Bridging Anticoagulation

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KEYWORDS

• Bridging anticoagulation • Perioperative interruption in warfarin • Risk stratification • Heparin

HOSPITAL MEDICINE CLINICS CHECKLIST

1. Review the planned procedure or surgery to characterize the bleeding risk and determine if interruption in anticoagulation is required.
2. If interruption in anticoagulation is required, risk-stratify the patient according to their risk of thromboembolic events.
3. For high-risk patients, offer bridging anticoagulation with either unfractionated heparin (UFH) or low molecular weight heparin (LMWH) around the time of surgery.
4. For low-risk patients, bridging may be deferred.
5. Moderate-risk patients will require a discussion as to the risks and benefits of bridging anticoagulation based on patient preferences, the particular bridging agent to be used, and the planned surgery or procedure.
6. Warfarin should be held 5 days before the planned surgery to allow the international normalized ratio (INR) to normalize.
7. Introduce bridging anticoagulation when the INR falls below the therapeutic range or if INR monitoring not practical 3 days before surgery.
8. The last dose of LMWH should be administered no sooner than 24 hours before the planned surgery or procedure. In the case of UFH, the infusion should be discontinued approximately 4 to 5 hours before the surgery or procedure.

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9. Following the procedure, resume warfarin within 12 to 24 hours, and LMWH or UFH in 24 to 72 hours depending on the bleeding risk associated with the particular surgery or procedure.
10. Discontinue the bridging agent once the INR has returned to the therapeutic range on 2 consecutive measurements at least 24 hours apart.

DEFINITIONS

What is bridging anticoagulation?

Bridging anticoagulation is the use of a short-acting anticoagulant such as unfractionated heparin (UFH) or low molecular weight heparin (LMWH) in place of warfarin when interruption of anticoagulation is required for either a surgical or procedural reason. It is also applied to the use of a rapid-acting anticoagulant during the initiation of anticoagulation with warfarin before the patient has achieved a therapeutic international normalized ratio (INR) level, and to the management of subtherapeutic INR values during chronic warfarin therapy. For the purposes of this review, the authors begin with a discussion of why bridging is sometimes required and the use of bridging anticoagulation on initiation of chronic warfarin therapy, but focus mostly on periprocedural bridging anticoagulation. Of note, bridging is not generally required with the newer oral factor Xa inhibitors (such as rivaroxaban or apixaban) or direct thrombin inhibitors (such as dabigatran) because of their rapid onset and offset.

EPIDEMIOLOGY

How often is bridging anticoagulation utilized?

The clinical conundrum of whether to bridge patients planned for long-term treatment with oral anticoagulation is a common one that providers must confront on an almost daily basis. An estimated 2 to 3 million people take warfarin regularly in the United States, with approximately 10% of these patients requiring a temporary interruption in warfarin therapy for purposes of a procedure or surgery each year.[1]

PHYSIOLOGY OF WARFARIN

Why is bridging a potential need with warfarin therapy?

The need for bridging anticoagulation is rooted in warfarin's pharmacokinetics and mechanism of action. Warfarin acts by competitively disrupting the binding of vitamin K, interfering with the production of vitamin K–dependent clotting factors (II, VII, IX, X), and antithrombotic factors (protein C and protein S). Consequently, when warfarin therapy is first started or is resumed after a period of interruption, existing clotting factors must gradually be consumed before therapeutic anticoagulation can be achieved. This time frame can vary based on a patient's genetics, other medications, and dietary intake of vitamin K, and typically lasts for several days. During this period patients are at risk for thrombosis, and an additional bridging anticoagulant is often used until warfarin exerts a therapeutic effect.

There is also the potential for increased hypercoagulability while warfarin is initiated, further adding to the risk of thrombosis and potential need of bridging anticoagulation,

because the rate at which the vitamin K–dependent factors are depleted varies among the factors. Specifically, factor II, IX, and X have relatively longer half-lives so that existing factors are depleted more slowly, whereas factor VII and protein C have shorter half-lives and are thereby depleted more quickly. The result is that during the initial period of warfarin treatment, laboratory testing may show an increased INR but the patient may still be hypercoagulable. This situation arises for several reasons. First, relatively rapid depletion of factor VII contributes to INR elevation in vitro. Second, rapid depletion of protein C and incomplete depletion of factors II, IX, and X shifts the balance toward relative hypercoagulability in vivo.[2] It is for this reason that a period of overlap with 2 consecutive INR measurements in the therapeutic range, and separated by at least 24 hours, is desirable before removal of the bridging agent to ensure that adequate depletion of clotting factor has been achieved.

