Preventing VTE in Surgical Patients: An Educational Supplement to a Live, CRM-Based Workshop for Quality Improvement
This supplement is a non-certified educational resource designed to support the live educational program “Crew Resource Management and the Prevention of VTE in Surgery: A Quality Improvement Initiative.” During the live training session, specialized education was offered on Crew Resource Management (an aviation-industry–based approach to quality improvement) and its application in healthcare, as well as on basic thromboprophylaxis strategies. This publication has been developed to supplement that training by exploring the rationale behind improving rates of appropriate thromboprophylaxis in the current framework of VTE performance measures and summarizing core guideline-based thromboprophylaxis strategies.

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#### PART 1: Applying Performance Measures to Improve Quality—Rationale, Strategies, and Results

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INTRODUCTION

Venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and pulmonary embolism (PE), is a major health problem in the United States (US) that is responsible for significant healthcare costs, illness, and death. It has been recognized as the most common singular cause of death in the US, and the Surgeon General estimates that at least 100,000 deaths may be attributable to VTE events each year. In addition, the number of patients with a primary or secondary hospital discharge diagnosis of PE has nearly doubled in recent years, increasing from 126,546 in 1998 to 229,637 in 2005.4

Despite the proven effectiveness of various thromboprophylaxis regimens, their rates of appropriate use remain suboptimal.5-8 This fact was highlighted in a recent subanalysis of the ENDORSE survey, which considered nearly 18,500 major surgery patients. Overall, more than one-third of patients at risk of VTE (38%) did not receive prophylaxis (6,446 of 17,084 patients). Rates of prophylaxis are highest among orthopaedic surgery patients (86.0% of those at risk of VTE) and lowest among urologic/gynecologic (53.8%) and other surgeries (53.6%), but rates were suboptimal across all patient populations. In addition, the recent VTE START study showed that, of 68,278 patients deemed to be at risk of VTE and eligible for pharmacologic thromboprophylaxis, 36.8% did not receive any form of prophylaxis, and an additional 50.2% of patients received suboptimal prophylaxis.8 Furthermore, other studies have show that, even when appropriate patients receive thromboprophylaxis, therapeutic regimens are often not continued for optimal lengths of time. In light of these and other supporting facts, the Agency for Healthcare Research and Quality (AHRQ) identified VTE prevention as the most important patient safety practice that our nation could improve.2

Risk of VTE in Surgical Patients

Surgery is one of the best known and best studied risk factors for VTE. Historical studies of patients undergoing general surgical procedures found that, without prophylaxis, rates of objectively confirmed, asymptomatic DVT were between 15% and 30%, and rates of fatal PE were between 0.2% and 0.9%. Rates are highest among those undergoing orthopaedic surgery (Table 1).3

Because it is no longer ethical or appropriate to conduct studies without VTE prophylaxis, it is impossible to know whether rates of VTE have decreased due to general advances in medical practice (e.g., more rapid mobilization, improved perioperative care) or increased due to factors such as shorter hospital stays (which may result in suboptimal duration of thromboprophylaxis) and more challenging patient populations (e.g., increased comorbidities, advanced age). Either way, because 23 million people in the US undergo surgery each year, the absolute number of patients at risk of developing VTE is significant.8

What's Inside

This publication aims to give healthcare professionals and administrators tools to help improve this situation. It has been divided into two sections. The first section outlines the importance of VTE performance measures, discusses strategies that can improve rates of VTE prophylaxis, and provides case studies of successful quality improvement initiatives from several institutions. The second part of this publication is more clinically focused and reviews key strategies in VTE risk assessment and prophylaxis, including considerations in timing, duration, and assessment of bleeding risk.

