

Periprocedural Antithrombotic Management: A Review of the Literature and Practical Approach for the Hospitalist Physician

Russell Vinik, MD^{1,2}
Nathan Wanner, MD^{1,2}
Robert C. Pendleton, MD^{1,2}

¹Department of Internal Medicine, General Medicine Hospitalist Group, University of Utah, Salt Lake City, Utah.

²University Healthcare Thrombosis Service, University of Utah, Salt Lake City, Utah.

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Many patients who are on long-term antithrombotic therapy (e.g. warfarin and/or antiplatelet agents) must be assessed for temporary discontinuation for a procedure or surgery, making this a salient topic for the hospitalist physician.

Discontinuation of antithrombotic therapy can place patients at increased risk of thromboembolic complications while continuing antithrombotic therapy can increase procedure-related bleeding risk. Bridging anticoagulation with heparin or low molecular weight heparins is often used in the periprocedural period, but a great deal of uncertainty exists about how and when to use bridging anticoagulation. Because there is very little Level 1 evidence to define optimal care, both clinical practice and expert consensus guideline opinions vary. For the hospitalist, it is of critical importance to understand the available data, controversies, and management options in order to approach patient care rationally. This review provides a step-wise literature-based discussion addressing the following four questions: (1) What is the optimal management of antiplatelet therapy in the periprocedural period? (2) Are there very low bleeding risk procedures that do not require interruption of oral anticoagulation? (3) Are there low thromboembolic risk populations who do not require periprocedural bridging? (4) How do you manage patients who must discontinue anti-coagulants but are at an increased thrombotic risk?

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The management of patients on long-term antithrombotic therapy (vitamin K antagonists [VKA] or antiplatelet agents) who may require temporary disruption for an invasive procedure is challenging. Management is controversial due to methodologically limited prospective data and varied consensus opinions. Yet periprocedural anticoagulation management is a commonly encountered clinical problem. It is estimated that there are 2.5 million patients on long-term VKA therapy in North America¹ and 41% of the U.S. population over age 40 years is on antiplatelet therapy.² Further, the need for temporary disruption of these therapies for an invasive procedure is frequent. As an example, in 1 European study, approximately 15% of patients on long-term VKA required a major surgical procedure in 4 years of follow-up.³ The role of the hospitalist physician in managing these patients is increasing as hospitalists care for an increasing number of surgical patients and provide periprocedural consultation both in and out of the hospital. Therefore, it is imperative for the hospitalist physician to be proficient in making thoughtful and individualized recommendations on the appropriate management of periprocedural anticoagulants, drawing from the available literature and evidence-based practice guidelines. Importantly, the Society of Hospital Medicine has cited perioperative management as an important core competency.⁴

The hospitalist physician is likely to encounter numerous periprocedural scenarios, including the management of

antiplatelet agents, identifying low bleeding risk procedures wherein interruption of anticoagulants is unnecessary, and recognizing patients with a low short-term thromboembolic risk where anticoagulants can be disrupted without the need for heparin or low molecular weight heparin (LMWH) in the periprocedural period (defined as bridging therapy). Further, all other clinical scenarios require both a careful individualized assessment of the patient's risk of periprocedural bleeding and thromboembolism and a thoughtful discussion with all involved parties. This discussion may involve the person performing the procedure, the anesthesiologist, and the patient. The purpose of this work is to explore these relevant areas through a review of the literature with a particular focus on the recently published 2008 American College of Chest Physicians (ACCP) evidence-based clinical practice guidelines.

We reviewed medical literature from 1990 through May 2008 with the following key words: "bridging," "anticoagulation," "perioperative," "antiplatelet," "heparin," and "low molecular weight heparin." Individual studies were then independently reviewed by the authors. Studies that were felt relevant to a hospitalist physician were retrieved and reviewed. If there was uncertainty regarding applicability to a hospitalist setting, a second author's opinion was rendered. Additionally, we reviewed 1 author's personal reference list of articles relating to periprocedural anticoagulation that has been compiled over the past 10 years. This list

and the reference lists of retrieved articles were also reviewed. Data were summarized to answer 4 clinically relevant questions:

1. What is the optimal management of antiplatelet therapy in the periprocedural period?
2. Are there very low-bleeding risk procedures that do not require interruption of oral anticoagulation?
3. Are there low thromboembolic risk populations who do not require periprocedural bridging?
4. How do you manage patients who must discontinue anti-coagulants but are at an increased thrombotic risk?