INITIATION OF WARFARIN THERAPY

When initiating long-term anticoagulation with warfarin, under what circumstances is bridging required?

The decision to offer bridging anticoagulation when starting a patient for the first time on long-term anticoagulation begins with addressing the indication for anticoagulation. For patients with newly diagnosed venous thromboembolism (VTE), bridging anticoagulation is appropriate if the patient is a candidate for long-term anticoagulation with warfarin. Exceptions to this are if the patient is being considered for thrombolysis, as in the case of a massive pulmonary embolism (PE) or certain patients with submassive PE, or possibly if treatment with an oral factor Xa inhibitor or oral direct thrombin inhibitor is planned. If long-term therapy with warfarin is desired, a decision must be made about use of UFH, LMWH, or fondaparinux until warfarin can become therapeutic. UFH offers the advantage of a shorter half-life if there is concern for bleeding, and can be safely used in patients with significant renal insufficiency, but requires intravenous administration and hospitalization. LMWH has the advantage of producing a consistent anticoagulant effect, which negates the need for frequent laboratory monitoring. It is also administered subcutaneously, making outpatient bridging anticoagulation a possibility. Bridging anticoagulation is continued for at least 5 to 7 days while warfarin is administered concurrently until the INR reaches the desired therapeutic range on 2 consecutive measurements 24 hours apart.[3]

In patients with newly diagnosed nonvalvular atrial fibrillation, the decision to offer bridging anticoagulation can be more patient specific. In general, if a patient is considered to be a candidate for long-term treatment with warfarin and at high risk of stroke, offering bridging anticoagulation is reasonable but not required.[4] In the outpatient setting, this is typically done with LMWH or fondaparinux. For moderate-risk patients the treatment decision can be individualized. In addition, if patients are being considered for a trial of cardioversion, initiation of bridging anticoagulation is generally recommended.[4]

For patients with newly implanted mechanical valves, use of bridging anticoagulation will generally be required, but is managed in accordance with the patient's surgical risk of bleeding and is outside the purview of this review.

INTERRUPTION FOR PROCEDURES AND SURGERY

How should warfarin be managed when anticoagulation must be held for surgery or a procedure?

Patients on chronic anticoagulation with warfarin frequently require interruption in treatment for purposes of elective and nonelective surgeries or procedures. Each of these patients will require consideration as to the need for bridging during this period.

APPROACH TO RISK STRATIFICATION ACCORDING TO RISK OF BLEEDING AND STROKE

What is the proper approach to determining if bridging anticoagulation is required?

Determining whether bridging anticoagulation is indicated requires an understanding of a patient's risk of thromboembolism, and the bleeding risk associated with the planned surgery. Risk of thrombosis is typically higher in the postoperative period than would otherwise be predicted based on a patient's baseline risks, because of endothelial damage relating to the surgery, the reduced mobility that many patients experience postoperatively, and the potential prothrombotic quality to warfarin initiation as described previously. For venous thrombosis, there may be as much as a 100-fold increase in the risk of thrombosis compared with baseline. The risk is also higher for arterial thrombosis, as patients with atrial fibrillation have higher than anticipated rates of postoperative stroke than would be expected from their $CHADS_2$ score alone.[5,6] As such, the postoperative period carries a particularly high risk of thrombosis.

At the same time, the use of bridging anticoagulation is balanced by increased risk of bleeding, including surgical-site bleeding, and the need for repeat surgical exploration. These risks are generally surgery specific and must be weighed against the risks of thrombotic events associated with interruption in anticoagulation. In addition, introduction of UFH or LMWH includes the potential for medication side effects, such the development of heparin-induced thrombocytopenia (HIT) with heparin agents or reversible liver injury as can occur with LMWH.

Practitioners also should account for patient preferences relating to risk avoidance, historical practice patterns, and preferences of the proceduralist or surgeon. Ultimately, practitioners should consider the following questions to determine whether bridging is needed:

- What is the surgery-related bleeding risk and is warfarin interruption required?
- If interruption is required, should bridging anticoagulation be offered?
- If interruption is required, how should warfarin be managed during this period?
- If bridging is indicated, what agent should be used and how should it be managed?

What is the surgery-related bleeding risk, and are there circumstances when warfarin interruption is not required?