References


Table 1. Approximate Risk of DVT by Type of Surgery

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<thead>
<tr>
<th>TYPE OF SURGERY</th>
<th>DVT PREVALENCE (%)</th>
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<tbody>
<tr>
<td>Major orthopaedic</td>
<td>40-60</td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>15-40</td>
</tr>
<tr>
<td>General surgery</td>
<td>15-40</td>
</tr>
<tr>
<td>Major gynecologic</td>
<td>15-40</td>
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<tr>
<td>Major urologic</td>
<td>15-40</td>
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PART 1: Applying Performance Measures to Improve Quality—Rationale, Strategies, and Results

Introduction
A number of healthcare- and quality-focused organizations have identified VTE prophylaxis as an important aspect of hospital-based care in which focused improvements can significantly enhance patient outcomes. Key organizations include The Joint Commission, the National Quality Forum (NQF), and the Centers for Medicare and Medicaid Services (CMS). These groups have worked separately and jointly to influence current policy and develop recommendations, programs, and mandates to improve rates of thromboprophylaxis.

In this first part of our publication, we will review the goals and recent progress of these organizations, as well as the resources they offer and the role they have had in effecting change. In addition, to illustrate the benefits of quality improvement in VTE prophylaxis, we will highlight several successful case studies.

Rationale for Quality Improvement
Professional Advocacy Efforts to Improve Patient Safety
The Joint Commission. The Joint Commission is the nation's top accrediting and standards-setting agency for healthcare, and more than 18,000 healthcare professionals are guided by Joint Commission standards when caring for patients and improving their clinical performance. Since 1951, this organization has maintained state-of-the-art standards for improving the quality and safety of healthcare. In 1999, after seeking input from a variety of stakeholders, The Joint Commission began to consider key core measure areas that could help hospitals improve patient care. Four initial areas were chosen from these efforts—acute myocardial infarction, heart failure, pneumonia, and pregnancy-related conditions—and, over the course of the next several years and in conjunction with the CMS, specific measures were developed and aligned into one common set of measures published as the Specifications Manual for National Hospital Quality Measures. In 2004, the additional area of surgical infection prevention was added, and this measure set was transitioned to the Surgical Care Improvement Project (SCIP) in 2006.

Surgical Care Improvement Project. SCIP is a national quality partnership of organizations seeking to significantly reduce surgical complications. It was initiated by the CMS in 2003 with the ultimate goal of reducing the national incidence of surgical complications by 25% by the year 2010. It is led by a steering committee of 10 national organizations, including the AHRQ, American College of Surgeons, American Hospital Association, Centers for Disease Control and Prevention, CMS, and Joint Commission. Of the six core measures developed by SCIP partners and the steering committee, two (SCIP-VTE-1 and SCIP-VTE-2) directly address VTE prophylaxis (Table 1).

Beginning in 2007, CMS linked hospital reimbursement to the public reporting of these two SCIP VTE measures. More than 3,600 hospitals are now routinely reporting their data, which are available to the public via Hospital Compare (www.hospitalcompare.hhs.gov).

The National Quality Forum. The NQF has also been actively involved in efforts to improve surgical outcomes related to VTE. This nonprofit organization is made up of consumer groups, public and private purchasers, healthcare professionals, hospitals, accrediting and certifying bodies, supporting industries, and healthcare research/quality improvement groups and is dedicated to improving the quality of US healthcare by:

- Setting national priorities and goals to improve performance
- Endorsing national consensus standards for measuring and publicly reporting on performance
- Promoting the attainment of national goals through education and outreach

In 2005, the NQF initiated a two-phase project to develop consensus standards and performance measures for VTE. During the first phase of the project, the steering committee recommended the national endorsement of the SCIP-VTE performance measures. In the second phase of the project, the NQF issued a “Call for Measures” and subsequently identified 19 performance measures for evaluation, several of which were field tested by The Joint Commission in more than 50 volunteer hospitals. Of these additional performance measures, six related to VTE were ultimately endorsed by the NQF steering committee (Table 1).

Reimbursement Issues
The CMS has identified a number of hospital-acquired conditions (HACs) (sometimes referred to as “never events”) that are:

- Defined as high cost, high volume, or both
- Identified through ICD-9 coding as complicating conditions or major complicating conditions that result in higher-paying Medicare severity diagnosis-related groups (MS-DRGs) when present as secondary diagnoses on claims
- Reasonably preventable through the application of evidence-based guidelines

As a provision of the Deficit Reduction Act of 2005, Medicare will not reimburse hospitals for the additional costs associated with an HAC.