Clinical Question #1: What Is the Optimal Management of Antiplatelet Therapy in the Periprocedural Period?

The optimal management of oral antiplatelet therapy in the periprocedural period is not well studied. Most reviews, expert recommendations, and consensus statements either do not comment on periprocedural antiplatelet management or recommend the routine discontinuation of therapy at least 7 days prior to surgery.^{3,5,6} However, as the 2008 ACCP guidelines highlight, the recommendation to routinely discontinue antiplatelet therapy 7 days prior to the procedure is an oversimplification.¹ In the era of both bare metal cardiac stents and drug-eluting stents, the optimal management of these patients requires that 2 primary questions be asked: (1) Is this a low-bleeding risk procedure whereby antiplatelet therapy can be continued? (2) Does the patient have a coronary stent whereby the continuation of antiplatelet therapy or delay of the intervention is necessary?

In the context of ongoing aspirin therapy, certain procedures have a low risk of significant hemorrhagic complications. These low bleeding risk procedures include cataract surgery, cutaneous surgery, oral surgery, and endoscopic procedures, including those with mucosal biopsies.⁷⁻¹⁰ Patients undergoing these procedures may safely continue low dose aspirin therapy, especially if they have a high-risk indication for their aspirin such as recent myocardial infarction, stroke, or the presence of a coronary stent.^{5,7-10} Whether these procedures can be safely performed in the setting of a thienopyridine or combination antiplatelet therapy is uncertain.

In the past several decades, the management of obstructive coronary artery disease has undergone a major evolution. Placement of coronary stents has become commonplace, and there are now several million patients with drug-eluting stents.¹¹ The major complication of these devices is stent thrombosis, which results in death or myocardial infarction in up to 64% of patients.¹² Fortunately, dual antiplatelet therapy (aspirin and a thienopyridine such as clopidogrel) markedly reduces this risk.¹³ Current guidelines recommend using combination antiplatelet therapy for at least 4 to 6 weeks and ideally up to 12 months after placement of a bare metal stent and at least 12 months after placement of either a sirolimus- or paclitaxel-eluting stent.^{1,14} During this period of dual antiplatelet therapy, the premature discontinuation of the thienopyridine may be

catastrophic. To guide clinicians in managing these patients in the periprocedural period, recent consensus guidelines recommend the following:^{1,12}

1. In patients who are expected to need an invasive surgical procedure in the next 12 months, consideration should be given to avoiding drug-eluting stents.
2. Elective procedures which have an increased risk of bleeding should be deferred for at least 6 weeks after bare metal stent implantation and 12 months after drug-eluting stent implantation.
3. For patients undergoing a surgical procedure within 6 weeks of bare metal stent implantation and 12 months of drug-eluting stent implantation, continuation of aspirin and clopidogrel is recommended. If bleeding risk prohibits this, then a cardiologist should be consulted.
4. In patients with a drug-eluting stent who need to undergo a procedure whereby the thienopyridine needs to be discontinued, aspirin should be continued if at all possible, and the thienopyridine should be resumed as soon as possible after the procedure. It may be reasonable to consider a loading dose of clopidogrel, up to 600 mg, in this setting, although prospective supportive data is lacking.¹

It is important to recognize that delayed stent thrombosis is now reported well beyond 1 year after drug-eluting stent implantation, and that there may not be a diminution in risk after the initial 12 months.¹⁵⁻¹⁷ Until additional data is available, it seems prudent, if possible, to at least continue aspirin in the periprocedural period in these patients. If bleeding concerns obviate this, then antiplatelet therapy should be discontinued and resumed as soon as possible.