Risk of bleeding around the time of a procedure or surgery is most closely related to the type of surgery being undertaken. Unfortunately, there is no well-validated prediction tool to estimate surgery-related bleeding risk, and as a consequence procedures are often grouped into categories of high or low risk. For most surgeries, including cardiothoracic surgery, intra-abdominal surgery, and neurosurgery, interruption of anticoagulation is typically required, as these are surgeries with high bleeding risk. However, there is a growing body of evidence that for a group of procedures with low bleeding risk, interruption of anticoagulation is not necessary. The full list of procedures for which therapeutic anticoagulation with warfarin may be safely continued under most circumstances is presented in **Box 1**. Some of these are discussed in more detail herein. In each case, the INR should be tapered to the lower part of the therapeutic range. The patient should also have an INR checked in the period shortly before surgery to ensure that there is no excessive bleeding risk; if the INR is

Box 1
Procedures for which warfarin can be safely continued under most circumstances

- Arthrocentesis
- Bone marrow biopsy
- Cardiac catheterization (if semiurgent)
- Cataract surgery
- Minor dermatologic surgery
- Diagnostic endoscopy (with or without biopsy)
- Pacemaker/implantable cardioverter-defibrillator implantation in patients at high thrombotic risk
- Venography
- Minor dental procedures

significantly more than 2.0, the procedure should be delayed or a small dose of vitamin K may be given to certain patients.

Many dermatologic procedures may be conducted without interruption in anticoagulation. Most studies examining risk of bleeding with warfarin and dermatologic procedures have had significant methodological limitations, but 2 prospective trials have examined the risk of bleeding in patients undergoing a range of dermatologic procedures. The first, published in 2002, examined minor dermatologic procedures and demonstrated an increase in bleeding associated with warfarin therapy. However, a subsequent series of patients undergoing Mohs surgery published in 2004 suggested that these bleeds are typically self-limited and minor in nature.[7,8] As such, based on the balance of evidence most experts now recommend that for minor dermatologic procedures warfarin can be safely continued.[9]

In general, interruption of warfarin is not required for minor dental procedures including tooth extractions and root canals. This guideline is supported by data from 5 randomized trials and a systematic review demonstrating no increase in bleeding among patients who continued on warfarin compared with those for whom warfarin dosing was adjusted.[10] It is recommended that if warfarin is continued, local hemostatic agents such as oral tranexamic acid or additional sutures be used at the time of any dental procedure to ensure appropriate hemostasis. As an alternative, the most recent American College of Chest Physicians (ACCP) guidelines also support the partial interruption of warfarin. In this case, warfarin may be held for 2 to 3 days before the procedure without the introduction of bridging for minor dental procedures.[9]

Cataract surgery is another procedure for which warfarin therapy may be continued. Multiple studies and subsequent meta-analysis have shown that patients treated with warfarin have an increased risk of bleeding, but most bleeds were self-limited and no patients suffered visual impairment as a result of bleeding.[11,12] As such, expert recommendations support continuation of oral anticoagulation without interruption for most cataract surgery.[9] On some occasions cataract surgery may require retrobulbar anesthesia. Although the risk of bleeding is low in this context, reportedly less than 1%, formation of a retrobulbar hematoma may result in blindness, so it is reasonable to be cautious with use of oral anticoagulants and this type of anesthesia.[9]

Current American College of Cardiology and American Heart Association (ACC/AHA) guidelines recommend that warfarin be interrupted for cardiac catheterization

and the INR be allowed to decrease to less than 1.5 if possible. If appropriate, bridging anticoagulation should be offered for these patients (see later discussion on risk stratification).[13] However, for semiurgent and emergent procedures, patients may undergo cardiac catheterization without interruption of therapeutic anticoagulation if no left ventricular or transseptal puncture is required.[13,14] The guidelines make no comment about arterial access (radial vs femoral approach), but generally a radial approach would be preferable in patients who are therapeutically anticoagulated because hemostasis can be achieved more easily at this site.

