoscopy (EGD) • Endoscopic retrograde cholangiopancreatography (ERCP) diagnostic • Endoscopic ultrasound without fine needle aspiration • Push enteroscopy without biopsy • Sigmoidoscopy without biopsy
Gynecology Oncology Procedures		
• All other Gynecology Oncology procedures	• Cold knife conization (CKC)/loop electrosurgical excision procedure (LEEP) • Superficial wide local excisions	• Colposcopy • Dilatation and curettage • Endometrial biopsy • Exam under anesthesia • Hysteroscopy • Insertion/Removal of intrauterine device • Laser ablation of the cervix/vulva/vagina • Vulvar/vaginal/cervical biopsies
Head and Neck Surgery Procedures		
• All other Head and Neck Surgery procedures	N/A	• Flexible nasopharyngeal laryngoscopy (when performed outside of the OR)

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APPENDIX A: Procedure Bleeding Risk - continued

Note: For patients who have other risk factors for bleeding (*e.g.*, recent bleeding event, thrombocytopenia) consider utilizing the management recommendations for high risk bleeding procedures.

High Bleeding Risk	Moderate Bleeding Risk	Low Bleeding Risk
Interventional Radiology Procedures		
• Ablations: solid organs, bone, soft tissues, lung • Angiography with arterial intervention (*e.g.*, angioplasty) with access size > 6 French • Aortic stent graft • Catheter directed thrombolysis (arterial and venous) • Gastrostomy, jejunostomy tube placement • Intrathecal chemotherapy • Lung interventions: biopsy, fiducial placement, intratumoral injection, and drainage (parenchymal) • Percutaneous embolectomy, thrombectomy • Portal vein embolization and stenting • Solid organ biopsies, fiducial placement, and intratumoral injection (*e.g.*, liver, prostate, cervical) • Solid organ drainage: nephrostomy, biliary, cholecystostomy • Spine procedures: vertebroplasty, kyphoplasty (see Appendix D) • Transjugular intrahepatic porto-systemic shunt (TIPS) • Venous interventions (intrathoracic, intracranial)	• Carotid stent placement • Catheter exchange < 6 weeks (*e.g.*, biliary, nephrostomy, abscess, gastrostomy, jejunostomy) • Deep, non-organ biopsy, fiducial placement, and intratumoral injection • Diagnostic angiography, with access size up to 6 French • Non-organ drainage (*e.g.*, abdominal or retroperitoneal abscess) • Non-tunneled chest tube placement (pleural space) • Thoracentesis • Trans-arterial embolotherapy • Transjugular liver biopsy • Tunneled central venous catheter placement • Tunneled drainage catheter placement or removal • Venous interventions (peripheral) • Venous port placement	• Catheter exchange > 6 weeks (*e.g.*, biliary, nephrostomy, abscess, gastrostomy, jejunostomy) • Diagnostic angiography (radial approach) • Intraperitoneal catheter placement • Inferior vena cava filter placement or retrieval • Non-tunneled central line placment or removal • Paracentesis • Superficial (*e.g.*, lymph nodes, thyroid) or palpable mass biopsies, fiducial placement, and intratumoral injection • Superficial abscess drainage • Tunneled central venous catheter removal • Venous port removal
Neuroradiology Procedures		
• Lumbar puncture (see Appendix C) • Solid organ biopsies	• Deep, non-organ biopsy	• Superficial or palpable mass biopsies

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APPENDIX A: Procedure Bleeding Risk - continued

Note: For patients who have other risk factors for bleeding (*e.g.*, recent bleeding event, thrombocytopenia) consider utilizing the management recommendations for high risk bleeding procedures.

High Bleeding Risk	Moderate Bleeding Risk	Low Bleeding Risk
Ophthalmic Procedures		
• Eye plaque brachytherapy • Orbital surgery/major eyelid surgery/lacrimal surgery/ eye removal/orbital removal • Posterior eye surgery • Scleral buckle	• Conjunctival surgery • Descemet's stripping endothelial keratoplasty (DSEK) • Glaucoma procedures (*i.e.*, trabeculectomy) • Minor eyelid or pericular surgery • Penetrating keratoplasty	• Cataract surgery • Intravitreal injection of pharmacologic agent • Vitreoretinal surgery (except scleral buckle)
Orthopedic Procedures		
• Arthroplasty • Carpal tunnel repair • All other OR Oncologic Orthopedic procedures	• Arthroscopy • Shoulder, foot, and ankle tendon repair	• Joint or soft tissue injections
Plastic Surgery Procedures		
• All OR Plastic Surgery procedures • For non-OR procedures, consult Plastic Surgery for peri-operative anticoagulant management	N/A	N/A
Pulmonary Procedures		
• Diagnostic bronchoscopy with endobronchial biopsy • Diagnostic bronchoscopy with endobronchial ultrasound-guided transbronchial needle aspiration • Diagnostic bronchoscopy with transbronchial biopsy • Pleuroscopy, pleural biopsy • Therapeutic bronchoscopy with endobronchial tumor destruction, stenosis relief, management of hemoptysis	• Bronchial or tracheal stent placement • Chemical pleurodesis • Non-tunneled chest tube placement (pleural space) • Thoracentesis • Tracheostomy • Tunneled pleural catheter placement or removal	• Diagnostic bronchoscopy airway exam without biopsy • Diagnostic bronchoscopy with bronchoalveolar lavage without biopsy

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APPENDIX A: Procedure Bleeding Risk – continued

Note: For patients who have other risk factors for bleeding (*e.g.*, recent bleeding event, thrombocytopenia) consider utilizing the management recommendations for high risk bleeding procedures.

High Bleeding Risk	Moderate Bleeding Risk	Low Bleeding Risk
Surgical Oncology		
• All other OR Surgical Oncology procedures • Complex central line placement (subclavian or internal jugular vein vascular device placement) • Complex dialysis/apheresis catheter placement	• Diagnostic laparoscopy (if any open procedures are planned or possible, procedure would be considered high risk) • Incision and drainage • Non-complicated central line placement (subclavian or internal jugular vein vascular device placement) • Non-complicated dialysis/apheresis catheter placement (subclavian or internal jugular vein) • Superficial wide local excision • Tunneled central venous catheter removal • Venous port placement or removal	• Femoral vein vascular access device placement • Non-tunneled central venous catheter exchange or removal
Thoracic and Cardiovascular Surgery Procedures		
• All OR Thoracic and Cardiovascular Surgery Procedures • Endoscopic mucosal resection (EMR) • For other high bleeding risk procedures, see Pulmonary Procedures section on Page 6	• Pericardial window • For other moderate bleeding risk procedures, see Pulmonary Procedures section on Page 6	• Diagnostic esophagogastroduodenoscopy (EGD) • For other low bleeding risk procedures, see Pulmonary Procedures section on Page 6
Urology Procedures		
• All OR Urology procedures • Prostate biopsy • Solid organ fiducial placement	N/A	• Cystoscopy without bladder resection

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Peri-Procedure Management of Anticoagulants

APPENDIX A: Procedure Bleeding Risk – continued

Note: For patients who have other risk factors for bleeding (*e.g.*, recent bleeding event, thrombocytopenia) consider utilizing the management recommendations for high risk bleeding procedures.