For patients on chronic antiplatelet therapy who do not have a cardiac stent and who are not undergoing a low-bleeding-risk procedure, the risks and benefits of the continuation or discontinuation of antiplatelet therapy in the periprocedural period are uncertain as absolute risks in the periprocedural period have not been well studied. Relative risks/benefits, however, can be estimated from prior studies. Aspirin leads to an approximate 25% relative risk reduction in cardiac or thrombotic event rates compared to placebo.^{14,18} Although important, the absolute benefit of 1 week of therapy (vs. no therapy during the periprocedural period) is estimated to be small. The small absolute benefit of continued aspirin therapy may be offset by an increase in significant bleeding events. Although, not well studied, continued aspirin increases significant bleeding by 50% with absolute event rates varying by type of procedure.⁸ In some procedures, such as intracranial surgery or transurethral prostatectomy, this bleeding risk is prohibitive. For others, the risk may be modest and the decision to continue vs. discontinue aspirin therapy may be at the discretion of the person performing the procedure. In general, for most patients who do not have a coronary stent and have not had a recent (past 3 months) myocardial infarction or stroke, discontinuation of antiplatelet therapy 7 to 10 days prior to the procedure seems prudent. The primary

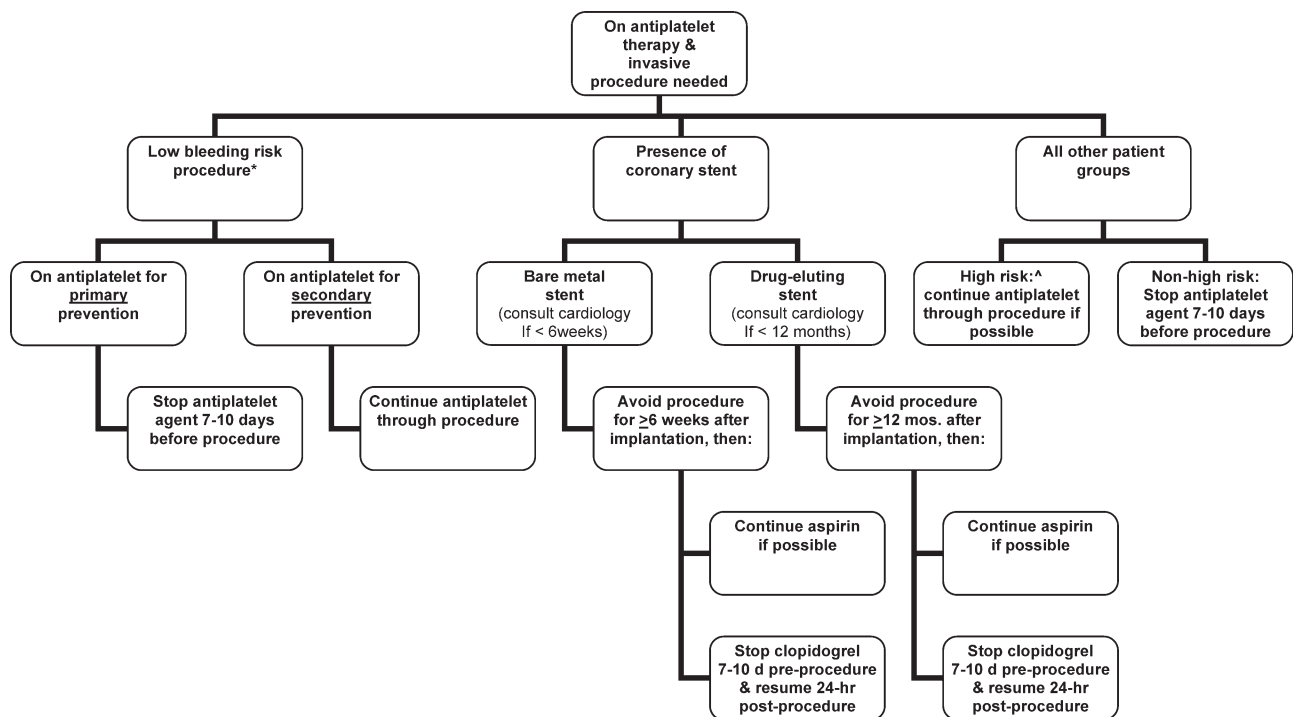


FIGURE 1. A management algorithm of antiplatelet therapy in the periprocedural period. The optimal management of antiplatelet agents in the periprocedural period is not well studied. This algorithm draws from available evidence and is consistent with recent practice guidelines by the American College of Chest Physicians¹ and the American Heart Association.¹⁴ *Low-bleeding-risk procedures include cutaneous, endoscopic, and oral surgery. ^High-risk indications for antiplatelet therapy include a recent cardiac event or stroke (past 3 months) or the need for percutaneous coronary intervention or coronary artery bypass surgery.