Lastly, recent data support the continuation of warfarin therapy over the introduction of bridging anticoagulation for high-risk patients undergoing pacemaker or defibrillator implantation. In a study of 681 patients at high thromboembolic risk, those randomized to continue on warfarin had markedly lower rates of pocket hematoma formation compared with the bridging group (3.5% vs 16%). There were no differences in thromboembolism rates or other major complications. The lower bleeding rate with warfarin when compared with bridging was attributed in part to better local hemostatic control at the time of the surgery in patients on anticoagulation at the time of the procedure, whereas patients in the bridging arm were at risk for delayed bleeding when anticoagulation was reintroduced.[15] This result is provocative, emphasizing that bridging anticoagulation carries significant risks and that our understanding of the optimal management of these patients remains limited. Based on these results and previous studies, some experts now suggest that patients undergoing pacemaker or implantable cardioverter-defibrillator implantation for whom interruption of warfarin confers a high risk of thromboembolism should continue on warfarin at the time of the procedure. This approach is preferred over temporary interruption with bridging.[16]

For all other procedures or surgeries, current evidence and expert opinion generally support the interruption of anticoagulation (either with or without bridging) over continuation of warfarin therapy at the time of procedure. For a full list of procedures and their associated risks of bleeding, the reader is referred to the most recent ACCP guidelines.[9]

If interruption of warfarin is required, should bridging anticoagulation be offered?

Any reasoned assessment of the need of bridging anticoagulation must include an evaluation of the thromboembolic risk associated with interruption in anticoagulation. With this in mind, most experts group patients into categories of high, moderate, and low risk for thromboembolism based on their indication for anticoagulation and risk profile (**Table 1**). These categories are then used to determine whether bridging should be offered.

Generally speaking, patients with recent VTE or stroke, a high $CHADS_2$ score ($\geq$5), an implanted mechanical mitral valve replacement, or an older aortic valve replacement are considered to be at high risk. For these patients, bridging anticoagulation should be offered and administered in accordance with the guidelines outlined below. Alternatively, for patients with relatively low risks of thromboembolic events, such as those with a low $CHADS_2$ score ($\leq$2), remote history of VTE, or a bileaflet aortic valve replacement with no other risk factors for stroke, bridging anticoagulation is not required, and will typically only increase the risk of bleeding events without sufficient benefit in terms of reduction of thrombotic risk.

For moderate-risk patients, the decision to bridge needs to be based on patient and provider preferences, as the benefits of bridging anticoagulation in this group are poorly defined, and current guidelines allow significant leeway.[9] As such, for patients who have a strong preference to avoid thrombotic events such as stroke, bridging may

Table 1
Risk of thromboembolic events

Risk Category	Atrial Fibrillation	Mechanical Heart Valve	Venous Thromboembolism
High	$CHADS_2$ score of 5 or 6 Recent stroke/TIA (<3 mo) Concomitant rheumatic valvular heart disease	Any mechanical mitral valve replacement Older aortic mechanical valve replacement (eg, caged-ball, tilting disk) Recent stroke/TIA (<3 mo)	Recent VTE (<3 mo) Severe thrombophilia[a]
Moderate	$CHADS_2$ score of 3 or 4	Bileaflet aortic valve replacement with at least 1 additional risk factor[b]	VTE in previous 3–12 mo Nonsevere thrombophilia History of recurrent VTE Active cancer
Low	$CHADS_2$ score of 0–2	Bileaflet aortic valve replacement without other risk factors[b]	VTE more than 12 mo previously

Abbreviations: TIA, transient ischemic attack; VTE, venous thromboembolism.

[a] Deficiency of protein C, protein S, or antithrombin; antiphospholipid syndrome; homozygous factor V Leiden or prothrombin gene mutation; or multiple thrombophilias.

[b] Age $\geq$75 years, atrial fibrillation, congestive heart failure, hypertension, diabetes mellitus, or stroke/TIA.

Adapted from Spyropoulos AC, Douketis JD. How I treat anticoagulated patients undergoing an elective procedure or surgery. Blood 2012;120(15):2954–62.

be preferred. Patients who place an emphasis on avoiding bleeding, or are uncomfortable with the administration of short-acting anticoagulation for other reasons, may prefer not to receive bridging anticoagulation. The BRIDGE trial, a multicenter randomized trial funded by the National Institutes of Health comparing bridging using the LMWH dalteparin in moderate-risk patients with atrial fibrillation with a nonbridging strategy, is expected to provide further clinical evidence to guide the care of moderate-risk patients. The study is expected to conclude in 2014.[17] For now, the management of moderate-risk patients remains an area with limited available data, and practice patterns may vary widely according to provider and patient preferences.

PHARMACOLOGIC STRATEGIES FOR BRIDGING

If bridging anticoagulation is offered, what agents can be used and how is warfarin cessation managed?