High Bleeding Risk	Moderate Bleeding Risk	Low Bleeding Risk
Vascular Access and Procedures Team		
• Complex central line placement (subclavian or internal jugular vein vascular device placement) • Complex dialysis/apheresis catheter placement • Lumbar puncture (see Appendix C)	• Non-complicated central line placement (subclavian or internal jugular vein vascular device placement) • Non-complicated dialysis/apheresis catheter placement (subclavian or internal jugular vein)	• Femoral vein vascular access device placement • Non-tunneled central venous catheter exchange or removal • Paracentesis • Peripherally inserted central catheter (PICC) placement • Tunneled central venous catheter removal • Venous port removal
Vascular Surgery Procedures		
• All open and hybrid Vascular Surgery procedures • Consult with Vascular Surgery for peri-operative anticoagulant management	N/A	N/A

Peri-Procedure Management of Anticoagulants

APPENDIX B: Reversal of Anticoagulants

<table>
<tr><th>Anticoagulant</th><th>Recommended Treatment</th></tr>
<tr><td>Warfarin</td><td>
• Administer prothrombin complex concentrate (Kcentra®) IVPB based on INR and actual body weight:
<table>
<tr><th>INR</th><th>Dosage</th><th>Maximum Dose</th></tr>
<tr><td>2-3.9</td><td>25 units/kg</td><td>2,500 units</td></tr>
<tr><td>4-6</td><td>35 units/kg</td><td>3,500 units</td></tr>
<tr><td>> 6</td><td>50 units/kg</td><td>5,000 units</td></tr>
</table>
• Consider using ideal or adjusted body weight for obese patients
• Add vitamin K 10 mg IV at 1 mg/minute for 1 dose for prolonged reversal of warfarin
• If prothrombin complex concentrate (Kcentra®) not available, use fresh frozen plasma 15 mL/kg or if INR is not supratherapeutic (e.g., ≤ 3); may use 5-8 mL/kg for urgent reversal
</td></tr>
<tr><td>Dabigatran</td><td>
• Administer activated charcoal 25-50 grams oral or nasogastric tube times one dose if ingested within the previous 2 hours
• Administer idarucizumab 2.5 grams IV times two doses
• Consider repeated dose of idarucizumab if after several hours the patient re-bleeds or has worsening coagulopathy
• Consider hemodialysis for life-threatening bleeds
</td></tr>
<tr><td>Apixaban or rivaroxaban</td><td>
• Administer activated charcoal 25-50 grams oral or nasogastric tube times one dose if ingested within the previous 2 hours
• Andexanet alfa: If last dose of apixaban or rivaroxaban was given within 18 hours.
<table>
<tr><th rowspan="2">FXa Inhibitor</th><th rowspan="2">FXa Inhibitor Last Dose</th><th colspan="2">Timing of FXa Inhibitor Last Dose Before Andexanet Alfa Initiation</th></tr>
<tr><th>< 8 hours or unknown</th><th>≥ 8 hours</th></tr>
<tr><td rowspan="2">Apixaban</td><td>≤ 5 mg</td><td>Low dose</td><td rowspan="4">Low dose</td></tr>
<tr><td>> 5 mg/unknown</td><td>High dose</td></tr>
<tr><td rowspan="2">Rivaroxaban</td><td>≤ 10 mg</td><td>Low dose</td></tr>
<tr><td>> 10 mg/unknown</td><td>High dose</td></tr>
</table>
Low dose: 400 mg IV bolus, followed by 4 mg/minute IV infusion for up to 120 minutes
High dose: 800 mg IV bolus, followed by 8 mg/minute IV infusion for up to 120 minutes
• If last dose of apixaban or rivaroxaban given > 18 hours, andexanet alfa may be given if compelling indication necessitating reversal is present (e.g., acute renal failure or overdose)
• If andexanet alfa not available, administer prothrombin complex concentrate (Kcentra®) 25 units/kg (maximum dose 2,500 units) to 50 units/kg (maximum dose 5,000 units) IVPB based on actual body weight. Consider using ideal or adjusted body weight for obese patients.
</td></tr>
</table>

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APPENDIX B: Reversal of Anticoagulants - continued

Anticoagulant	Recommended Treatment
Edoxaban[1] or betrixaban[1]	• Administer activated charcoal 25-50 grams oral or nasogastric tube times one dose if ingested within the previous 2 hours • Administer prothrombin complex concentrate (Kcentra®) 25 units/kg (maximum dose 2,500 units) to 50 units/kg (maximum dose 5,000 units) IVPB based on actual body weight • Consider using ideal or adjusted body weight for obese patients
Heparin	• Administer 1 mg of protamine IV for every 100 units of IV heparin given over the last 2-2.5 hours • Single doses should not exceed 50 mg • Consider repeat dosing if continued bleeding or a prolonged aPTT
Enoxaparin or dalteparin	• Administer 1 mg of protamine IV for every 100 units of dalteparin or 1 mg of enoxaparin given within the previous 8 hours • Administer 0.5 mg of protamine IV for every 100 units of dalteparin or 1 mg of enoxaparin given in the previous 8 to 12 hours • Single doses of protamine should not exceed 50 mg • Consider coagulation factor VIIa recombinant 20 mcg/kg IV times one dose
Fondaparinux	• Administer prothrombin complex concentrate (Kcentra®) 25 units/kg (maximum dose 2,500 units) to 50 units/kg (maximum dose 5,000 units) IVPB based on actual body weight • Consider using ideal or adjusted body weight for obese patients • Consider coagulation factor VIIa recombinant 20 mcg/kg IV times one dose

[1] Non-formulary

Peri-Procedure Management of Anticoagulants

APPENDIX C: Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture)

Note: Consult proceduralist if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.