exceptions are patients who are undergoing percutaneous coronary intervention or coronary artery bypass grafting. For these procedures continuing aspirin is recommended.¹ Figure 1 outlines a proposed management strategy based upon available evidence and guidelines.

Clinical Question #2: Are There Very-Low-Bleeding-Risk Procedures That Do Not Require Interruption of Oral Anticoagulation?

Some procedures are associated with a low-enough risk of bleeding that it is safe to proceed without interrupting VKA anticoagulation. This approach spares the risk and cost that occur with the holding of oral anticoagulants and institution of bridging therapy. When considering this strategy, it is important that the specialist performing the procedure is included in the discussion. Dental, dermatologic, and cataract procedures are common outpatient procedures that are associated with low bleeding risk. The relative safety of these procedures in patients who are anticoagulated is discussed thoroughly in the ACCP guidelines.¹ Other low-bleeding-risk procedures for which a hospitalist may be consulted include certain endoscopic procedures, paracentesis, central venous catheter placement, and arthrocentesis.

The American Society for Gastrointestinal Endoscopy has published guidelines recommending that anticoagulation

can be safely continued in patients undergoing the following endoscopic procedures with a low bleeding risk: esophago-gastroduodenoscopy (EGD), flexible sigmoidoscopy, and colonoscopy, all with or without mucosal biopsy; enteroscopy, biliary/pancreatic stent placement, endoscopic ultrasound without biopsy, and endoscopic retrograde cholangiopancreatography (ERCP) without sphincterotomy.¹⁹ Conversely, high-risk procedures for which interruption of anticoagulation is recommended include polypectomy, biliary sphincterotomy, variceal treatment, percutaneous endoscopic gastrostomy (PEG) placement, dilation of strictures, and endoscopic ultrasound-guided fine-needle aspiration.

Limited data suggest that paracentesis, central venous catheter placement, and arthrocentesis may be safe to perform in the setting of anticoagulation. For patients undergoing paracentesis there is little evidence in anticoagulated patients; however, it is probably safe to continue anticoagulation as studies have demonstrated the safety of this procedure in patients with significant thrombocytopenia and coagulopathy.^{20,21} Limited data also supports that central venous catheter placement may be safely performed in the setting of abnormal coagulation tests, although some recommend avoiding the subclavian site due to the risk of hemothorax and the inability to apply adequate compression.^{22–26} With regard to arthrocentesis, multiple authors

have endorsed the idea that joint and soft-tissue aspirations and injections present a low risk of serious bleeding even with anticoagulation.^{27–29} This is supported by limited data.^{30,31}

Other procedures such as lumbar puncture, thoracentesis, and cardiac catheterization are somewhat more controversial in the anticoagulated patient. Anticoagulation should generally be interrupted for lumbar puncture,^{29,32} as 1 study involving patients who were started on heparin immediately after the procedure had a 2% incidence of spinal hematoma and 6.7% major complication rate.³³ With regard to thoracentesis, evidence is very limited, but experts generally

accept that it may be safely performed in patients with mild coagulopathy.^{34,35} One frequently-cited study found no bleeding complications in 57 patients with mild elevation in prothrombin time, which correlated to an International Normalized Ratio of approximately 2.2 or less.³⁶ A recent report also revealed no serious bleeding complications in 33 thoracenteses performed on patients receiving full anticoagulation with warfarin, heparin, and/or low molecular weight heparin.³⁷

Therapeutic anticoagulation has traditionally been felt to be a relative contraindication to cardiac catheterization.^{38,39} In spite of this, several observational studies have suggested it may be safely performed using a standard approach,⁴⁰ using vascular closure devices,⁴¹ or using a radial artery approach instead of the more commonly used femoral site.^{42–44} The small size of these observational reports, the diagnostic rather than therapeutic nature of most cases, the limited use of other antithrombotic and antiplatelet medications, and the experience required to use the transradial approach are all major limitations preventing widespread acceptance of cardiac catheterization in therapeutically anticoagulated patients.