Considerations in managing bridging anticoagulation include when warfarin should be discontinued, when the bridging agent (usually UFH or LMWH) should be started, immediate periprocedural management of the bridging agent, and the timing of reinitiation of the oral agent and discontinuation of the bridging agent.

In elective surgeries, warfarin should be discontinued 5 days before the planned procedure. Although this time frame may be adjusted depending on the degree of elevation of the INR, this is often difficult to manage logistically, and the 5-day period is the default standard. Most patients on chronic warfarin therapy will see a return to a normal INR within this period of time. If a slightly prolonged INR is acceptable for the planned procedure (ie, if the procedure carries a low risk of significant bleeding), the warfarin may be discontinued closer to surgery with the caveat that time to INR normalization is variable. It is best to avoid reversal agents such as vitamin K in elective

surgeries, as their use may result in a prolonged warfarin resistance in the postoperative period, although low-dose oral therapy (eg, 1 mg) may be acceptable in selected cases.

If the need for surgery is more urgent, vitamin K, fresh frozen plasma (FFP), and prothrombin complex concentrates (PCCs) may be used to effect a rapid correction of the INR. Vitamin K, when given in low doses (1–3 mg) intravenously or higher doses orally (2.5–5.0 mg), can normalize a therapeutically elevated INR in 24 to 48 hours. Although the use of vitamin K may lengthen the time necessary for postoperative bridging secondary to acquired warfarin resistance, using low doses of the reversal agent may attenuate this effect. If surgery must be performed immediately in a patient who is anticoagulated with warfarin, intravenous vitamin K (5–10 mg) should be administered along with either a 4-factor or 3-factor PCC plus FFP. A 4-factor PCC is generally preferable because of its ease of use and rapidity with which it can be infused, as well as the decrease in administered volume compared with that necessary with the use of FFP. PCCs and vitamin K, however, should be considered prothrombotic agents, and their use must be carefully considered in those at high risk for thrombosis.

Once the INR drops below the therapeutic range for the patient-specific indication (typically 2.0 for atrial fibrillation and VTE and 2.5 for certain mechanical heart valves), intravenous UFH or subcutaneous LMWH can be administered. There are no data supporting the use of the newer oral anticoagulants (eg, dabigatran, rivaroxaban, apixaban) as a temporary bridging agent to long-term warfarin therapy.

When UFH is used, an aggressive high-intensity protocol with use of boluses may not be necessary, as these protocols are typically designed for use with acute thrombosis, whereby immediate achievement of a therapeutic activated partial thromboplastin time (aPTT) is of critical importance. A “prophylactic” protocol, however, should not be used, and the goal aPTT should be 1.5 to 2 times the control. UFH is continued until 4 to 6 hours before surgery, at which time it is discontinued. Although UFH has the advantage of having its effects dissipate quickly after discontinuation, its utility in this setting is limited by the need for an intravenous line and frequent monitoring of the aPTT, and thus generally requires hospitalization of the patient.

As it does not require monitoring, is administered subcutaneously, and can be given in an outpatient setting, LMWH is frequently used as the bridging agent. Enoxaparin is commonly used for this indication at a dose of 1 mg/kg twice daily, although other agents may be dosed on a daily basis. Because of its prolonged duration of action, when dosed daily the final preprocedure dose of LMWH is usually given the day before the planned surgery at a dose of 50% the usual dose. If dosed twice daily, the usual morning dose the day before surgery is given with omission of the evening dose. LMWH should be used with caution in those with renal disease, and should be avoided in patients with a creatinine clearance of less than 30 mL/min. Although dosing guidelines are available for use in these patients, the renal clearance is variable and its use is best avoided in this situation. The safety of using LMWH for anticoagulation in patients with mechanical heart valves is also controversial. Initial reports suggested an increased risk of thrombosis[18]; however, these cases were likely secondary to underdosing, and the most recent guidelines now suggest that LMWH in therapeutic doses is a reasonable option in this situation.[19] The use of LMWH in pregnant patients with mechanical heart valves is particularly controversial. Although the US Food and Drug Administration specifically states that LMWH has not been adequately studied for use in this situation, most major guidelines describe it as a reasonable option given the teratogenicity of warfarin. If used, the advantages and disadvantages of LMWH should be carefully discussed with the patient, and factor Xa levels should be regularly monitored.

How should postoperative bridging anticoagulation be managed?