Prophylaxis Dosages	Hold Recommendations Prior to Catheter Insertion	Management While Epidural Catheter in Place	Restart Recommendations After Catheter Removal
Unfractionated heparin 5,000 units SQ every 8 hours or every 12 hours	May be given without time restrictions	No time restriction	May be given without time restrictions
Unfractionated heparin 7,500 units SQ every 8 hours	12 hours	Do not give unless approved by Acute Pain service	4 hours
Dalteparin 5,000 units SQ every 24 hours Enoxaparin 30 mg or 40 mg SQ every 24 hours	12 hours – CrCl ≥ 30 mL/minute 24 hours – CrCl < 30 mL/minute	May be given BUT: • Must wait 8 hours after catheter PLACEMENT before giving dose • Must wait 12 hours after last dose before REMOVING catheter	4 hours
Enoxaparin 30 mg or 40 mg SQ every 12 hours	12 hours – CrCl ≥ 30 mL/minute 24 hours – CrCl < 30 mL/minute	Do not give unless approved by Acute Pain service	4 hours
Fondaparinux 2.5 mg SQ every 24 hours	48 hours – CrCl ≥ 30 mL/minute CrCl < 30 mL/minute: Consult Benign Hematology	Do not give unless approved by Acute Pain service	6 hours
Apixaban 2.5 mg PO every 12 hours	48 hours – CrCl ≥ 50 mL/minute 72 hours – CrCl 30-49 mL/minute CrCl < 30 mL/minute: Consult Benign Hematology	Do not give unless approved by Acute Pain service	6 hours
Rivaroxaban 10 mg PO every 24 hours	24 hours – CrCl ≥ 50 mL/minute 72 hours – CrCl 30-49 mL/minute CrCl < 30 mL/minute: Consult Benign Hematology	Do not give unless approved by Acute Pain service	6 hours

[1] Non-formulary

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Peri-Procedure Management of Anticoagulants

APPENDIX C: Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture) - continued

Note: Consult proceduralist if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.

Treatment Dosages	Hold Recommendations Prior to Catheter Insertion	Management While Epidural Catheter in Place	Restart Recommendations After Catheter Removal
Unfractionated heparin SQ > 10,000 units/dose or > 20,000 units/day	At least 24 hours or when aPTT is < 45 seconds	Do not give unless approved by Acute Pain service	4 hours
Unfractionated heparin IV infusion	At least 6 hours or when aPTT is < 45 seconds	Do not give unless approved by Acute Pain service	4 hours
Dalteparin, enoxaparin	24 hours – CrCl ≥ 30 mL/minute 48 hours – CrCl < 30 mL/minute	Do not give unless approved by Acute Pain service	4 hours
Fondaparinux	72 hours – CrCl ≥ 30 mL/minute CrCl < 30 mL/minute: Consult Benign Hematology	Do not give unless approved by Acute Pain service	6 hours
Apixaban, rivaroxaban, edoxaban[1]	72 hours – CrCl ≥ 30 mL/minute[2] CrCl < 30 mL/minute: Consult Benign Hematology	Do not give unless approved by Acute Pain service	6 hours
Dabigatran	120 hours – CrCl ≥ 50 mL/minute[2] CrCl < 50 mL/minute: Consult Benign Hematology	Do not give unless approved by Acute Pain service	6 hours
Warfarin (Coumadin®)	When INR < 1.5	Do not give unless approved by Acute Pain service	4 hours
Argatroban IV infusion	At least 4 hours or when aPTT is < 45 seconds	Do not give unless approved by Acute Pain service	4 hours
Bivalirudin IV infusion	At least 4 hours or when aPTT is < 45 seconds	Do not give unless approved by Acute Pain service	4 hours

[1] Non-formulary
[2] For lumbar puncture, hold treatment doses 48 hours prior to procedure

APPENDIX D: Procedure Bleeding Risk and Management of Anticoagulants for Interventional Spine and Pain Procedures

Procedure Bleeding Risk

High Risk Bleed:	**Moderate Risk Bleed[1]:**	**Low Risk Bleed[1]:**
• Spinal cord stimulation trial and implant • Dorsal root ganglion stimulation • Intrathecal catheter and pump implant • Vertebral augmentation (vertebroplasty and kyphoplasty) • Percutaneous decompression laminotomy • Epiduroscopy and epidural decompression • Peripheral nerve stimulator trial and implant (for locations close to critical vessels or highly-invasive procedures) • Intrathecal injections • Epidural blood patch • Paravertebral blocks • Radiofrequency- and cryo-ablations of peripheral nerves (for locations close to critical vessels or highly-invasive procedures) • Radiofrequency- and cryo-ablations of sympathetic ganglia	• Interlaminar and transforaminal epidural steroid injections • Cervical facet medial branch nerve blocks • Radiofrequency ablation of the cervical facet joints • Intradiscal procedures (cervical, thoracic, lumbar) • Sympathetic blocks (stellate, thoracic, splanchnic, celiac, lumbar, hypogastric) • Trigeminal and sphenopalatine ganglia blocks • Cervical intra-articular injections • Trans-nasal sphenopalatine ganglion block • Injections at ligaments and tendons • Radiofrequency- and cryo-ablations of peripheral nerves (for locations not close to critical vessels and low-invasive procedures)	• Peripheral nerve blocks with no catheter placement (excluding trigeminal nerve blocks) • Peripheral nerve blocks with catheter placement (for locations not close to critical vessels and low-invasive procedures) • Peripheral joints and musculoskeletal injections • Trigger point injections including piriformis injection • Sacroiliac joint injection and sacral lateral branch blocks • Thoracic and lumbar facet medial branch nerve block • Radiofrequency ablations of thoracic and lumbar facet joints • Peripheral nerve stimulator trial and implant (for locations not close to critical vessels and low-invasive procedures) • Pocket revision and implantable pulse generator/intrathecal pump replacement

[1] Patients with high risk of bleeding (*e.g.*, old age, history of bleeding tendency, concurrent uses of other anticoagulants/antiplatelets, liver cirrhosis or advanced liver disease, advanced renal disease, and patients on vascular endothelial growth factor (VEGF) inhibitor therapy) undergoing low- or moderate-risk procedures should be treated as moderate or high risk, respectively

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APPENDIX D: Procedure Bleeding Risk and Management of Anticoagulants for Interventional Spine and Pain Procedures - continued

Management of Anticoagulants for Interventional Spine and Pain Procedures based on Bleeding Risk

Note: Consult proceduralist if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.

Prophylaxis Dosages	Low Risk		Moderate Risk		High Risk	
	Hold Recommendations Prior to Procedure	Restart Recommendations After Procedure	Hold Recommendations Prior to Procedure	Restart Recommendations After Procedure	Hold Recommendations Prior to Procedure	Restart Recommendations After Procedure
Unfractionated heparin 5,000 units SQ every 8 hours or every 12 hours	6 hours	2 hours	6 hours	6 hours	24 hours	8 hours
Unfractionated heparin 7,500 units SQ every 8 hours	6 hours	4 hours	6 hours	6 hours	24 hours	8 hours
Dalteparin ≥ 30 mL/minute	12 hours	4 hours	24 hours	12 hours	24 hours	24 hours
Dalteparin < 30 mL/minute	Consult Benign Hematology	4 hours	Consult Benign Hematology	12 hours	Consult Benign Hematology	24 hours
Enoxaparin CrCl ≥ 30 mL/minute	12 hours	4 hours	12 hours	12 hours	24 hours	24 hours
Enoxaparin CrCl < 30 mL/minute	24 hours	4 hours	24 hours	12 hours	48 hours	24 hours
Fondaparinux CrCl ≥ 30 mL/minute	48 hours	6 hours	96 hours	24 hours	120 hours	24 hours
Fondaparinux CrCl < 30 mL/minute	Consult Benign Hematology	6 hours	Consult Benign Hematology	24 hours	Consult Benign Hematology	24 hours
Apixaban CrCl ≥ 25 mL/minute Rivaroxaban CrCl ≥ 30 mL/minute	24 hours	6 hours	24 hours	24 hours	72 hours	24 hours
Apixaban CrCl < 25 mL/minute Rivaroxaban CrCl < 30 mL/minute	Consult Benign Hematology	6 hours	Consult Benign Hematology	24 hours	Consult Benign Hematology	24 hours

[1] Non-formulary

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APPENDIX D: Procedure Bleeding Risk and Management of Anticoagulants for Interventional Spine and Pain Procedures - continued

Management of Anticoagulants for Interventional Spine and Pain Procedures based on Bleeding Risk

Note: Consult proceduralist if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.