In 2009, DVT and PE associated with total knee and hip replacements were added to the CMS’s list of HACs; this policy change provides additional financial incentive for hospitals to optimize their approach to VTE prophylaxis.
Implementing a Successful VTE Prophylaxis Program

Common Barriers and Basic Strategies

As suggested above, benefits such as improved guidelines adherence, improved patient safety/outcomes, and reduced expenses from preventable VTE events drive quality improvement programs in VTE prophylaxis. Despite these potential benefits, rates of thromboprophylaxis remain suboptimal in many institutions. What factors might be contributing to this dichotomy?

A 2006 review of the literature sheds light on this question by identifying a number of barriers related to the appropriate use of thromboprophylaxis. These include healthcare-professional–related barriers (eg, lack of familiarity or agreement with guidelines, misconceptions of risk, time pressure, lack of outcome expectancy, primary focus on the underlying disease or surgical procedure), guideline-related barriers (insufficient evidence strength and difficult-to-understand, inconvenient, or inconsistent recommendation), and systems-related barriers (eg, lack of resources/equipment, lack of a reminder system). Barriers most commonly cited were: (1) the fear of bleeding risk associated with antithrombotic agents; (2) the fact that most VTE is asymptomatic or only subtly symptomatic, leading to under diagnosis and under estimation of risk; (3) trends toward shorter hospital stays, even after major surgery, meaning that patients often leave the hospital before VTE can be detected; and (4) external factors blocking or delaying the broader use of routine VTE prophylaxis, such as cost concerns, lack of specifications for VTE prophylaxis in hospital protocols, and perceived or actual lack of peer support among physicians.

Fortunately, basic, proven strategies can be implemented to help overcome these challenges and better adhere to guideline recommendations. These strategies can be grouped into three general types of support:

- **Educational support**, such as posters, pocket guidelines, lectures, continuing medical education, and quality assurance programs
- **System support**, such as risk-assessment models, clinical decision support tools, computer reminder systems, and combined prescription/monitoring charts
- **Process support**, such as working groups to identify barriers, monitoring of policies implemented, and audit/feedback

Ideally, several measures should be combined in a multifaceted program that not only raises the awareness of VTE prophylaxis, but also implements processes to effect change and provide feedback to the institution (Figure 1).

VTE Quality Improvement Resources

Many organizations, including those discussed above, have developed a wide assortment of tools to help hospitals and other healthcare organizations successfully implement a VTE prophylaxis program.

**TABLE 1. National Hospital Quality Measures for VTE Prophylaxis**

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>DESCRIPTION</th>
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<tr>
<td>SCIP MEASURES</td>
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<tr>
<td>SCIP-VTE-1</td>
<td>Surgery patients with recommended VTE prophylaxis ordered any time from hospital arrival to 24 hours after anesthesia end time</td>
</tr>
<tr>
<td>SCIP-VTE-2</td>
<td>Surgery patients who receive appropriate VTE prophylaxis within 24 hours prior to anesthesia start time to 24 hours after anesthesia end time</td>
</tr>
<tr>
<td>NQF PHASE 2 MEASURES</td>
<td></td>
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<tr>
<td>VTE-1</td>
<td>Patients who received VTE prophylaxis or have documentation why no VTE prophylaxis was given on the day of or the day after hospital admission</td>
</tr>
<tr>
<td>VTE-2</td>
<td>Patients who receive VTE prophylaxis or have documentation why no VTE prophylaxis was given on the day of or the day after ICU admission or transfer</td>
</tr>
<tr>
<td>VTE-3</td>
<td>Patients who receive overlap therapy (warfarin AND parenteral anticoagulation) for ≥ 5 days, with an INR ≥ 2.0 prior to discontinuation of parenteral anticoagulation; OR ≥ 5 days, with an INR &lt; 2.0 and discharged on overlap therapy; OR &lt; 5 days and discharged on overlap therapy</td>
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<tr>
<td>VTE-4</td>
<td>Patients who have their intravenous UFH therapy dosages AND platelet counts monitored according to defined parameters such as a nomogram or protocol</td>
</tr>
<tr>
<td>VTE-5</td>
<td>Patients with documentation that they/their caregivers were given written instructions or other educational material about warfarin that addressed ALL of the following: medication compliance, dietary advice, follow-up monitoring, and potential for adverse drug reactions and interactions</td>
</tr>
<tr>
<td>VTE-6</td>
<td>Incidence of potentially preventable VTE, defined by percent of patients who develop confirmed VTE during hospitalization and had received no VTE prophylaxis prior to the VTE diagnostic test order date</td>
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FIGURE 1. Stages of a Multifaceted Intervention to Improve Adherence to VTE Prophylaxis Guidelines

