BIDMC Periprocedural Guidelines for the Management of Patients on Anticoagulant and Antiplatelet Agents

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General Principles

These guidelines are designed to assist the provider in the management of patients on anticoagulant and/or antiplatelet therapy who are being considered for invasive or surgical procedures.

The first section, titled “Procedure-Specific Guidelines,” lists procedures by type (endoscopic, dental, etc) and categorizes them by bleeding risk (high or low). The list of surgeries and procedures covered is not exhaustive, and the focus is primarily to define common procedures for which continuing anticoagulant and/or platelet therapy may be possible. For major surgical procedures, there is general agreement that anticoagulants should be stopped, whereas, in some cases antiplatelet agents can be continued.

The second section, titled “Patient-Specific Guidelines,” provides periprocedural management and bridging strategies based on the patient’s indication for anticoagulant and/or antiplatelet therapy and their risk for thromboembolic events.

Whenever possible, periprocedural antithrombotic management strategies were standardized across specialties that perform similar procedures. However, due to existing variation in clinical practice between specialties, and a lack of high-quality evidence upon which to define best practice, the reader will note areas of inconsistencies in these guidelines.

In each instance, the care team should consider each step in the Management Pathway when creating a periprocedural anticoagulant and antiplatelet care plan. Given that each clinical situation is different, it is important to balance the likelihood and consequences of perioperative bleeding versus thromboembolism.

Patients should be specifically instructed to contact their medical specialist (cardiologist, hematologist, etc) or proceduralist (cardiologist, surgeon, interventional radiologist, etc), before stopping any anticoagulant or antiplatelet agent, even if instructed to stop such therapy by another healthcare provider. Healthcare providers who perform invasive or surgical procedures that require the interruption of anticoagulant and/or antiplatelet agents should be aware of the potential risks (thrombosis, embolism, death) associated with discontinuing these therapies, and should contact the patient’s medical specialist to discuss the optimal patient management strategy.

All decisions, treatment plans, and clinical communications about periprocedural antiplatelet and anticoagulant management should be clearly communicated to the patient and documented in the medical record.

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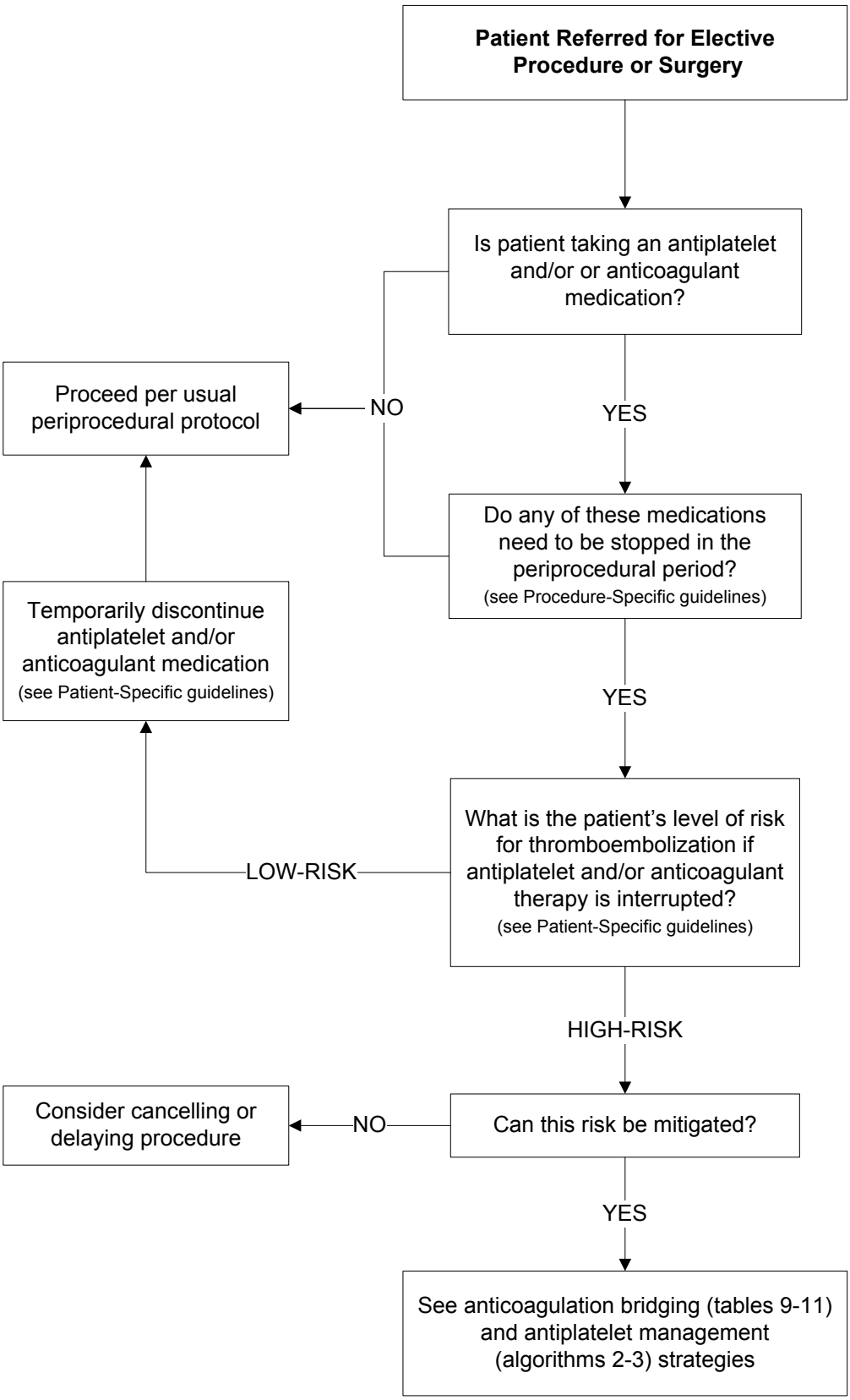
Algorithm 1. Periprocedural Antithrombotic Medication Management Pathway



This guideline has been designed to assist the clinician in decision making. It is not intended to replace clinical judgment where individual patient characteristics may require modification of these recommendations.