Treatment Dosages	Low Risk		Moderate Risk		High Risk	
	Hold Recommendations Prior to Procedure	**Restart Recommendations After Procedure**	**Hold Recommendations Prior to Procedure**	**Restart Recommendations After Procedure**	**Hold Recommendations Prior to Procedure**	**Restart Recommendations After Procedure**
Unfractionated heparin SQ > 10,000 units/dose or > 20,000 units/day	At least 24 hours or when aPTT < 45 seconds	4 hours	At least 24 hours or when aPTT < 45 seconds	24 hours	At least 24 hours or when aPTT < 45 seconds	24 hours
Unfractionated heparin IV infusion	At least 6 hours or when aPTT < 45 seconds	4 hours	At least 6 hours or when aPTT < 45 seconds	24 hours	At least 6 hours or when aPTT < 45 seconds	24 hours
Dalteparin, Enoxaparin CrCl ≥ 30 mL/minute	24 hours	4 hours	24 hours	12 hours	24 hours	24 hours
Dalteparin, Enoxaparin CrCl < 30 mL/minute	Consult Benign Hematology	4 hours	Consult Benign Hematology	12 hours	Consult Benign Hematology	24 hours
Fondaparinux CrCl ≥ 30 mL/minute	48 hours	6 hours	96 hours	24 hours	120 hours	24 hours
Fondaparinux CrCl < 30 mL/minute	Consult Benign Hematology	6 hours	Consult Benign Hematology	24 hours	Consult Benign Hematology	24 hours
Apixaban CrCl ≥ 25 mL/minute Rivaroxaban CrCl ≥ 30 mL/minute Edoxaban[1] CrCl ≥ 30 mL/minute	24 hours	6 hours	48 hours	24 hours	72 hours	24 hours
Apixaban CrCl < 25 mL/minute Rivaroxaban CrCl < 30 mL/minute Edoxaban[1] CrCl < 30 mL/minute	Consult Benign Hematology	6 hours	Consult Benign Hematology	24 hours	Consult Benign Hematology	24 hours
Dabigatran CrCl ≥ 50 mL/minute	48 hours	6 hours	72 hours	24 hours	96 hours	24 hours
Dabigatran CrCl 30-49 mL/minute	72 hours	6 hours	120 hours	24 hours	120 hours	24 hours
Dabigatran CrCl < 30 mL/minute	Consult Benign Hematology	6 hours	Consult Benign Hematology	24 hours	Consult Benign Hematology	24 hours
Warfarin (Coumadin®)	INR < 1.5	Restart same evening	INR < 1.5	24 hours	INR < 1.5	24 hours
Argatroban IV Infusion Bivalirudin IV Infusion	At least 4 hours or when aPTT < 45 seconds	6 hours	At least 4 hours or when aPTT < 45 seconds	24 hours	At least 4 hours or when aPTT < 45 seconds	24 hours

[1] Non-formulary

APPENDIX E: Procedure Bleeding Risk and Management of Anticoagulants for Neurosurgery Procedures

Procedure Bleeding Risk

High Risk Bleed:	Moderate Risk Bleed:	Low Risk Bleed:
• All other neurosurgery cranial and spinal procedures	• Ommaya reservoir placement/removal • Intraventricular catheter (EVD) placement/removal • Steriotactic biopsy • Lumbar drain placement/removal • Gamma knife procedures[1] • Extradural skull base procedures • Ventriculoperitoneal (VP) shunt placement/removal	• Ommaya reservoir tap • Ventriculoperitoneal (VP) shunt tap

[1] Anticoagulation may be continued especially for patients with a high risk for thromboembolism. Consult with Neurosurgery prior to procedure.

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APPENDIX E: Procedure Bleeding Risk and Management of Anticoagulants for Neurosurgery Procedures - continued

Management of Anticoagulants for Neurosurgery Procedures based on Bleeding Risk

Note: Consult Neurosurgery if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.
Restart recommendations after neurosurgical procedures are based on hemostasis being established.

			Restart Recommendations Based on Thromboembolic (TE) Risk			
	Procedure Bleed Risk	**Hold Recommendations Prior to Procedure**	**High Risk: VTE/Stroke within 3 months, mitral valve prosthesis, caged ball or tilting disc aortic valve prosthesis[2,3]**	**Low Risk: Patients not included in the high risk category[3]**	**Atrial fibrillation with CHA_2DS_2-VASc score ≥ 4[3,4,5]**	**Atrial fibrillation with CHA_2DS_2-VASc score < 4[3,4,5]**
Enoxaparin/dalteparin prophylaxis dose	Moderate	1 day	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Enoxaparin 1 mg/kg every 12 hours[6] CrCl ≥ 30 mL/minute ½ life: 4-7 hours	Moderate	Evening dose on day prior to procedure	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Enoxaparin 1.5 mg/kg every 24 hours[6] or Dalteparin daily dosing[7] CrCl ≥ 30 mL/minute ½ life: 4-7 hours	Moderate	Give ½ dose in morning of day prior to procedure	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Unfractionated heparin ½ life: 1-1.5 hours	Moderate	4-6 hours prior to procedure or when aPTT < 45 seconds	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days

[1] Non-formulary
[2] Consider temporary inferior vena cava (IVC) filter in patients with high TE risk where anticoagulation cannot be resumed within 5-10 days
[3] Longer hold times may be needed for intraparenchymal hemorrhage, intradural spine procedures, and surgical procedures on vascular tumors (glioblastoma, renal cell, thyroid, choriocarcinoma)
[4] Consider left atrial appendage occlusion (LAAO) in patients unable to resume anticoagulation or those with a high risk for recurrent hemorrhage
[5] For CHA_2DS_2-VASc criteria and scoring, see Page 25
[6] Enoxaparin dosing for patients with CrCl < 30 mL/minute should be 1 mg/kg every 24 hours. For moderate and high risk procedures, hold enoxaparin at least 1 day prior to procedure or consider transitioning patient to unfractionated heparin.
[7] For patients on dalteparin with CrCl < 30 mL/minute and planned moderate and/or high risk bleeding procedure, hold dalteparin at least 1 day prior to procedure or consider transitioning patient to unfractionated heparin

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APPENDIX E: Procedure Bleeding Risk and Management of Anticoagulants for Neurosurgery Procedures - continued

Management of Anticoagulants for Neurosurgery Procedures based on Bleeding Risk

Note: Consult Neurosurgery if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.
Restart recommendations after neurosurgical procedures are based on hemostasis being established.