STAGE 1. Raise awareness of VTE risk in your own practice or institution (eg, local audit)

STAGE 2. Create initiatives to raise awareness of VTE risk assessment (eg, continuing medical education)

STAGE 3. Institute a process to remind physicians to assess all patients for VTE risk (eg, electronic alert)

STAGE 4. Implement a process to facilitate and simplify prescribing: matching VTE risk to appropriate prophylaxis (eg, risk-assessment module linked to guidelines)

STAGE 5. Incorporate a feedback process to assess impact of changes and detect improvements in clinical practice and outcomes (eg, audit and feedback, linking back to stage 1)


Society of Hospital Medicine’s (SHM) Preventing Hospital-Acquired Venous Thromboembolism: A Guide to Effective Improvement. This guide is a comprehensive “how-to” manual filled with flow charts, algorithms, and detailed descriptions of the steps necessary to implement and maintain a successful VTE prevention program. It offers the following key recommendations:

Set up the team for success—Ensuring support within the institution; survey prior/ongoing VTE prophylaxis efforts; clarify stakeholders, reporting hierarchy, and approval process; assemble an effective team and set goals and timelines; establish and follow a structured framework to plan and guide progress

Lay out the evidence/identify best practices—Know the literature on VTE risk and prevention and draft the VTE protocol

Analyze care delivery—Diagram current care delivery to identify failure modes and analyze care delivery to identify rate-limiting steps

Collect data to track performance—Determine the prevalence of appropriate VTE prophylaxis; determine the incidence of hospital-acquired VTE; collect data and report data with run charts; transform general goals into a metric-specific aim statement; monitor for detrimental effects of improvement changes

Layer interventions—Start with an effective VTE protocol; determine key principles for effective intervention (including the protocol); raise performance incrementally by moving up a hierarchy of increasing reliability

Continue to improve—Learn by testing and refining change in the clinical setting (ie, “plan-do-study-act”); revise the protocol to include appropriate variations; “weed out” inappropriate variations; export improvement to other units

Appendix C of the SHM’s guide includes sample VTE protocols from seven US hospital systems. Its full content is available at the SHM and AHRQ Web sites (www.hospitalmedicine.org or at www.ahrq.gov/QUAL/vtguide/). A companion template to document the implementation of a VTE protocol per SHM recommendations is also available from the Web site (search the phrase “VTE prevention snapshot”).

The SHM has also published a “Hierarchy of Reliability,” which is a helpful tool that predicts rates of VTE prophylaxis according to an institution’s level of intervention. It can be used to help project potential improvement in thromboprophylaxis that might accompany specific process changes and includes the following levels and corresponding estimated rates of prophylaxis:

- **Level 1:** State of nature (no protocol), 40%
- **Level 2:** Average (decision support in place, but not linked to order system; or prompts exist, but are not linked to decision support), 50%
- **Level 3:** VTE protocol (protocol in place and well integrated into point-of-care), 65% to 85%
- **Level 4:** Additional quality improvement strategies in place, 90%
- **Level 5:** Oversights identified and mitigated, 95%

Quality improvement strategies that can help healthcare professionals and their institutions increase the level at which they are operating can be found on the SHM’s Web site at www.hospitalmedicine.org/ResourceRoomRedesign/RR_VTE/html_VTE/06Reliable/03_Layering.cfm.