In summary, there are numerous procedures that may be safely pursued in the setting of therapeutic anticoagulation. However, for most of these procedures the data is somewhat limited. As such, it is paramount for the hospitalist physician to recognize these clinical scenarios and to discuss management options with the patient and the person performing the procedure, if applicable.

TABLE 1. CHADS₂ Scoring System

CHADS ₂ Score*	Annual Risk of Stroke (%)
0	1.9
1	2.8
2	4.0
3	5.9
4	8.5
5	12.5
6	18.2

NOTE: CHADS₂ scoring system is a validated risk assessment tool for evaluating the annual stroke risk in patients with atrial fibrillation.⁶⁹

* 1 point each for: congestive heart failure, hypertension, age ≥75 years, and diabetes mellitus; 2 points for stroke/TIA. **Abbreviations:** CHADS₂, congestive heart failure–hypertension–age ≥75 years–diabetes mellitus–stroke/TIA; TIA, transient ischemic attack.

TABLE 2. Summary of Guidelines on Bridging Therapy

Indication for chronic anticoagulation	Estimated Annual Thrombotic Risk Without Anticoagulation	Practice Guideline Preferred Management Recommendations		
		ACCP ⁸¹	ACC/AHA ^{45,46}	British Haematologic Society ¹⁷⁰
Dual prosthetic or older-generation valve	>10%	Bridge	Bridge	Bridge
VTE within 3 months or severe thrombophilia		Bridge	N/A	Bridge
Pregnancy with prosthetic valve		Bridge	Bridge	N/A
Bileaflet valve in the mitral position		Bridge	Bridge	Prophylaxis
Valve with acute embolism <6 months		Bridge	N/A	Bridge
A-fib valvular or CHADS ₂ score 5-6		Bridge	Consider bridging	N/A
Recurrent venous thromboembolism	4-10%	Bridge	N/A	N/A
VTE within 3-12 months or active cancer		Bridge	N/A	Prophylaxis
Bileaflet aortic valve with additional risk factors [‡]		Bridge	Bridge	Prophylaxis
A-fib CHADS ₂ score 3-4		Bridge	Consider bridging	N/A
Bileaflet aortic valve without additional risk factors [‡]	<4%	Prophylaxis or no bridging	No bridging	Prophylaxis
VTE >12 months		Prophylaxis or no bridging	N/A	Prophylaxis
A-fib CHADS ₂ score 0-2 and no previous CVA/TIA		Prophylaxis or no bridging	No bridging	N/A

Abbreviations: ACC, American College of Cardiology; ACCP, American College of Chest Physicians; A-fib, atrial fibrillation; AHA, American Heart Association; CHADS₂, CHF–Htn–age ≥75 years–DM–stroke/TIA (see Table 1); CHF, congestive heart failure; CVA, cerebrovascular accident; DM, diabetes mellitus; Htn, hypertension; N/A, not applicable; TIA, transient ischemic attack; VTE, venous thromboembolism.

* ACCP recommends withholding full-dose anticoagulation for 48-72 hours postprocedure in patients at high risk of postoperative bleeding.

[†] Extrapolated from the British Committee for Standards in Haematology.

[‡] Risk factors: A-fib, prior stroke or TIA, Htn, DM, CHF, age >75 years.