			Restart Recommendations Based on Thromboembolic (TE) Risk			
	Procedure Bleed Risk	**Hold Recommendations Prior to Procedure**	**High Risk: VTE/Stroke within 3 months, mitral valve prosthesis, caged ball or tilting disc aortic valve prosthesis[2,3]**	**Low Risk: Patients not included in the high risk category[3]**	**Atrial fibrillation with CHA_2DS_2-VASc score ≥ 4[3,4,5]**	**Atrial fibrillation with CHA_2DS_2-VASc score < 4[3,4,5]**
Fondaparinux treatment dose CrCl ≥ 50 mL/minute ½ life: 17-21 hours	Moderate	2 days	2-3 days	3-5 days	3-5 days	5-7 days
	High	4 days	5-10 days	10-12 days	7-10 days	10-12 days
Fondaparinux treatment dose CrCl < 50 mL/minute	Moderate	5 days	2-3 days	3-5 days	3-5 days	5-7 days
	High	6 days	5-10 days	10-12 days	7-10 days	10-12 days
Argatroban Normal hepatic function Child-Pugh score[6] ≤ 6 ½ life: 45 minutes	Moderate	3 hours prior to procedure or when aPTT < 45 seconds	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Argatroban Hepatic dysfunction Child-Pugh score[6] > 6	Moderate	9 hours prior to procedure or when aPTT < 45 seconds	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Bivalirudin CrCl ≥ 30 mL/minute ½ life: 30 minutes	Moderate	1.5 hours prior to procedure or when aPTT < 45 seconds	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Bivalirudin CrCl < 30 mL/minute	Moderate	3 hours prior to procedure or when aPTT < 45 seconds	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days

[1] Non-formulary
[2] Consider temporary inferior vena cava (IVC) filter in patients with high TE risk where anticoagulation cannot be resumed within 5-10 days
[3] Longer hold times may be needed for intraparenchymal hemorrhage, intradural spine procedures, and surgical procedures on vascular tumors (glioblastoma, renal cell, thyroid, choriocarcinoma)
[4] Consider left atrial appendage occlusion (LAAO) in patients unable to resume anticoagulation or those with a high risk for recurrent hemorrhage
[5] For CHA_2DS_2-VASc criteria and scoring, see Page 25
[6] See Appendix J: Child-Pugh Score

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APPENDIX E: Procedure Bleeding Risk and Management of Anticoagulants for Neurosurgery Procedures - continued

Management of Anticoagulants for Neurosurgery Procedures based on Bleeding Risk

Note: Consult Neurosurgery if patient has recently (within the past 10 days) taken full dose thrombolytic medication (altepase). If patient on betrixaban[1], consult Benign Hematology for peri-procedure management.

Restart recommendations after neurosurgical procedures are based on hemostasis being established.

			Restart Recommendations Based on Thromboembolic (TE) Risk			
	Procedure Bleed Risk	**Hold Recommendations Prior to Procedure**	**High Risk: VTE/Stroke within 3 months, mitral valve prosthesis, caged ball or tilting disc aortic valve prosthesis[2,3]**	**Low Risk: Patients not included in the high risk category[3]**	**Atrial fibrillation with CHA_2DS_2-VASc score ≥ 4[3,4,5]**	**Atrial fibrillation with CHA_2DS_2-VASc score < 4[3,4,5]**
Warfarin	Moderate	5 days, see Appendix G for hold and bridge recommendations	2-3 days	3-5 days	3-5 days	5-7 days
	High		5-10 days	10-12 days	7-10 days	10-12 days
Apixaban CrCl ≥ 25 mL/minute Dabigatran CrCl ≥ 50 mL/minute Edoxaban[1] CrCl ≥ 30 mL/minute Rivaroxaban CrCl ≥ 30 mL/minute	Moderate	1 day	2-3 days	3-5 days	3-5 days	5-7 days
	High	2 days	5-10 days	10-12 days	7-10 days	10-12 days
Apixaban CrCl < 25 mL/minute[6] Edoxaban[1] CrCl < 30 mL/minute[6] Rivaroxaban CrCl < 30 mL/minute[6]	Moderate	2 days	2-3 days	3-5 days	3-5 days	5-7 days
	High	3 days	5-10 days	10-12 days	7-10 days	10-12 days
Dabigatran CrCl 30-49 mL/minute	Moderate	2 days	2-3 days	3-5 days	3-5 days	5-7 days
	High	4 days	5-10 days	10-12 days	7-10 days	10-12 days
Dabigatran CrCl < 30 mL/minute[6]	Moderate	3 days	2-3 days	3-5 days	3-5 days	5-7 days
	High	5 days	5-10 days	10-12 days	7-10 days	10-12 days

[1] Non-formulary
[2] Consider temporary inferior vena cava (IVC) filter in patients with high TE risk where anticoagulation cannot be resumed within 5-10 days
[3] Longer hold times may be needed for intraparenchymal hemorrhage, intradural spine procedures, and surgical procedures on vascular tumors (glioblastoma, renal cell, thyroid, choriocarcinoma)
[4] Consider left atrial appendage occlusion (LAAO) in patients unable to resume anticoagulation or those with a high risk for recurrent hemorrhage
[5] For CHA_2DS_2-VASc criteria and scoring, see Page 25
[6] Consider consult to Benign Hematology

APPENDIX F: Parenteral Anticoagulant Management

See Appendix C for Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture)
See Appendix D for Management of Anticoagulant for Interventional Spine and Pain Procedures
See Appendix E for Management of Anticoagulant for Neurosurgery Procedures

- **The following recommendations for hold strategy are based on current guidelines and estimated half-life of each anticoagulant. Data for hold strategies in cancer patients are very limited. Clinicians should always consider risk of bleeding versus risk of thrombosis in cancer patients in determining the hold strategy.**
- Moderate risk of bleeding needs 2-3 drug half-lives between the last dose and surgery; aim for mild to moderate residual anticoagulant effect at surgery < 12% - 25%
- High risk of bleeding needs 4-5 drug half-lives between the last dose and surgery; aim for minimal residual anticoagulant effect at surgery < 3% - 6%