University of Washington Medical Center. With funding from AHRQ, a team of clinicians at the University of Washington Medical Center (UWMC) and Harborview Medical Center in Seattle developed and implemented the evidence-based, system-supported VTE Safety Toolkit. The toolkit, which is available free at http://vte.son.washington.edu, encourages the implementation of VTE prevention policies and safe practices. It includes algorithms, guidelines, recommendations, and order sets for the prevention, diagnosis, and treatment of VTE, as well as patient and provider education materials.

Premier Healthcare Alliance. A supporting partnership organization of SCIP, Premier was created by a consortium of nearly 200 hospitals and healthcare systems. It serves more than 2,400 US hospitals and 70,000 other healthcare sites by collecting and analyzing clinical and financial data from member institutions, organizing committees of members to make decisions and set direction for the alliance, sponsoring seminars and conferences, and sharing best practices.

The Premier Web site (www.premierinc.com) devotes an
entire page to VTE resources, with links to audioconferences, resources for prevention (including the SHM and UWMC VTE toolkits), national initiatives and tools, and select guidelines (type “venous thromboembolism resources” into the site’s Search box).

Case Studies and Lessons Learned

Several case studies published in recent years highlight the effectiveness that quality improvement programs aimed at thromboprophylaxis can have on raising rates of guidelines-based prophylaxis and reducing rates of VTE-related events.

University of California at San Diego, 2005

The SHM guide discussed above describes implementing a VTE protocol in a 300-bed referral center at the University of California at San Diego (UCSD). The guide describes the University’s process of forming a team and developing the protocol, their logic behind several key protocol decisions, and suggestions for implementing a protocol, monitoring its use, performing chart reviews, tracking performance, and providing feedback.

Begun in January 2005, the program reduced the incidence of preventable VTE from 1.2 events/1,000 patient days to a low of 0 by April 2006. The percentage of at-risk patients who received appropriate VTE prophylaxis rose from 53% in February 2005 to a high of 90% in May 2006 (Figure 2). Notably, a more recent update of this analysis revealed that the three-tier risk-assessment model that UCSD developed and implemented not only increased thromboprophylaxis prescription rates, but also significantly reduced the risk of hospital-acquired VTE (RR, 0.69; 95% CI, 0.47-0.79) and preventable hospital-acquired VTE (RR, 0.14; 95% CI, 0.06-0.31) over a 3-year period (2005-2007). The percentage of patients receiving adequate prophylaxis improved each year (58%, 78%, and 93%, P < 0.001) and reached 98% in the last 6 months of the retrospective observation period, demonstrating the significant impact that protocol development and implementation can have in clinical practice.

Brigham and Women’s Hospital, Boston, MA, 2005

Kucher et al developed a computer program linked to a patient database to identify those at risk of VTE. High-risk patients were randomized to have a VTE-risk alert included in their records (n = 1,255) or no alert included (n = 1,251). As a result of the electronic alert, significantly more patients in the intervention arm received mechanical thromboprophylaxis (10.0% vs. 1.5%, P < 0.001) or pharmacologic intervention (23.6% vs. 13.0%, P < 0.001) relative to the control arm. Clinically confirmed DVT or PE at 90 days, which was the primary endpoint of the study, occurred in 4.9% of patients in the intervention group versus 8.2% of the control group. The electronic alert reduced the risk of VTE by 41% at 90 days (HR, 0.59; 95% CI, 0.43 to 0.81; P = 0.001). In 2008, the system was reevaluated in a new cohort of patients. Prophylaxis increased by 50% during this study, but nearly two-thirds of physicians ignored the electronic alerts, underscoring the need for additional strategies to increase rates of prophylaxis in high-risk patients.

Roswell Park Cancer Institute, Buffalo, NY, 2006

Roswell Park implemented a program of VTE prophylaxis on all medical and surgical services based on the National Comprehensive Cancer Network guidelines. Components included mandatory physician order entry forms, including computerized physician order entry; informational materials, field in-services, and seminars to promote VTE awareness and staff education; and manual audits of patient charts every 3 months to track adherence. Adherence rates increased as shown in Table 2 below, which resulted in a significant decrease in the incidence of VTE, from 0.39% in the fourth quarter of 2006 to 0.08% in the second quarter of 2008 (P < 0.0001).