Table 1. Management of Antithrombotic Agents prior to Gastroenterology Procedures

Procedures with low-risk of bleeding • EGD, sigmoidoscopy, colonoscopy enteroscopy, with or without biopsy • ERCP without sphincterotomy • EUS without FNA • Capsule endoscopy • Enteral stent deployment (without dilation) • Cold snare or forceps polypectomy of <1 cm - For paracentesis see Table 8.	**Antiplatelet Agents***
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with moderate to high-risk of bleeding • Polypectomy ≥ 1cm • ERCP with sphincterotomy • EUS with FNA • PEG placement • Cystogastrostomy • Pneumatic or bougie dilation • Treatment of varices • Tumor ablation by any technique - For liver biopsy see Table 8.	**Antiplatelet Agents*** Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants Anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.

EGD = Esophagogastroduodenoscopy; ERCP = Endoscopic Retrograde Cholangiopancreatography; EUS = Endoscopic Ultrasound; FNA = Fine Needle Aspiration; INR = International Normalized Ratio; LMWH = Low molecular weight heparin: NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban); PEG = Percutaneous Endoscopic Gastrostomy.

*Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs.
References: [1, 2]

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Table 2. Management of Antithrombotic Agents prior to Ophthalmological Surgery	
Procedures with low-risk of bleeding • Cataract surgery • Corneal transplant • Refractive surgery • Intravitreal injections • Minor lid procedures	**Antiplatelet Agents*** No adjustments need to be made.
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with moderate to high-risk of bleeding • Vitreoretinal surgery • Trabeculectomy • Major lid or orbital surgery	**Antiplatelet Agents*** Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants Anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.

INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban).

*Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs.
References: [1, 3-6]

Table 3. Management of Antithrombotic Therapy prior to Dental Procedures	
Procedures with low-risk of bleeding • Endodontics (root canal treatment) • Extractions (1-5) • Minor oral surgery • Periodontal surgery • Biopsies • Subgingival scaling • Local anesthesia (infiltrations, nerve blocks)	**Antiplatelet Agents*** No adjustments need to be made.
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with high-risk of bleeding • Extractions (> 5) • Impacted extractions (> 2) • Apicoectomy (root removal) • Alveolar surgery (bone removal) • Complex oral maxillofacial surgery	**Antiplatelet Agents*** Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants Anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.
Recommendations for local hemostasis • The use of oxidized cellulose ('Surgicel') or collagen sponges and sutures • Cyklokapron (tranexamic acid) mouthwashes used four times a day for 2 days. INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban). *Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs. References: [1, 7, 8]	

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Table 4. Management of Antithrombotic Agents prior to Cutaneous Surgery	
Low risk cutaneous surgery • Punch biopsy • Excisional biopsy • Cryosurgery • Curettage • Electrodessication	**Antiplatelet Agents*** No adjustments need to be made.
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with moderate to high-risk of bleeding • Periorbital surgery • Periauricular surgery • Excision • Mohs surgery	**Antiplatelet Agents*** Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants Anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.
INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban). *Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs. References: [1, 9]	

Table 5. Management of Antithrombotic Agents prior to Urological Surgery	
Procedures with low-risk of bleeding • Cystoscopy • Urethroscopy • Urodynamic testing	**Antiplatelet Agents*** No adjustments need to be made.
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with moderate to high-risk of bleeding • Cystoscopy with biopsy • Urethroscopy with biopsy • Vasectomy • Transrectal prostate biopsy • Transurethral resection of the prostate • Transurethral resection of bladder tumor • Laser ablation of the prostate	**Antiplatelet Agents*** Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants Anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.
INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban). *Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs. References: [10, 11]	

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Table 6. Management of Antithrombotic Agents prior to Anesthesia Procedures	
Procedures with low-risk of bleeding • Trigger point injections • IV infusions • Botox injections • Qutenza application	**Antiplatelet Agents*** No adjustments need to be made.
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure that it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with moderate to high-risk of bleeding Applies to all neuraxial routes • Spinal • Epidural • Intrathecal • Peripheral nerve and plexus	**Antiplatelet Agents*** See Table 17 for recommendations, including the timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants All therapeutic and most prophylactic anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 17 for recommended timing of interruption and initiation of anticoagulant therapy.
INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban). *Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs. References: [12]	

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Table 7. Management of Antithrombotic Agents prior to Interventional Pulmonary Procedures

Procedures with low-risk of bleeding Flexible bronchoscopy: • Airway inspection • Bronchoalveolar lavage /wash	**Antiplatelet Agents*** No adjustments need to be made.
	Anticoagulants No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range. There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.
Procedures with moderate to high-risk of bleeding Percutaneous: • Thoracentesis • All chest tubes(percutaneous/surgical) • U/S guided pleural/lung FNA or core biopsy • Tracheostomy • Thoracoscopy Flexible bronchoscopy: • Endobronchial biopsy • Transbronchial needle aspiration • Transbronchial biopsy Rigid bronchoscopy: • Stent placement and removal • Cryotherapy • Argon plasma coagulation • Electrocautery • Laser • Tumor debridement • Endobronchial valve placement • Bronchial thermoplasty	**Antiplatelet Agents*** Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy. Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.
	Anticoagulants Anticoagulants must be stopped. Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.

INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban).

*Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs.

References: [13-15]

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Table 8. Management of Antithrombotic Agents prior to Interventional Radiology Procedures

<table>
<tr>
<td>Procedures with low-risk of bleeding

Percutaneous biopsy, aspiration, drainage, injection
• Paracentesis
• Thoracentesis
• Soft tissue (aspiration only)
• Superficial lymph node
• Salivary gland (FNA only)
• Thyroid/Parathyroid (FNA or drainage only)†
• Breast (including wire localization)
• Joint/Tendon sheath/Bursa
Transvenous procedures:
• Central line insertion
• PICC line insertion or reposition
• Venous catheter port check
• IVC filter insertion or retrieval
• Adrenal venous sampling
• Transjugular liver biopsy
Imaging
• Cholangiogram (via existing catheter)
• AV fistulogram
Gastrointestinal
• Gastrostomy/jejunostomy tube replacement (> 30 days after placement)</td>
<td>Antiplatelet Agents*

No adjustments need to be made.