TABLE 3. Summary of Key Bridging Studies

Author ^{Reference} /Study Type	Number of Patients	Patient Population	Type of Procedure	Bridging Strategy	Major Bleeds	Minor Bleeds	TE Rate
Turpie and Douketis ⁶² /single arm cohort	174	66% aortic valve; 34% mitral or dual prosthetic valve	Not specified	Enoxaparin 1 mg/kg twice daily	2.3%	Not specified	None
Kovacs et al. ⁶¹ /single arm cohort	224	Prosthetic heart valves or a-fib plus 1 major risk factor	67 surgical; 157 nonsurgical	Preoperative bridging with dalteparin 200 IU/kg daily; dose reduced to 100 IU/kg on postoperative day -1; restarted at 100 IU/kg on POD 1; dose reduced to 5000 IU daily if high risk for bleeding	6.7%; 8/15 occurred intraoperatively or <6 hours postoperatively; 2/15 occurred after 4 weeks	Not specified	3.6%; 6/8 episodes occurred after warfarin held secondary to thrombotic episodes judged to be due to cardioembolism
Douketis et al. ⁵⁹ /prospective registry	650	A-fib 58%; mechanical heart valve 33%	251 surgical; 399 nonsurgical	Dalteparin 100 IU/kg twice daily; held after high bleeding risk procedure and patients with poor hemostasis	0.92%	5.9%	0.6%
Spyropoulos et al. ⁶² /prospective registry; 14 centers in United States and Canada	901	UFH: 40% mechanical valves, 33% a-fib; LMWH: 24% mechanical valve, 40% a-fib	394 surgical; 507 nonsurgical	LMWH mostly given twice daily 80%; UFH 20%	5.5% UFH; 3.3% LMWH	9.1% UFH; 12.0% LMWH	2.4% UFH; 0.9% LMWH
Dunn et al. ⁶⁶ /prospective cohort	260	A-fib 68% or prior DVT 37% (excluding prosthetic heart valves)	105 surgical; 145 nonsurgical	Enoxaparin 1.5 mg/kg daily	3.5% overall; minor surgery/procedures 0.9%; major surgery 28% group	42%	1.9%; 1/5 events occurred after bleeding led to withdrawal of AC
Omran et al. ⁷¹ /prospective registry	779	Various indications	Major and minor procedures	All patients bridged with enoxaparin; moderate TE risk 1 mg/kg daily; high TE risk 1 mg/kg twice daily	0.5%; all in high-risk group	5.9%	0
Garcia et al. ⁷¹ /prospective, observational cohort of 101 sites in United States	1024 patients with 1293 interruptions of AC	A-fib 53%; VTE 14%; prosthetic valve 13%	Outpatient procedures only	At discretion of provider. Bridging performed in 8.3% of interruptions; 3% a-fib, 10% VTE, and 29% mechanical valves	0.6%; 4/6 patients with major bleed received bridging	1.7%; 10/17 patients with minor bleed received bridging	0.7%; no events in patients who were bridged
Wysokinski et al. ⁶⁴ /prospective cohort	345 consecutive patients undergoing 386 procedures	100% nonvalvular a-fib	Major and minor surgeries/procedures	Individualized in AC clinic; 52% of patients bridged	2.7%; no difference whether patient received bridging or not	3.0%; 10/11 occurred in bridged patients	1.1%; no difference in bridged vs. nonbridged patients

NOTE: Studies included are prospective cohort studies with at least 150 patients and registries with greater than 500 patients in which consecutive patients were followed for postintervention outcome assessment.

Abbreviations: AC, anticoagulation; a-fib, atrial fibrillation; bid, twice daily; DVT, deep venous thrombosis; IU, anti-Xa activity in International Units; LMWH, low molecular weight heparin; POD, postoperative day; TE, thromboembolism; UFH, unfractionated heparin; VTE, venous thromboembolism.

Clinical Question #3: Are There Low-Thromboembolic-Risk Populations Who Do Not Require Periprocedural Bridging?

Although it has previously been noted that there is a wide variation of opinion on when and how to perform periprocedural bridging, it is generally agreed that in the following conditions the risk of thrombosis is low enough that bridging with full dose heparin or LMWH is not necessary.^{1,5,45–49}

1. Atrial fibrillation without previous stroke or transient ischemic attack (TIA) and no more than 2 additional thrombotic risk factors on the CHADS₂ scoring system (Table 1).
2. A single venous thromboembolic event that occurred greater than 12 months ago with no ongoing risk factors such as active malignancy, high risk thrombophilia, or the antiphospholipid antibody syndrome.
3. Bileaflet aortic valve without the presence of additional risk factors (ie, patients <75 years of age with the absence of atrial fibrillation, prior stroke or transient ischemic attack, hypertension, diabetes, or congestive heart failure).