<table>
<thead>
<tr>
<th>TABLE 2. Sample Increase in Thromboprophylaxis Adherence Rates</th>
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<td></td>
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<tr>
<td>Medical Services</td>
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<tr>
<td>Surgical Services</td>
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<td>Institution-wide</td>
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Hartford Hospital, Hartford, CT, 2007

Pharmacy, medical, and information technology services collaborated to implement a program to improve VTE prophylaxis in medical patients. The intervention was a message, displayed by the computerized physician order entry system, reminding providers of the need to assess patients for VTE.

FIGURE 2. Sample Reduction in VTE Events With Increase in Appropriate Thromboprophylaxis

Hospital staff, pharmacists, physicians, nurse practitioners, physician assistants, and nurses received extensive education about the program. A retrospective chart review that used a risk-assessment tool measured the impact of the program. VTE adherence rates increased from 49% to 93% ($P < 0.001$). Before the program, only 25% of patients with contraindications to pharmacologic prophylaxis received mechanical prophylaxis; after implementation of the program, this increased to 100%.

**Conclusion**

VTE remains a major public health problem that primarily affects hospitalized and recently hospitalized patients. Many organizations recognize that the inadequate or inappropriate use of thromboprophylaxis can lead to suboptimal patient outcomes. Accordingly, these organizations have developed guidelines, incentives, and mandates to increase adherence to best practice. Numerous case studies have demonstrated that these tools and guidelines can significantly increase rates of prophylaxis and serve as an example to other institutions seeking similar improvements.

**References**

Now that we have discussed performance measures that have been established by quality improvement organizations and successful strategies for implementing them, we turn to the more clinical aspects of thromboprophylaxis. In this second part of our publication, we will provide a basic review of risk assessment strategies and thromboprophylaxis options. Within this discussion, we will also consider issues such as duration of prophylaxis and bleeding risk.

Risk Assessment

The symptoms and signs of VTE can be subtle and difficult to detect. DVT is often asymptomatic or mildly symptomatic. Clinically apparent symptoms and signs are caused by an obstruction of venous blood flow and inflammation of vessel walls and most commonly include the sudden swelling of an extremity, redness or discoloration of the skin, warmth of the affected area, low-grade fever, and pain that worsens with exercise and does not disappear with rest.1 Common symptoms and signs of PE include shortness of breath, pleuritic chest pain, hemoptysis, syncope, tachycardia, tachypnea, and hypotension.1 PE can also be asymptomatic, and, in some cases, fatal PE is the first and only sign of DVT.1

Because of the often asymptomatic nature of DVT, risk assessment is a key step in appropriate VTE prophylaxis. The ACCP guidelines currently recommend stratifying hospitalized patients who are at risk of VTE into low-, moderate-, or high-risk groups based on multiple factors, including patient-specific factors, the type and duration of surgery, and the extent and duration of immobility.3 Surgical patients who are mobile and undergoing minor surgery are considered to be low-risk. In contrast, all patients undergoing total hip arthroplasty (THA), total knee arthroplasty (TKA), or hip fracture surgery (HFS) are considered to be high-risk.3

A recent study by Maynard et al funded by the AHRQ demonstrated that this approach, when linked to prophylaxis options, increases rates of appropriate thromboprophylaxis and lowers rates of hospital-acquired VTE.4 In this study, researchers collaborated with a multidisciplinary team to develop a simple model of risk assessment that incorporated three levels of risk for all hospitalized patients, including those undergoing surgery (Table 1). Each level of risk was linked to appropriate VTE thromboprophylaxis options as defined by major VTE guidelines, and the model was integrated into mandatory computerized order sets. The administration of appropriate VTE thromboprophylaxis increased from a baseline of 58% to 93% in the third year of the study ($P < 0.001$, unadjusted relative benefit 1.61; 95% CI, 1.52-1.69).4

Thromboprophylaxis Options

Guideline-recommended options for thromboprophylaxis include pharmacologic and nonpharmacologic methods. The ACCP notes that, with the exception of low-risk patients who are mobile and undergoing minor surgery, all patients should be considered for mechanical and/or pharmacologic thromboprophylaxis.3 A summary of ACCP guideline recommendations, organized by surgery type and based on level of risk, can be found in Tool 1 at the end of this publication.