Anticoagulants

No adjustment in warfarin need be made, but it is recommended an INR be checked < 48 hours prior to the procedure to ensure it remains in the target range.

There are insufficient data to make specific recommendations regarding continuing other anticoagulants (NOACs, LMWH, etc.), but it may be reasonable to assume they carry a similar risk of periprocedural bleeding as warfarin.</td>
</tr>
<tr>
<td>Procedures with moderate to high-risk of bleeding

Percutaneous, biopsy aspiration, drainage, injection
• Renal biopsy / Nephrostomy‡
• Liver biopsy / Cholangiogram‡
• Cholecystostomy‡
• Lung nodule/mass
• Deep lymph node
• Transrectal/Transvaginal
• Fiducial seed
• Bone
• Soft-tissue (biopsy)
• Radiofrequency ablation
Transvenous
• Tunneled line
• Port placement
• TIPS‡
Transarterial
• Angiography/Angioplasty/Stenting
• Embolization
Percutaneous
Gastrointestinal
• Gastrostomy/jejunostomy tube placement or replacement (< 30 days after placement)
Neuraxial
• Lumbar/spinal puncture (see Table 17)</td>
<td>Antiplatelet Agents*

Whether to discontinue antiplatelet agents has not been determined, and should be based on a risk-benefit assessment by the proceduralist and relevant providers. See Table 16 for recommended timing of interruption and initiation of antiplatelet therapy.

Patients with Coronary Stents or Peripheral Artery Stents should be instructed to contact their cardiologist or proceduralist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.

Anticoagulants

Anticoagulants must be stopped.

Risk assessment and bridging strategies for patients on warfarin are outlined in Table 9 (atrial fibrillation), Table 10 (prosthetic heart valves), and Table 11 (venous thromboembolism). See Table 16 for recommended timing of interruption and initiation of anticoagulant therapy.</td>
</tr>
<tr>
<td colspan="2">†Whenever possible, hold warfarin prior to thyroid or parathyroid FNA/drainage.
‡ Whenever possible, hold aspirin AND non-aspirin antiplatelet agents prior to these procedures.
INR = International Normalized Ratio; LMWH = Low molecular weight heparin; NOACs = New Oral Anticoagulants (dabigatran, rivaroxaban, apixiban, edoxaban).
*Antiplatelet agents include: aspirin and/or non-aspirin antiplatelet agents: clopidogrel, ticagrelor, prasugrel, ticlodipine, dipyridamole, cilostazol, NSAIDs.
References: [16]</td>
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Table 9. Warfarin Bridging Guidelines for Patients with Atrial Fibrillation

Only use this table if it has already been determined that anticoagulation must be stopped prior to procedure

Risk for Embolism	Patient Characteristics	Recommendation
Low Risk	Non-valvular atrial fibrillation with CHA_2DS_2-VASc 0-4 without prior transient ischemic attack, stroke, or peripheral arterial thromboembolism.	• Discontinue warfarin 5 days prior to the procedure (i.e., give last dose on day minus 6 where day of surgery = day 0) so the INR falls to < 1.5. Bridging therapy not indicated. • See Table 16 for recommendations on when to restart warfarin after the procedure.
High Risk	Valvular*; or non-valvular atrial fibrillation with CHA_2DS_2-VASc 5-9 or with prior transient ischemic attack, stroke, or peripheral arterial thromboembolism. *(Consider delaying procedure for patients with recent stroke)*	• Discontinue warfarin 5 days prior to the procedure (i.e., give last dose on day minus 6 where day of surgery = day 0) so the INR falls to < 1.5, checking daily INRs. • ‡If bridging is indicated, start therapeutic UFH or LMWH when the INR falls below the patient's target (typically 48 hrs before the procedure). • See Table 16 for recommendations on timing the last dose of bridging anticoagulation prior to the procedure and restarting bridging therapy and warfarin after the procedure. • After warfarin is restarted, therapeutic UFH or LMWH should be continued until the INR is therapeutic for 24 hours.

*For the purposes of these guidelines, "valvular" includes those with mitral stenosis, severe valvular dysfunction, and/or any prosthetic heart valves (See Table 12. FDA approved prosthetic heart valves)

‡The optimal strategy for perioperative management of anticoagulation in patients with a high CHA_2DS_2-VASc risk score (5-9) is unclear and therefore an individualized approach developed in consultation with the patient's cardiologist is recommended.

INR = International Normalized Ratio; LMWH = Low molecular weight heparin; Therapeutic dosing = intravenous UFH at PTT 60-100 or subcutaneous LMWH at treatment (not prophylactic) doses; UFH = Unfractionated heparin.

References: [1, 17-21]

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Table 10. Warfarin Bridging Guidelines for Patients with Prosthetic Heart Valves

Only use this table if it has already been determined that anticoagulation must be stopped prior to procedure

Risk for embolism	Type of valve	Recommendation
Low Risk	• Bileaflet mechanical AVR without risk factors • Bioprosthetic AVR without risk factors • Medtronic Hall disc AVR without risk factors	• Discontinue warfarin 5 days prior to the procedure (i.e., give last dose on day minus 6 where day of surgery = day 0) so the INR falls to < 1.5. Bridging therapy not indicated. • See Table 16 for recommendations on when to restart warfarin after the procedure.
High Risk	• Bileaflet mechanical AVR with risk factors • Medtronic Hall disc AVR with risk factors • Bioprosthetic AVR or MVR with risk factors • Any mechanical MVR or TVR • Ball or Disc valve - excluding Medtronic Hall AVR without risk factors	• Discontinue warfarin 5 days prior to the procedure (i.e., give last dose on day minus 6 where day of surgery = day 0) so the INR falls to < 1.5, checking daily INRs. • ‡If bridging is indicated, start therapeutic UFH or LMWH when the INR falls below the patient's target (typically 48 hrs before the procedure). • See Table 16 for recommendations on timing the last dose of bridging anticoagulation prior to the procedure and restarting bridging therapy and warfarin after the procedure. • After warfarin is restarted, therapeutic UFH or LMWH should be continued until the INR is therapeutic for 24 hours.