Parenteral Agent Holding Time

	Procedure Bleed Risk	Day -6	Day -5	Day -4	Day -3	Day -2	Day -1	Day of Procedure	Day +1	Day +2	Day +3
Enoxaparin/dalteparin prophylaxis dose	Moderate	-	-	-	-	-	Hold one day prior to the procedure	→	Resume 24 hours after procedure	-	-
	High	-	-	-	-	-		→		-	-
Enoxaparin 1 mg/kg every 12 hours[1] CrCl ≥ 30 mL/minute ½ life: 4-7 hours	Moderate	-	-	-	-	-	Hold evening dose on day prior to the procedure	→	Resume 24 hours after procedure	-	-
	High	-	-	-	-	-		→	→	Resume 48-72 hours after procedure[2]	
Enoxaparin 1.5 mg/kg every 24 hours[1] or Dalteparin daily dosing[3] CrCl ≥ 30 mL/minute ½ life: 4-7 hours	Moderate	-	-	-	-	-	Give ½ dose in morning on day prior to the procedure	→	Resume 24 hours after procedure	-	-
	High	-	-	-	-	-		→	→	Resume 48-72 hours after procedure[2]	
Unfractionated heparin ½ life: 1-1.5 hours	Moderate	-	-	-	-	-	Hold 4-6 hours prior to procedure or when aPTT < 45 seconds	→	Resume 12-24 hours after procedure	-	-
	High	-	-	-	-	-		→	→	Resume 48-72 hours after procedure[2]	

[1] Enoxaparin dosing for patients with CrCl < 30 mL/minute should be 1 mg/kg every 24 hours. For moderate and high risk procedures, hold enoxaparin at least 1 day prior to procedure or consider transitioning patient to unfractionated heparin.
[2] For patients with high risk of thromboembolism (see Appendix I), consider resuming anticoagulation earlier if hemostasis can be achieved and approved by proceduralist
[3] For patients on dalteparin with CrCl < 30 mL/minute and planned moderate and/or high risk bleeding procedure, hold dalteparin at least 1 day prior to procedure or consider transitioning patient to unfractionated heparin

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APPENDIX F: Parenteral Anticoagulant Management - continued

See Appendix C for Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture)
See Appendix D for Management of Anticoagulant for Interventional Spine and Pain Procedures
See Appendix E for Management of Anticoagulant for Neurosurgery Procedures

- **The following recommendations for hold strategy are based on current guidelines and estimated half-life of each anticoagulant. Data for hold strategies in cancer patients are very limited. Clinicians should always consider risk of bleeding versus risk of thrombosis in cancer patients in determining the hold strategy.**
- Moderate risk of bleeding needs 2-3 drug half-lives between the last dose and surgery; aim for mild to moderate residual anticoagulant effect at surgery < 12% - 25%
- High risk of bleeding needs 4-5 drug half-lives between the last dose and surgery; aim for minimal residual anticoagulant effect at surgery < 3% - 6%

Parenteral Agent Holding Time

	Procedure Bleed Risk	Day -6	Day -5	Day -4	Day -3	Day -2	Day -1	Day of Procedure	Day +1	Day +2	Day +3
Fondaparinux treatment dose CrCl ≥ 50 mL/minute ½ life: 17-21 hours	Moderate	-	-	-	-	Hold 2 days prior to procedure	→	→	Resume 24 hours after procedure	-	-
	High	-	-	Hold 4 days prior to procedure	→	→	→	→		Resume 48-72 hours after procedure[1]	
Fondaparinux treatment dose CrCl < 50 mL/minute	Moderate	-	Hold 5 days prior to procedure	→	→	→	→	→	Resume 24 hours after procedure	-	
	High	Hold 6 days prior to procedure	→	→	→	→	→	→		Resume 48-72 hours after procedure[1]	
Argatroban Normal hepatic function Child-Pugh score[2] ≤ 6 ½ life: 45 minutes	Moderate	-	-	-	-	-	Hold 3 hours prior to procedure or when aPTT < 45 seconds	→	Resume 12 hours after procedure	-	-
	High	-	-	-	-	-	→	→	Resume 24 hours after procedure	-	-
Argatroban Hepatic dysfunction Child-Pugh score[2] > 6	Moderate	-	-	-	-	-	Hold 9 hours prior to procedure or when aPTT < 45 seconds	→	Resume 12 hours after procedure	-	-
	High	-	-	-	-	-	→	→	Resume 24 hours after procedure	-	-

[1] For patients with high risk of thromboembolism (see Appendix I), consider resuming anticoagulation earlier if hemostasis can be achieved and approved by proceduralist
[2] See Appendix J: Child-Pugh Score

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APPENDIX F: Parenteral Anticoagulant Management - continued

See Appendix C for Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture)
See Appendix D for Management of Anticoagulant for Interventional Spine and Pain Procedures
See Appendix E for Management of Anticoagulant for Neurosurgery Procedures

- **The following recommendations for hold strategy are based on current guidelines and estimated half-life of each anticoagulant. Data for hold strategies in cancer patients are very limited. Clinicians should always consider risk of bleeding versus risk of thrombosis in cancer patients in determining the hold strategy.**
- Moderate risk of bleeding needs 2-3 drug half-lives between the last dose and surgery; aim for mild to moderate residual anticoagulant effect at surgery < 12% - 25%
- High risk of bleeding needs 4-5 drug half-lives between the last dose and surgery; aim for minimal residual anticoagulant effect at surgery < 3% - 6%

Parenteral Agent Holding Time

	Procedure Bleed Risk	Day -6	Day -5	Day -4	Day -3	Day -2	Day -1	Day of Procedure	Day +1	Day +2	Day +3
Bivalirudin CrCl ≥ 30 mL/minute ½ life: 30 minutes	Moderate	-	-	-	-	-	Hold 1.5 hours prior to procedure or when aPTT < 45 seconds	→	Resume 12 hours after procedure	-	-
	High	-	-	-	-	-		→	Resume 24 hours after procedure	-	-
Bivalirudin CrCl < 30 mL/minute	Moderate	-	-	-	-	-	Hold 3 hours prior to procedure or when aPTT < 45 seconds	→	Resume 12 hours after procedure	-	-
	High	-	-	-	-	-		→	Resume 24 hours after procedure	-	-

APPENDIX G: Warfarin Management

See Appendix C for Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture)
See Appendix D for Management of Anticoagulant for Interventional Spine and Pain Procedures

Hold recommendations for patients on warfarin who are NOT bridging therapy

- Obtain INR 5-7 days prior to procedure and hold based on results:

INR results 5-7 days prior to procedure:	Supratherapeutic	Therapeutic	Subtherapeutic
When to hold warfarin:	At least 5 days before procedure	5 days before procedure	3-4 days before procedure

- Recheck INR 24 hours prior to procedure to ensure result is at desired level
- If INR still above desired level (*e.g.*, > 1.5), consider low-dose oral vitamin K (1-2.5 mg) and recheck INR just prior to procedure
- If not checking INR, discontinue warfarin 5-6 days prior to procedure

Hold recommendations for patients on warfarin who are bridging therapy

Note: Consider checking INR 5-7 days before procedure and if subtherapeutic, begin bridging medication immediately. If supratherapeutic, consider holding warfarin for more than 5 days prior to procedure. Holding warfarin for more than 5 days may also be indicated in select patient populations (*e.g.*, elderly, liver dysfunction, low warfarin dose requirements, target INR of 3-4).