Clinical Question #4: How Do You Manage Patients Who Must Discontinue Anticoagulants But Are at an Increased Thrombotic Risk?

When anticoagulation must be held and the patient does not have a very low thromboembolic risk, a decision of whether or not to use bridging anticoagulation must be made. The current ACCP guideline gives grade 1C and 2C recommendations (evidence from observational studies, case series, or controlled trials with serious flaws) regarding for whom and how to implement bridging.¹ The grade “C” designation is due to a lack of high-quality randomized clinical trials. As such, the clinician must carefully consider an individual patient’s estimated thromboembolic risk, procedurally-related bleeding risk, patient-related bleeding risk factors, and the patient’s values regarding concerns of thromboembolism or bleeding. In these situations it is also imperative that the person performing the procedure is involved in the risk-to-benefit discussion.

When evaluating an individual patient’s risk of thromboembolism, clinicians sometimes estimate the perioperative risk by prorating the annual incidence of thromboembolic complications to the few days that anticoagulation is withheld.⁶⁷ Making this extrapolation discounts the effect of a potential increase in thromboembolic risk induced by surgery. As an example, an average patient with atrial fibrillation who has a 5% predicted annual stroke rate would be estimated to have a stroke risk of 0.05% if they are not anticoagulated for 4 days. However, studies have shown that the actual rate of perioperative thromboembolism is approximately 1%.¹ With these limitations and uncertainties in mind, and until there is better prospective outcomes data, we must consider *relative* risks in the context of absolute event rate estimates when deciding a perioperative anticoa-

TABLE 4. Low Molecular Weight Heparin Dosing Regimens Evaluated in Periprocedural Management Studies

Low Molecular Weight Heparin	Subcutaneous Dose
Dalteparin	
Low dose (prophylaxis dose)	5,000 IU once daily
Full dose	100 IU/kg twice daily or 200 IU/kg once daily
Enoxaparin	
Low dose (prophylaxis dose)	30 mg twice daily or 40mg daily
Full dose	1 mg/kg twice daily or 1.5 mg/kg once daily
Tinzaparin (full dose)	175 IU/kg once daily

Abbreviation: IU, anti-Xa activity in International Units.

gulant management plan. The estimated annual incidence of thrombosis without anticoagulation for various indications and the current guideline recommendations are presented in Table 2.

In addition to thromboembolic risk, we must also consider the bleeding risk associated with the procedure/surgery. Importantly, therapeutic heparin started early in the postoperative period is associated with major bleeding event rates as high as 10% to 20%.^{1,50} Once a major bleeding event occurs, this will often lead to an extended interruption of anticoagulant therapy, placing the patient at a more prolonged risk of an associated thromboembolic event. For this reason, the resumption of full-dose anticoagulation with LMWH/heparin should be delayed for at least 48 hours in most patients undergoing a surgery or procedure associated with an increased risk of bleeding. Examples of these “higher-bleeding-risk” procedures include major thoracic surgery, intracranial or spinal surgery, major vascular surgery, major orthopedic surgery, urologic surgery involving the bladder or prostate, major oncologic surgery, reconstructive plastic surgery, colonoscopy with associated polypectomy, renal or prostate biopsies, and placement of a cardiac pacemaker/defibrillator.^{1,51–57}

Taken together, these uncertainties surrounding thromboembolic and bleeding risk estimates imply that there are multiple options for periprocedural management. Several studies, many of which included patients with mechanical heart valves, have shown similar safety and efficacy between LMWH and intravenous (IV) unfractionated heparin.^{58–64} Table 3 summarizes these studies. The ACCP recommends bridging with LMWH over IV unfractionated heparin due to equal efficacy and cost savings with LMWH.¹ When bridging is used, careful attention must be given to the timing and dose of anticoagulation in both the preoperative and postoperative periods. Table 4 lists dosing of commonly used LMWHs in North America. When using LMWHs in the pre-procedural setting it is important to note that unacceptably high levels of anticoagulation remain present when a patient is given a full once-daily LMWH dose the morning prior to the procedure or when a full-dose, twice-daily LMWH dose