Table 12. FDA approved prosthetic heart valves
Table 13a. Anticoagulant and antiplatelet therapy for patients with prosthetic heart valves

Risk factors: Atrial fibrillation, previous thromboembolism, congestive heart failure, left ventricular systolic dysfunction (LVEF < 40%), hypercoagulable conditions, or > 1 prosthetic heart valve.

Note: Pregnant women with prosthetic heart valves who are treated with LMWH may be at higher risk for thromboembolism.

AVR = Aortic valve replacement; INR = International Normalized Ratio; LMWH = Low molecular weight heparin; MVR = mitral valve replacement; Therapeutic dosing = intravenous UFH at PTT 60-100 or subcutaneous LMWH at treatment (not prophylactic) doses; TVR = Tricuspid valve replacement; UFH = Unfractionated heparin.
References:[1, 17-19]

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Table 11. Warfarin Bridging Guidelines for Patients with Venous Thromboembolism (VTE)

Only use this table if it has already been determined that anticoagulation must be stopped prior to procedure

Risk for Thromboembolism	Patient characteristics	Recommendation
Low Risk	• VTE ≥ 3 months prior without risk factors	• Discontinue warfarin 5 days prior to the procedure (i.e., give last dose on day minus 6 where day of surgery = day 0) so the INR falls to < 1.5. Bridging therapy not indicated. • See Table 16 for recommendations on when to restart warfarin after the procedure.
High Risk	• VTE < 3 months prior • VTE at any time with risk factors (Consider delaying procedure for patients with recent VTE)	• Discontinue warfarin 5 days prior to the procedure (i.e., give last dose on day minus 6 where day of surgery = day 0) so the INR falls to < 1.5., checking daily INRs. • ‡If bridging is indicated, start therapeutic UFH or LMWH when the INR falls below the patient's target (typically 48 hrs before the procedure). • See Table 16 for recommendations on timing the last dose of bridging anticoagulation prior to the procedure and restarting bridging therapy and warfarin after the procedure. • After warfarin is restarted, therapeutic UFH or LMWH should be continued until the INR is therapeutic for 24 hours.

Risk factors: ≥ 2 unprovoked VTE; near fatal VTE; active malignancy; antiphospholipid antibodies; or severe thrombophilia (deficiency of protein C, protein S, or antithrombin; or multiple abnormalities).

‡ The optimal strategy for perioperative management of anticoagulation in patients at high risk for recurrent VTE is unclear and therefore an individualized approach developed in consultation with the patient's hematologist or prescribing provider is recommended.

INR = International Normalized Ratio; LMWH = Low molecular weight heparin; Therapeutic dosing = intravenous UFH at PTT 60-100 or subcutaneous LMWH at treatment (not prophylactic) doses; UFH = Unfractionated heparin; VTE = venous thromboembolism.

References: [1, 22, 23]

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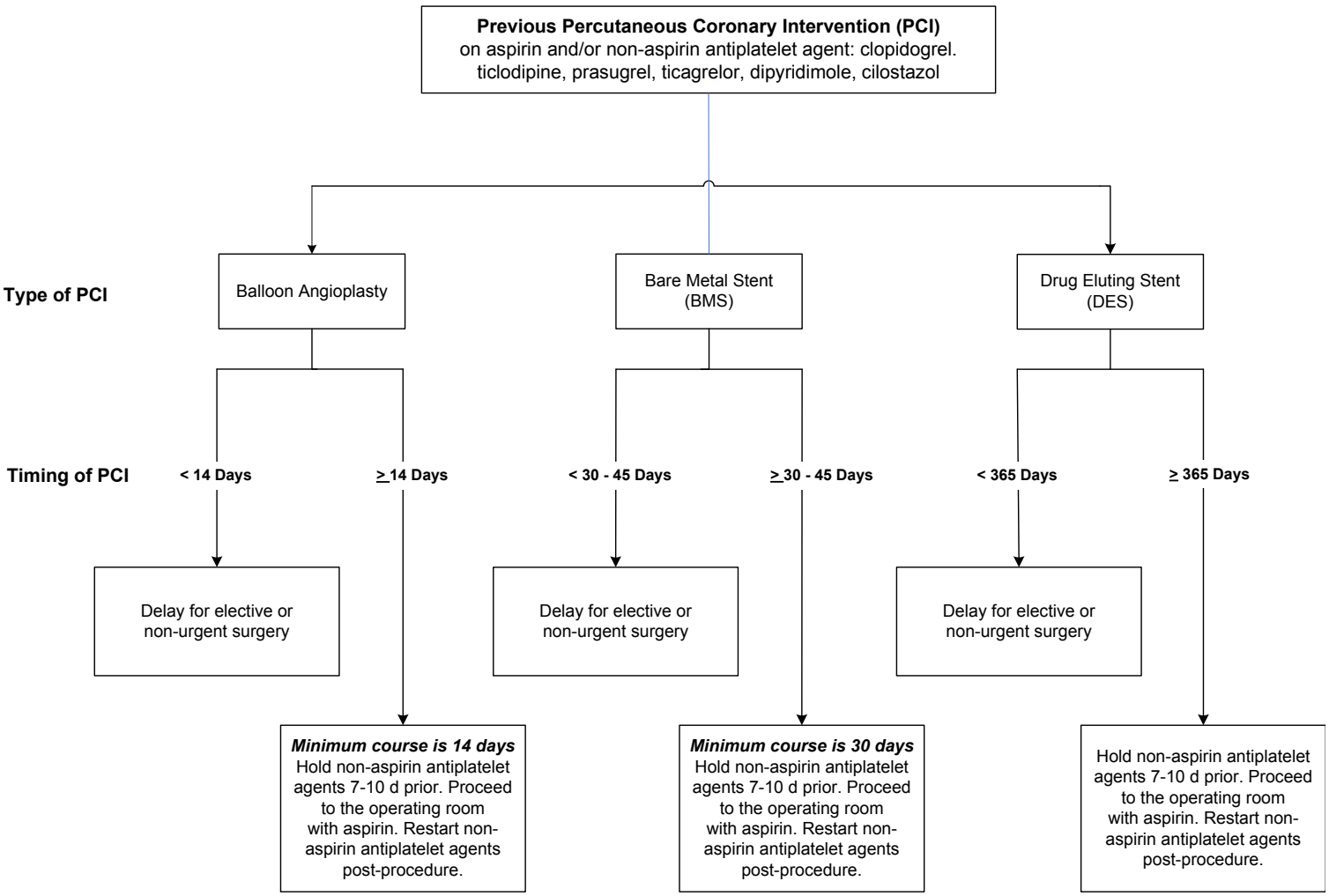
Algorithm 2. Perioperative Management of Patients on Antiplatelet Therapy for Previous Percutaneous Coronary Artery Intervention (PCI)