Day 0 is day of procedure

Day	Unfractionated Heparin[1]	LMWH twice daily[1,2]	LMWH once daily[1,2]
-6	Last dose of warfarin	Last dose of warfarin	Last dose of warfarin
-5	Start continuous heparin infusion when INR falls below therapeutic range or on day -3 if not monitoring INR	Start LMWH when INR falls below therapeutic range or on day -3 if not monitoring INR	Start LMWH when INR falls below therapeutic range or on day -3 if not monitoring INR
-4			
-3	Continuous heparin infusion	LMWH at 8 am and 8 pm	LMWH at 8 am
-2	Continuous heparin infusion	LMWH at 8 am and 8 pm	LMWH at 8 am
-1	Continuous heparin infusion[3]	LMWH at 8 am[3]	½ dose LMWH at 8 am[3]
0	Hold 4-6 hours prior to procedure	No LMWH	No LMWH

[1] If history of heparin induced thrombocytopenia (HIT), use apixaban (see Appendix H) or intravenous direct thrombin inhibitor (see Appendix F) to bridge
[2] If creatinine clearance < 30 mL/minute, recommend using unfractionated heparin to bridge
[3] If possible, check INR and if > 1.5, give vitamin K 1 mg PO and recheck INR on the day of procedure

Restarting Warfarin

- See Appendix E for restart recommendations based on thromboembolic risks for Neurosurgery Procedures
- In most cases warfarin can be restarted 24 hours after a procedure, whether the patient is high or moderate risk of bleeding
- If patient has high risk of thromboembolic risk (see Appendix I) and was bridged prior to procedure, restart bridging agent **and** warfarin post procedure, and discontinue bridging agent when INR is therapeutic

APPENDIX H: Direct Oral Anticoagulants (DOACs) Management

See Appendix C for Management of Anticoagulant for Regional Anesthesia (neuraxial and deep peripheral nerve procedures, including lumbar puncture)
See Appendix D for Management of Anticoagulant for Interventional Spine and Pain Procedures
See Appendix E for Management of Anticoagulant for Neurosurgery Procedures

- **The following recommendations for hold strategy are based on current guidelines and estimated half-life of each anticoagulant. Data for hold strategies in cancer patients are very limited. Clinicians should always consider risk of bleeding versus risk of thrombosis in cancer patients in determining the hold strategy.**
- Moderate risk of bleeding needs 2 - 3 drug half-lives between the last dose and surgery; aim for mild to moderate residual anticoagulant effect at surgery < 12% - 25%
- High risk of bleeding needs 4 - 5 drug half-lives between the last dose and surgery; aim for minimal residual anticoagulant effect at surgery < 3% - 6%
- For patients with high thromboembolic risk (see Appendix I) undergoing high risk bleeding procedures (see Appendix A), consult Benign Hematology for assistance in bridging DOAC. Please refer to Transitioning Between Anticoagulants (for internal use only) to assist with transitioning DOAC to a parenteral anticoagulant.

	Procedure Bleed Risk	Day -5	Day -4	Day -3	Day -2	Day -1	Day of Procedure	Day +1	Day +2	Day +3
Apixaban CrCl ≥ 25 mL/minute Dabigatran CrCl ≥ 50 mL/minute Edoxaban[1] CrCl ≥ 30 mL/minute Rivaroxaban CrCl ≥ 30 mL/minute	Moderate	-	-	-	-	Hold 1 day prior to procedure	→	Resume 24 hours after procedure	-	-
	High	-	-	-	Hold 2 days prior to procedure	→	→	→	Resume 48-72 hours after procedure[2]	
Apixaban CrCl < 25 mL/minute[3] Edoxaban[1] CrCl < 30 mL/minute[3] Rivaroxaban CrCl < 30 mL/minute[3]	Moderate	-	-	-	Hold 2 days prior to procedure	→	→	Resume 24 hours after procedure	-	-
	High	-	-	Hold 3 days prior to procedure	→	→	→	→	Resume 48-72 hours after procedure[2]	
Dabigatran CrCl 30-49 mL/minute	Moderate	-	-	-	Hold 2 days prior to procedure	→	→	Resume 24 hours after procedure	-	-
	High	-	Hold 4 days prior to procedure	→	→	→	→	→	Resume 48-72 hours after procedure[2]	
Dabigatran CrCl < 30 mL/minute[3]	Moderate	-	-	Hold 3 days prior to procedure	→	→	→	Resume 24 hours after procedure	-	-
	High	Hold 5 days prior to procedure	→	→	→	→	→	→	Resume 48-72 hours after procedure[2]	

[1] Non-formulary
[2] For patients with high risk of thromboembolism (see Appendix I), consider resuming anticoagulation earlier if hemostasis can be achieved and approved by proceduralist
[3] Consider consult to Benign Hematology

APPENDIX I: Thromboembolic Risks

Risk	Mechanical Heart Valve in the Aortic/Mitral Position	Atrial Fibrillation	Venous Thromboembolism (VTE)
High (requires bridging if on warfarin)	• Any mitral valve prosthesis • Any caged-ball or tilting disc aortic valve prosthesis • Stroke or transient ischemic attack (TIA) within 6 months	• CHA_2DS_2-VASc[1] score ≥ 5 • Stroke or TIA within 3 months • Rheumatic valvular heart disease	• VTE within 3 months • VTE of any duration with severe thrombophilia (*e.g.*, deficiency of protein C, protein S, or antithrombin, antiphospholipid antibodies, homozygous factor V Leiden or prothrombin G20210A, or multiple abnormalities)
Low	• Bileaflet aortic valve prosthesis	• CHA_2DS_2-VASc[1] score < 5	• VTE within the past 3-12 months • VTE with non-severe thrombophilia (*e.g.*, heterozygous factor V Leiden or prothrombin gene mutation) • Recurrent idiopathic VTE • Active cancer (treated within 6 months or palliative) • VTE > 12 months previous and no other risk factors

[1] **CHA_2DS_2-VASc Score**

Criteria	Points
Male	0
Female	1
Congestive heart failure history	1
Diabetes mellitus history	1
Hypertension history	1
Vascular disease history	1
Age 65-74 years	1
Age ≥ 75 years	2
Stroke/TIA/thromboembolism history	2

APPENDIX J: Child-Pugh Scoring System[1]

Chemical and biochemical parameters	Scores (points) for increasing abnormality		
	1	2	3
Encephalopathy	None	1 - 2	3 - 4
Ascites	None	Slight	Moderate
Albumin	> 3.5 g/dL	2.8 - 3.5 g/dL	< 2.8 g/dL
Bilirubin In primary biliary cirrhosis	< 2 mg/dL 1 - 4 mg/dL	2 - 3 mg/dL 4 -10 mg/dL	> 3 md/dL > 10 mg/dL
Prothrombin time prolonged **or** INR	1 - 4 seconds < 1.7	4 - 6 seconds 1.7 - 2.3	> 6 seconds > 2.3

[1] Child-Pugh score is obtained by adding the score for each parameter
Child-Pugh class:
Class A = 5 to 6 points
Class B = 7 to 9 points
Class C = 10 to 15 points