- Step 1** Evaluate indication for VKA and the type of planned surgery/procedure.
- Step 2** If the planned procedure is **very low bleeding risk** (see text) and the person performing procedure agrees then proceed without interrupting VKA.
- Step 3** If patient has a **relatively low thromboembolic risk** (see text) then:
 - Stop VKA therapy 5-6 days pre-procedure
 - Resume VKA post-procedure when hemostasis achieved.
- Step 4** For all others: evaluate the **relative risk of bleeding and thromboembolism**, the **patient's preferences/values** and the **proceduralist's perspective** to determine if bridge therapy is appropriate.
- Step 5** If bridging therapy is planned, recommendations include the following:

Time from procedure	Action:
- 5 to 6 days	Stop VKA
- 3 to 4 days	Start LMWH (if creatinine clearance <30ml/min use unfractionated heparin).
- 24 hr	Check INR & if >1.5, give 1-2mg oral vitamin K Last dose of LMWH in a.m.(1/2 dose if once daily regimen used)
0	If on heparin infusion, stop 4-hours pre-procedure.
+ 12-24 hr	Resume VKA if hemostasis achieved.
+ 24 hr	Timing & dose of LMWH/heparin dependent on risk/benefit: <ul style="list-style-type: none"> • High TE risk, low bleeding risk: <i>Full dose LMWH/heparin</i> • High TE risk, high bleeding risk: <i>None or low dose</i> • Moderate TE risk, high bleeding risk: <i>None or low dose</i> • Moderate TE risk, low bleeding risk: <i>Low or full dose</i>
+ 2-3 days	Reevaluate LMWH/heparin dose. If none or low dose initially chosen and no bleeding, then consider increasing from none to low-dose or from low dose to full-dose LMWH.
+ ≥4 days	Stop LMWH/heparin once INR at goal

LMWH- Low Molecular Weight Heparin
TE- Thromboembolic
INR- International Normalized Ratio

FIGURE 2. A 5-step approach to the periprocedural evaluation and management of patients receiving chronic vitamin K antagonist (VKA) therapy.

is given the evening prior to the procedure.^{65,66} For this reason, the ACCP recommends administering the last preoperative dose 24 hours before surgery and if full-dose once-daily LMWH is used, the dose should be decreased by one-half on the day before the surgery in order to ensure that no residual anticoagulant effect remains at the time of surgery.

In the postprocedural setting, timing and dose of anticoagulant is important, as major bleeding with the use of therapeutic anticoagulation can occur in up to 10% to 20% of cases. When restarting anticoagulation after the procedure, it is important to evaluate intraoperative hemostasis and to consider patient-related factors that may further increase bleeding risk. These include advanced age, concomitant antiplatelet or nonsteroidal antiinflammatory medications,

renal insufficiency, placement of spinal/epidural catheter, worsening liver disease, or the presence of other comorbid illnesses such as cancer.^{30,67,68} The ACCP recommends withholding full-dose anticoagulation for at least 48 to 72 hours in patients who are felt to be at a high risk for postoperative bleeding.¹ Figure 2 is a proposed management approach to the use of bridging anticoagulants that is consistent with the 2008 ACCP recommendations.

CONCLUSION

The evaluation and management of patients on long-term antiplatelet or VKA therapy who require an invasive procedure or surgery is a common, complicated, and controversial area. Importantly, it is an area in which the hospitalist

physician must be adept. Although there remain many unanswered clinical questions, an evolving literature base and recent practice guidelines can help guide management decisions.

Address for correspondence and reprint requests:

Russell Vinik, MD, University of Utah, Department of Internal Medicine, 50 North Medical Drive, Room 4B120, Salt Lake City, UT 84132; Telephone: 801-581-7818; Fax: 801-585-9166; E-mail: russell.vinik@hsc.utah.edu Received 12 August 2008; revision received 4 February 2009; accepted 8 February 2009.

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