1. Patients should be specifically instructed to contact their treating cardiologist before stopping any antiplatelet medications, even if instructed to stop such therapy by another healthcare provider.

2. Healthcare providers who perform invasive or surgical procedures that require the interruption of anticoagulant and/or antiplatelet agents should be aware of the potential risks (thrombosis, embolism, death) associated with discontinuing these therapies, and should contact the patient's cardiologist to discuss the optimal patient management strategy.

3. Elective procedures for which there is significant risk of perioperative or postoperative bleeding should be deferred until patients have completed an appropriate course of antiplatelet therapy: 12 months after DES implantation if they are not at high risk of bleeding, and a minimum of 1 month after BMS implantation.

4. For patients treated with DES who are to undergo subsequent procedures that mandate discontinuation of antiplatelet therapy, aspirin should be continued if at all possible, and the antiplatelet medication restarted as soon as possible after the procedure to decrease the risk of late stent thrombosis.

References: [24-26]

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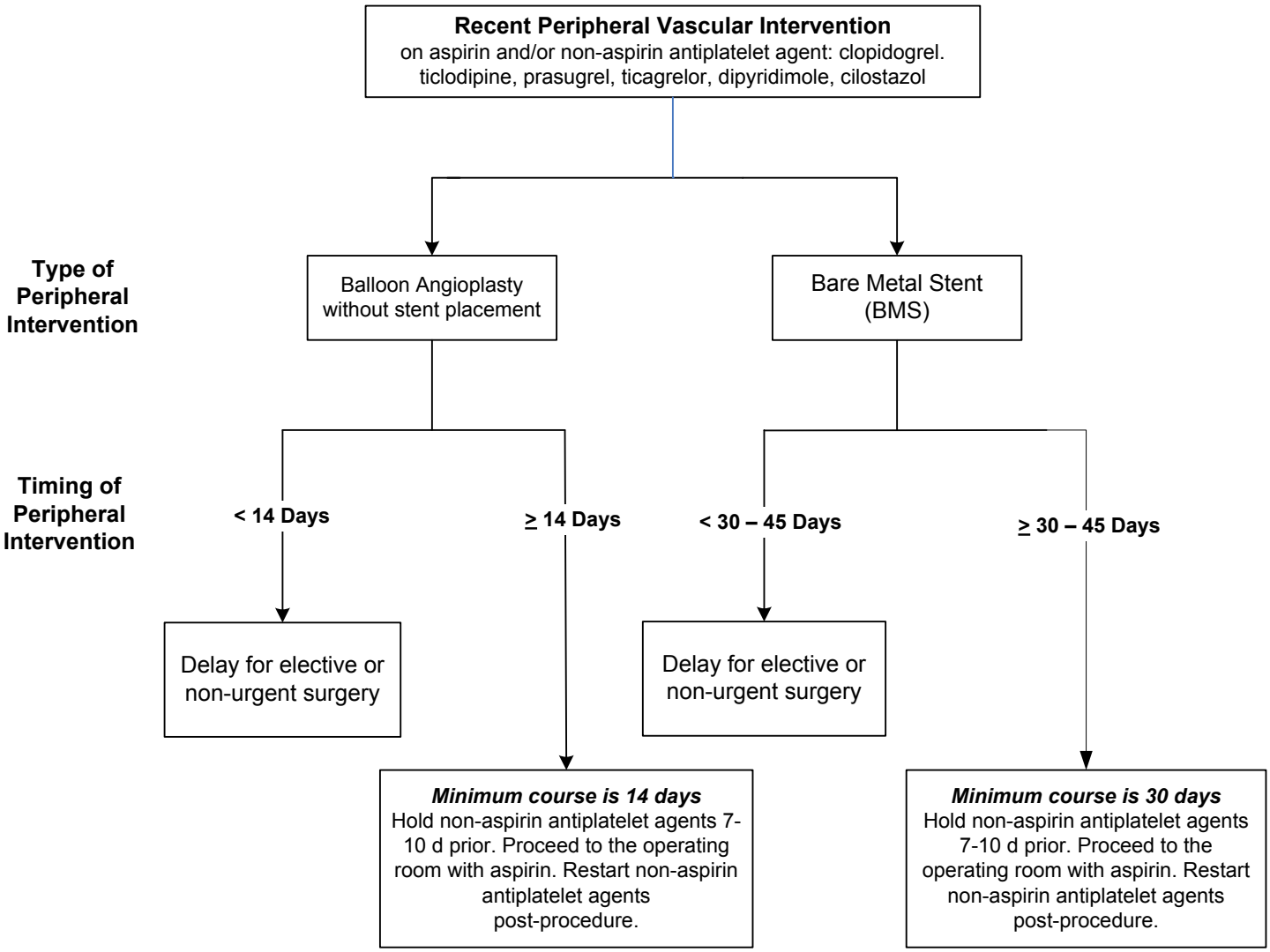
Algorithm 3. Perioperative Management of Patients on Antiplatelet Therapy for Prior Peripheral Vascular Intervention*