SUGGESTED READINGS

Burnett, A., Mahan, C., Vazquez, S., Oertel, L., Garcia, D., & Ansell, J. (2016). Guidance for the practical management of the direct oral anticoagulants (DOACs) in VTE treatment. *Journal of Thrombosis and Thrombolysis, 41*(1), 206–232. https://doi.org/10.1007/s11239-015-1310-7

Doherty, J., Gluckman, T., Hucker, W., Januzzi, J., Ortel, T., Saxonhouse, S., . . . Spinler, S. (2017). 2017 ACC expert consensus decision pathway for periprocedural management of anticoagulation in patients with nonvalvular atrial fibrillation: A report of the American College of Cardiology Clinical Expert Consensus Document Task Force. *Journal of the American College of Cardiology, 69*(7), 871–898. https://doi.org/10.1016/j.jacc.2016.11.024

Douketis, J., Spyropoulos, A., Duncan, J., Carrier, M., Le Gal, G., Tafur, A., . . . Schulman, S. (2019). Perioperative management of patients with atrial fibrillation receiving a direct oral anticoagulant. *Journal of American Medical Association Internal Medicine*, *179*(11), 1469-1478. https://doi.org/10.1001/jamainternmed.2019.2431

Douketis, J., Spyropoulos, A., Kaatz, S., Becker, R., Caprini, J., Dunn, A., . . . Ortel, T. (2015). Perioperative bridging anticoagulation in patients with atrial fibrillation. *The New England Journal of Medicine, 373*(9), 823–833. https://doi.org/10.1056/NEJMoa1501035

Douketis, J., Spyropoulos, A., Spencer, F., Mayr, M., Jaffer, A., Eckman, M., . . . Kunz, R. (2012). Perioperative management of antithrombotic therapy: Antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines, *Chest, 141*(2 Suppl), e326S–e350S. https://doi.org/10.1378/chest.11-2298

Dubois, V., Dincq, A., Douxfils, J., Ickx, B., Samama, C., Dogné, J., . . . Lessire, S. (2017). Perioperative management of patients on direct oral anticoagulants. *Thrombosis Journal, 15*(14), 14-30. https://doi.org/10.1186/s12959-017-0137-1

Garwood, C., Gortney, J., & Corbett, T. (2011). Is there a role for fondaparinux in perioperative bridging? *American Journal of Health-System Pharmacy, 68*(1), 36–42. https://doi.org/10.2146/ajhp100133

Gressel, G., Marcus, J., Mullen, M., & Sinno, A. (2021). Direct oral anticoagulant use in gynecologic oncology: A Society of Gynecologic Oncology Clinical Practice Statement. *Gynecologic Oncology, 160*(1), 312–321. https://doi.org/10.1016/j.ygyno.2020.11.020

Horlocker, T., Vandermeuelen, E., Kopp, S., Gogarten, W., Leffert, L., & Benzon, H. (2018). Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines (Fourth Edition). *Regional Anesthesia and Pain Medicine, 43*(3), 263–309. https://doi.org/10.1097/AAP.0000000000000763

Lewin, A., Collins, P., Sylvester, K., Rimsans, J., Fanikos, J., Goldhaber, S., & Connors, J. (2020). Development of an Institutional Periprocedural Management Guideline for oral anticoagulants. *Critical Pathways in Cardiology, 19*(4), 178–186. https://doi.org/10.1097/HPC.0000000000000221

Mar, P., Familtsev, D., Ezekowitz, M., Lakkireddy, D., & Gopinathannair, R. (2016). Periprocedural management of anticoagulation in patients taking novel oral anticoagulants: Review of the literature and recommendations for specific populations and procedures. *International Journal of Cardiology*, *202*, 578–585. https://doi.org/10.1016/j.ijcard.2015.09.035

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SUGGESTED READINGS - continued

Mehdi, Z., Birns, J., Partridge, J., Bhalla, A., & Dhesi, J. (2016). Perioperative management of adult patients with a history of stroke or transient ischaemic attack undergoing elective non-cardiac surgery. *Clinical Medicine, 16*(6), 535–540. https://doi.org/10.7861/clinmedicine.16-6-535

Narouze, S., Benzon, H., Provenzano, D., Buvanendran, A., De Andres, J., Deer, T., . . . Huntoon, M. (2018). Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications (Second Edition): Guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. *Regional Anesthesia and Pain Medicine, 43*(3), 225–262. https://doi.org/10.1097/AAP.0000000000000700

Nutescu, E. (2013). Oral anticoagulant therapies: Balancing the risks. *American Journal of Health-System Pharmacy, 70*(10 Suppl), S3–11. https://doi.org/10.2146/ajhp130040

Ortel, T. (2012). Perioperative management of patients on chronic antithrombotic therapy. *Blood, 120*(24), 4699–4705. https://doi.org/10.1182/blood-2012-05-423228

Patel, I., Rahim, S., Davidson, J., Hanks, S., Tam, A., Walker, T., . . . Weinberg, I. (2019). Society of Interventional Radiology Consensus Guidelines for the periprocedural management of thrombotic and bleeding risk in patients undergoing percutaneous image-guided interventions-part II: Recommendations. *Journal of Vascular and Interventional Radiology, 30*(8), 1168–1184. https://doi.org/10.1016/j.jvir.2019.04.017

Pudusseri, A. & Spyropoulos, A. (2014). Management of anticoagulants in the periprocedural period for patients with cancer. *Journal of the National Comprehensive Cancer Network: JNCCN, 12*(12), 1713–1720. https://doi.org/10.6004/jnccn.2014.0173

Raval, A., Cigarroa, J., Chung, M., Diaz-Sandoval, L., Diercks, D., Piccini, J., . . . Collins, S. (2017). Management of patients on non–vitamin K antagonist oral anticoagulants in the acute care and periprocedural setting: A scientific statement from the American Heart Association. *Circulation, 135*(10), e604–e633. https://doi.org/10.1161/CIR.0000000000000477

Steffel, J., Verhamme, P., Potpara, T., Albaladejo, P., Antz, M., Desteghe, L., . . . ESC Scientific Document Group. (2018). The 2018 European Heart Rhythm Association Practical Guide on the use of non-vitamin K antagonist oral anticoagulants in patients with atrial fibrillation. *European Heart Journal, 39*(16), 1330–1393. https://doi.org/10.1093/eurheartj/ehy136

Tao, J., & Oprea, A. (2020). Updates in periprocedural management of direct oral anticoagulants. *Current Opinion in Anaesthesiology, 33*(3), 423–431. https://doi.org/10.1097/ACO.0000000000000873

Witt, D., Clark, N., Kaatz, S., Schnurr, T., & Ansell, J. (2016). Guidance for the practical management of warfarin therapy in the treatment of venous thromboembolism. *Journal of Thrombosis and Thrombolysis, 41*(1), 187–205. https://doi.org/10.1007/s11239-015-1319-y

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