Determining the optimal timing of resumption of anticoagulation postoperatively is a balance between the increasing risk of thrombosis without anticoagulation and the high risk of bleeding in the immediate postoperative period. Individual patient and procedural characteristics of thrombotic risk and bleeding risk limit the utility of broad recommendations. In general, however, when the risk of bleeding is modest, bridging anticoagulation may be restarted 24 hours postoperatively. In higher-risk situations such as neurosurgery, anticoagulation may be withheld for 48 to 72 hours before restarting.

Both UFH and LMWH may be used as the postoperative bridging agent regardless of what was used preoperatively. Because it is short-acting and has a well-characterized reversal agent, UFH may be used in cases where the risk of bleeding or the consequences of bleeding are significant. The aPTT should be targeted to a level of 1.5 to 2 times the normal value, although an initial bolus of heparin may be omitted. LMWH in the usual therapeutic dosage is also a reasonable option. Warfarin can generally be restarted 12 to 24 hours after the surgery or procedure, including the evening of the day of surgery (assuming adequate hemostasis has been achieved). Patients may be restarted on their usual warfarin-dosing regimen postoperatively, as dosing patients with arbitrarily high doses of warfarin may increase the risk of a supratherapeutic INR without incurring any benefit. There is, however, some evidence that doubling the usual daily dose for 2 doses postoperatively is safe.[20]

NONPHARMACOLOGIC STRATEGIES FOR BRIDGING

Are any nonpharmacologic strategies available for the bridging period?

There are no nonpharmacologic strategies that can be used during an interruption in anticoagulation to effectively reduce a patient's expected risk of thrombotic events relating to atrial fibrillation or a mechanical valve. For patients with a history of VTE who cannot tolerate bridging anticoagulation there are potential additional strategies, although they should be considered as second-line options rather than primary strategies. For patients who require interruption of anticoagulation for more than a brief (48–72 hours) period, a prophylactic inferior vena cava (IVC) filter can be considered. This action should be undertaken only in select cases, however, with the goal of IVC removal once therapeutic anticoagulation can be resumed. In patients with acute VTE (occurring within a month before surgery), IVC filter placement may also be considered. The risk of recurrent events is relatively high immediately following the initial VTE event, and even a short-term interruption of anticoagulation may be poorly tolerated. There are also no good data to support this approach. In addition, for patients with a remote history of VTE (eg, >1 year) who require hospitalization, nonpharmacologic measures such as early mobilization, pneumatic compression devices, or prophylactic (low-dose) heparin for deep vein thrombosis prophylaxis should be used with the understanding that these will not fully reduce a patient's risk of thrombotic events, but do not carry the same risk of bleeding as therapeutic bridging anticoagulation.

PERFORMANCE IMPROVEMENT

How can hospitalists avoid unnecessary bridging anticoagulation?

Performance improvement in bridging anticoagulation should first focus on identifying patients for whom bridging is not required. This population includes both patients

undergoing a procedure with low bleeding risk whereby anticoagulation can be safely continued, and those patients who carry a low baseline risk and can safely be managed off anticoagulation for a brief period of time. Appropriate identification of these patients is likely to reduce unnecessary costs and interventions, and reduce the length of stay in hospital.

How can hospitalists reduce overutilization of UFH?

In the past, patients with mechanical valves would routinely require admission to the hospital for intravenous UFH any time they required interruption in anticoagulation. Newer valves that carry lower thrombotic risks and the advent of LMWH have reduced the need for this practice. Expert guidelines remain somewhat divided around the safety of LMWH in the perioperative period for patients with mechanical valves. Current ACCP guidelines support the use of either LMWH or intravenous UFH, whereas the older ACC/AHA and the European Society of Cardiology recommend intravenous UFH because it is more easily reversed in the event of bleeding. It should be noted that LMWH is significantly less expensive than UFH. In one study, there was an estimated cost saving of US$3200 per patient bridged using LMWH at home compared with UFH in the hospital.[21] As such, institutions may seek to increase utilization of LMWH in appropriate patients to reduce costs and avoid unnecessary admissions. Because of the convenience, patients are also likely to prefer use of LMWH when possible.

CLINICAL GUIDELINES

Antithrombotic therapy and prevention of thrombosis, 9th ed: ACCP Guidelines, 2012.[22]

ACC/AHA/ESC Guidelines for the management of patients with atrial fibrillation.[23]

ACC/AHA 2008 Focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease.[13]

Canadian Cardiovascular Society guidelines on the use of cardiac resynchronization therapy: implementation, 2013.[16]

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