1. Patients should be specifically instructed to contact the physician who performed their procedure (e.g. cardiologist, vascular surgeon, or interventional radiologist) before stopping any antiplatelet therapy, even if instructed to stop such therapy by another healthcare provider.
2. In the event the patient has also had a prior percutaneous coronary artery intervention (PCI), the recommendations in the "Guidelines for the Perioperative Management of patient with Prior PCI Undergoing Elective Surgery (algorithm 2.)" should take precedence.
3. Elective procedures for which there is significant risk of perioperative or postoperative bleeding should be deferred until patients have completed an appropriate course of antiplatelet therapy: at least 14 days for peripheral vascular balloon angioplasty, and at least 1 month for bare metal stents.
4. Healthcare providers who perform invasive or surgical procedures that require the interruption of anticoagulant and/or antiplatelet agents should be aware of the potential risks (thrombosis, embolism, death) associated with discontinuing these therapies, and should contact the patient's interventional proceduralist (cardiologist, vascular surgeon, interventional radiologist) to discuss the optimal patient management strategy.

* At present there are no consensus statements on the perioperative management of patients with peripheral vascular stents who are on anticoagulant and antiplatelet agents. The recommendations above are extrapolated from related literature and from BIDMC Cardiology, Vascular Surgery, and Interventional Radiology recommendations
References: [26, 27]

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Table 12. FDA-approved Prosthetic Heart Valves*		
Type	**Manufacturer**	**Model**
Mechanical		
Ball	Baxter	Starr-Edwards
Single Disc	Medtronic	Medtronic Hall
	Medical Inc.	Omniscience
	Alliance	Monostrut
Bileaflet	St. Jude	St. Jude
	Baxter	Duromedics
	CarboMedics	CarboMedics
	On-X	On-X
Biological		
Porcine	Medtronic	Hancock Standard
		Hancock Modified Orifice
	Baxter	Carpentier-Edwards Standard
		Carpentier-Edwards Supra-Annular
	St. Jude	Toronto Stentless (TSP)
	Medtronic	Free Style
	Medtronic	CoreValve Transcatheter Aortic Valve
Bovine	Edwards	Sapien Transcatheter Aortic Valve
Pericardial	Baxter	Carpentier-Edwards
Homograft	Noncommercial	
	Cryolife	
Autologous	Noncommercial	Pulmonary autograft

* This is not intended to be complete list of current or past valve models.

Table 10. Bridging in patients with prosthetic heart valves
Table 13a. Anticoagulant and antiplatelet therapy for patients with prosthetic heart valves
References: [28]

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Table 13a. Anticoagulant and Antiplatelet Therapy in Patients with Prosthetic Heart Valves	
Type and Position of Valve	**Goal INR and Antiplatelet Therapy**
• Bioprosthetic MVR or AVR without risk factors	Aspirin 81 mg
• Bileaflet mechanical AVR without risk factors • Medtronic Hall disc AVR without risk factors • Bioprosthetic AVR with risk factors	INR 2 to 3 AND Aspirin 81 mg
• Bileaflet mechanical AVR with risk factors • Medtronic Hall disc AVR with risk factors • Bioprosthetic MVR with risk factors • Any mechanical MVR or TVR • Ball or Disc valve (excluding Medtronic Hall AVR without risk factors)	INR 2.5 to 3.5 AND Aspirin 81 mg
Table 10. Bridging strategies for patients with prosthetic heart valves Table 12. FDA approved prosthetic heart valves Risk factors: Atrial fibrillation, previous thromboembolism, congestive heart failure, LV systolic dysfunction (LVEF < 40%), hypercoagulable conditions, or > 1 prosthetic valves. AVR = Aortic valve replacement INR = International Normalized Ratio = MVR = Mitral valve replacement, TVR = Tricuspid valve replacement. References: [17, 28]	

Table 13b. Antiplatelet Therapy in Patients with Transcatheter Aortic Valve Replacement (TAVR)	
Type of Valve	**Antiplatelet Therapy**
• Medtronic CoreValve	ASA 81 mg *and* clopidogrel 75 mg for 3-months after implantation THEN ASA 81 mg
• Edwards Sapien	ASA 81 mg *and* clopidogrel 75 mg for 3-months after implantation THEN ASA 81 mg
At present, there are no consensus guidelines describing patient conditions or comorbidities which may require modifications to these recommendations (e.g., concomitant use of oral anticoagulants). Therefore, any such decisions should be make in consultation with the implanting cardiologist.	

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Table 14. CHA_2DS_2-VASc Score: Stroke Risk in Patients With Nonvalvular AF Not Treated With Anticoagulation	
CHA2DS2-VASc Risk Criteria	**Score**
Congestive Heart Failure	1
Hypertension	1
Age ≥75 years	2
Diabetes Mellitus	1
Prior Transient Ischemic Attack or Stroke or Thromboembolism	2
Vascular Disease (prior MI, peripheral arterial disease, aortic plaque)	1
Age 65-74 years	1
Sex Category (i.e. female)	1
Max Score = 9	

Table 9. Warfarin Bridging Guidelines for Patients with Atrial Fibrillation

References: [29]

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Table 15. Platelet and INR Thresholds for Selected Procedures

Risk or Consequence of Bleeding	Procedure	Platelet Goal	INR Goal
Low	Arthrocentesis Joint and soft tissue injections Central line placement * Paracentesis† Bronchoscopy with lavage† Thoracentesis	> 30,000/uL	< 2.0
Moderate	Percutaneous biopsies Transbronchial biopsies	> 50,000/uL	< 1.5
High	Lumbar puncture§¶ Epidural catheter placement or removal¶ Epidural injections¶	> 80,000/uL	< 1.5

* Central lines can be removed regardless of platelet count or INR

† Paracentesis and bronchoscopy (without biopsy) can be safely performed with an INR of > 2, and platelet counts of < 50,000/uL. The upper limit for INR and the lower limit for platelets have not been established.

§ Data suggest that lumbar puncture can be safely performed at platelet counts as low as 30,000/uL.

¶ See Table 17 for recommended timing of interruption and initiation of antithrombotic therapy before and after neuraxial procedures.

Note: Many of the procedures listed above have been performed at higher than threshold INR values and when considering transfusion for prophylaxis, the risks of transfusion must be weighed against the likelihood of preventing bleeding complications.

For patients with hematological malignancies, the recommended INR and platelet counts may not be achievable and transfusion thresholds should be discussed with the hematology/oncology attending and the transfusion medicine consult service

References: [15, 30-41]

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Table 16. Recommended Timing for Periprocedural Interruption and Initiation of Antithrombotic Therapy

ANTITHROMBOTIC MEDICATION	STOP PRIOR TO PROCEDURE	RESTART AFTER PROCEDURE[1, 42]	
Antiplatelet Medications[†]		*Low bleeding risk*	*High bleeding risk*
Aspirin (81-325 mg daily +/- dipyridamole)	7-10 days	24 h	48 h
Ticlodipine (250 mg twice daily)	10-14 days	24 h	48 h
Clopidogrel (75 mg once daily)	7-10 days[*]	24 h	48 h
Prasugrel (10 mg once daily)	7-10 days[¥]	24 h	48 h
Ticagrelor (90 mg twice daily; t ½ = 8 h)	5 days[¢]	24 h	48 h
Cilostazol (100 mg twice daily; t ½ = 11h)	3 days	24 h	48 h
Vorapaxar (2.08 mg once daily; t ½ ~ 8 days)[43]	> 28 days	24 h	48 h
Anticoagulant Medications[‡]			
Warfarin (t ½ = 36-42 h, but highly variable)	5 days[§]	12 h	24 h
Intravenous UFH (t ½ ~ 60 min)[44]	4-6 h (and PTT normal)	24 h	48-72 h
LMWH (t ½ = 3-7h)[44, 45]			
Prophylactic dosing	12 h (24 h for CrCl < 30 mL/min)	12 h	24-36 h
Therapeutic dosing			
• Once daily (give 50% of last dose)	24 h (36 h for CrCl < 30 mL/min)	24 h	48-72 h
• Twice daily	24 h (36 h for CrCl < 30 mL/min)	24 h	48-72 h
Fondaparinux (t ½ = 17)[45]	2-3 day (3-5 days for CrCl < 50 mL/min)	24 h	48-72 h
Dabigatran (150 mg twice daily)[5,46]			
CrCl > 50 mL/min (t ½ = 14-17 h)	3 days	24 h	48-72 h
CrCl 30-50 mL/min (t ½ = 16-18 h)	4-5 days	24 h	48-72 h
CrCl 15-30 mL/min (t ½ = 16-18 h)	4-5 days[£]	24 h	48-72 h
Rivaroxaban (20 mg once daily)[5,47]			
CrCl > 50 mL/min (t ½ = 8-9 h)	2-3 days	24 h	48-72 h
CrCl 30-50 mL/min (t ½ = 9 h)	3-4 days	24 h	48-72 h
CrCl 15-29.9 mL/min (t ½ = 9-10 h)	3-4 days[∂]	24 h	48-72 h
Apixiban (5 mg twice daily)[5,48]			
CrCl > 50 mL/min (t ½ = 7-8 h)	2-3 days	24 h	48-72 h
CrCl 30-50 mL/min (t ½ = 17-18 h)	3-4 days	24 h	48-72 h
Edoxaban (60 mg once daily)[49, 50]			
CrCl > 51 mL/min (t ½ = 10-14 h)	2-3 days	24 h	48-72 h
CrCl 15-50 mL/min (t ½ = 17-18 h)	3-4 days[ŧ]	24 h	48-72 h

[†]Assuming minimal platelet effect by 7-days and no effect by 10-days for (irreversible) agents: aspirin, ticlodipine, clopidogrel, and prasugrel; ticlodipine drug clearance is prolonged by an additional 4-days after repeated dosing.[51] Ticagrelor, cilostazol, and vorapaxar half-life depends on rate of drug clearance.
[*]5-days is sufficient for cardiac surgery.[52]
[¥]7-days per manufacturer,[53] drug effect may persist up to 10 days.
[¢] 5-days per manufacturer,[54] shorter interval expected based on half-life.
[‡]Intervals based on 4-5 drug half-lives to achieve minimal residual anticoagulant effect; shorter intervals may be appropriate for procedures with low-risk or consequence of bleeding, but there are limited data to guide recommendations.[1, 5, 20-22]
[§]> 90% of patients will achieve an INR < 1.5 after skipping 5 doses.[1]
[£] Patients receiving dabigatran 75 mg twice daily.
[∂] Patients receiving rivaroxaban 15 mg daily.
[ŧ] Patients receiving edoxaban 30 mg daily.

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Table 17. Guidelines for Antithrombotic Therapy in Patients Undergoing Diagnostic or Therapeutic Neuraxial or Peripheral Nerve Procedures*

MEDICATION	PRIOR TO PROCEDURE† Minimum time between last dose of antithrombotic agent and neuraxial or peripheral nerve procedure	WHILE CATHETER IN PLACE Restrictions on use of antithrombotic agents in patients with neuraxial or nerve catheters in place	AFTER PROCEDURE‡ Minimum time between procedure or catheter removal and first dose of antithrombotic agent
ANTICOAGULANT MEDICATIONS (Prophylactic Dose)			
Unfractionated Heparin (5000 units SC **BID**)[12]	May be given; no time restrictions for catheter or needle placement/removal		
Unfractionated Heparin (5000 units SC **TID**)[55]	6 h	**CONTRAINDICATED while catheter in place:** may NOT be given unless approved by Pain Service Attending	6 h
Enoxaparin (t ½ = 3-7h)[12, 55, 56]			
40 mg SC once daily	12 h (24 h for CrCl < 30 mL/min)		
30 mg SC BID	12 h (24 h for CrCl < 30 mL/min)		
Fondaparinux 2.5 mg SC once daily (t ½ = 17h)[57]	2-3 day (3-5 days for CrCl < 50 mL/min)		
Rivaroxaban 10 mg PO once daily (t ½ = see below)[55]	24 h (36 h for CrCl < 50 mL/min)		
ANTICOAGULATION MEDICATIONS (Therapeutic Dose)			
Heparin (t ½ ~ 60 min)[55, 58]	4-6 h (and PTT normal)	**CONTRAINDICATED while catheter in place:** may NOT be given unless approved by Pain Service Attending	6 h
Argatroban (t ½ = 45 min)[45, 55]	4 h (and PTT normal)		
Bivalirudin(t ½ = 25 min)[45, 57]	2-3 h (3-5 h for CrCl < 50 mL/min; PTT normal)		
Enoxaparin(t ½ = 3-7h)[12, 55, 56]			
1.5 mg/kg SC once daily	36 h (48 h for CrCl < 30 mL/min)		
1 mg/kg SC BID	24 h (36 h for CrCl < 30 mL/min)		
Fondaparinux 5-10 mg SC once daily (t ½ = 17)[57]	2-3 days (3-5 days for CrCl < 50 mL/min)		
Warfarin (t ½ = 36-42 h, highly variable)	INR ≤ 1.5§		
Dabigatran (150 mg PO BID)[5,19, 59]			
CrCl > 50 mL/min (t ½ = 14-17h)	3 days		
CrCl 30-50 mL/min (t ½ = 16-18h)	4-5 days		
CrCl 15-30 mL/min (t ½ = 16-18h)	4-5 days£		
Rivaroxaban (20 mg PO once daily)[5,47, 59]			
CrCl > 50 mL/min (t ½ = 8-9h)	2 days£		
CrCl 30-50 mL/min (t ½ = 9h)	3 days		
CrCl 15-29.9 mL/min (t ½ = 9-10h)	4 days∂		
Apixiban (5 mg PO BID)[5,48]			
CrCl > 50 mL/min (t ½ = 7-8h)	2-3 days∂		
CrCl 30-50 mL/min (t ½ = 17-18h)	3-4 days		
Edoxaban (60 mg once daily)[49, 50]			
CrCl > 51 mL/min (t ½ = 10-14 h)	2-3 days		
CrCl 15-50 mL/min (t ½ = 17-18 h)	3-4 days‡		
ANTIPLATELET MEDICATIONS¶			
Aspirin/NSAIDs[12, 55]	May be given; no time restrictions for catheter or needle placement/removal		
Abciximab[12, 51, 55]	48 h≠	**CONTRAINDICATED while catheter in place:** may NOT be given unless approved by Pain Service Attending	6 h
Eptifibatide[12, 51, 55]	8 h (up to 24 h for CrCl < 60 mL/min)		
Tirobifan[12, 51, 55]	8 h (up to 24 h for CrCl < 60 mL/min)		
Clopidogrel (75 mg PO once daily)[51]	7-10 days^Δ		
Ticlodipine (250 mg PO BID)[51]	10-14 days		
Prasugrel (10 mg PO once daily)[53, 55]	7-10 days¥		
Ticagrelor (90 mg twice daily; t ½ = 8 h) [54, 55]	5 days€		
Cilostazol (100 mg twice daily; t ½ = 11h)[55]	3 days		
Vorapaxar (2.08 mg once daily; t ½ ~ 8 days) [43]	> 28 days		
THROMBOLYTIC MEDICATIONS			
Alteplase (2 mg for catheter clearance)	May be given; no time restrictions for catheter or needle placement/removal (maximum 4mg/24 hours)		
Alteplase (Full dose; t ½ ~ 5 min)	Unknown	**CONTRAINDICATED while catheter in place:** may NOT be given unless approved by Pain Service Attending	At least 10 days[12]
Tenecteplase (Full dose; t ½ = 90-130 min)			

* "Neuraxial" refers to epidural or spinal (intrathecal) needle and/or catheter placement. "Peripheral" refers peripheral nerve or plexus needle and/or catheter placement.
† The recommended pre-procedure time intervals are based on the ARSA[12], ESA[54], and SIR5[6] guidelines. When these guidelines were inconsistent, the strategy with the longest time interval was chosen. When no recommendations existed, intervals were based on 4-5 drug half-lives to achieve minimal residual anticoagulant effect.
‡ The ARSA[12] and ESA5[4] guidelines allow for shorter time intervals for restarting some of the listed antithrombotic agents; 6 hrs was chosen for consistency and to provide an additional margin of safety. Longer time intervals are recommended after a traumatic or bloody catheter/needle placement.
§ > 90% of patients will achieve an INR < 1.5 after skipping 5 doses.[1]
£ Patients receiving dabigatran 75 mg twice daily.
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CONTINUED FROM PREVIOUS PAGE…
∂ Patients receiving rivaroxaban 15 mg daily.
ŧ Patients receiving edoxaban 30 mg daily.
¶ Assuming minimal platelet effect by 7-days, and no effect by 10-days for irreversible inhibitors: aspirin, ticlodipine, clopidogrel, and prasugrel. Ticlodipine drug clearance is prolonged by an additional 4-days after repeated dosing.[50] For reversible inhibitors, ticagrelor, vorapaxar, and cilostazol, half-life depends on rate of drug clearance.
≠ Platelet function may remain abnormal for up to 7 days post infusion.
Δ 5-days per manufacturer,[59] drug effect may persist up to 10 days.
¥ 7-days per manufacturer,[52] drug effect may persist up to 10 days.
¢ 5-days per manufacturer,[53] shorter interval expected based on half-life.
ŧ Patients receiving edoxaban 30 mg daily.

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These guidelines are endorsed by the following BIDMC Departments and Committees:

Pharmacy and Therapeutics
Interventional Procedure Committee
Department of Emergency Medicine
Department of Anesthesia
Department of Dermatology
Department of Medicine
Department of Neurosurgery
Department of Neurology
Department of Orthopedics
Department of Radiology
Department of Urology
Department of Surgery

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Version 2. Approved 08/09
Version 3. Approved 11/09
Version 4. Approved 01/11
Version 5. Approved 09/13
Version 5. Approved 06/14
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