Ambulation

The most basic intervention that may help prevent surgical patients from developing VTE is early and frequent ambulation. Note, however, that although the benefits of this practice are widely accepted, little evidence exists to show that it prevents VTE.5 Still, for low-risk general surgery patients

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**TABLE 1. Sample Three-Tier Approach to Risk Assessment by Maynard et al.**

<table>
<thead>
<tr>
<th>LEVEL OF RISK</th>
<th>TYPE OF PATIENT</th>
<th>PREVENTION MEASURE</th>
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<tbody>
<tr>
<td>Low</td>
<td>• Ambulatory patient without VTE risk factors&lt;br&gt;• Same-day surgical or minor surgical patients</td>
<td>• Early ambulation</td>
</tr>
<tr>
<td>Moderate</td>
<td>• Patients who do not fall into the low- or high-risk categories&lt;br&gt;• Most surgical patients</td>
<td>• One of the following: &lt;br&gt;– UFH 5,000 U SC every 8 hours&lt;br&gt;– LMWH daily&lt;br&gt;– UFH 5,000 U SC every 12 hours (for those &lt; 50 kg or &gt; 75 years)</td>
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<tr>
<td></td>
<td></td>
<td>• Consider adding IPC to any of the above regimens</td>
</tr>
<tr>
<td>High</td>
<td>• Hip or knee replacement surgery&lt;br&gt;• Hip, pelvic, or severe hip or knee fractures&lt;br&gt;• Pelvic or abdominal cancer-related surgery&lt;br&gt;• Acute spinal cord injury with paresis&lt;br&gt;• Multiple major trauma</td>
<td>• One of the following: &lt;br&gt;– LMWH (UFH if end-stage renal disease)&lt;br&gt;– Fondaparinux 2.5 mg SC daily&lt;br&gt;– Warfarin (INR target range 2.0-3.0)&lt;br&gt;• ALSO add IPC (unless contraindicated)</td>
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INR = international normalized ratio; IPC = intermittent pneumatic compression; LMWH = low-molecular-weight heparin; SC = subcutaneously; U = units; UFH = unfractionated heparin; VTE = venous thromboembolism.

*Modified to highlight recommendations for surgical patients

undergoing minor procedures who have no additional risk factors, the ACCP suggests early, frequent ambulation as the sole method of VTE prophylaxis.2

**Antithrombotic Drugs**

Pharmacologic prophylaxis is generally recommended for patients with a high postoperative risk of VTE, as well as those with a moderate postoperative risk in combination with the presence of additional VTE risk factors, unless the patient has a high risk of bleeding.2 Antithrombotic agents approved by the US Food and Drug Administration (FDA) for VTE prophylaxis include unfractionated heparin (UFH), the low-molecular-weight heparins (LMWHs) dalteparin and enoxaparin, the factor Xa inhibitor fondaparinux, and the vitamin K antagonist (VKA) warfarin. The safety and efficacy of these agents have been thoroughly assessed in a number of randomized controlled trials (RCTs) and meta-analyses, and, in general, the ACCP guidelines do not rank the effectiveness of available drugs. Rather, agents are ranked by level of evidence supporting their use in specific surgical procedures and patient bleeding risk. In addition, the current ACCP guidelines do not include detailed dosing recommendations. Instead, they recommend that these agents be prescribed in accordance with manufacturer dosing instructions, which are summarized in Tool 2.4 A comprehensive review of each of these agents is beyond the scope of this monograph; however, important considerations that may influence prescribing are described below.

**Unfractionated Heparin.** Current product labeling for UFH states that the value of low-dose UFH as VTE prophylaxis for hip surgery has not been established.2 The American Academy of Orthopaedic Surgeons (AAOS) does not recommend UFH for any orthopaedic surgeries, and the ACCP specifically recommends against single-agent UFH as VTE prophylaxis in THA and TKA.46 However, the ACCP considers UFH to be an appropriate option for a variety of other nonorthopaedic surgeries (Tool 1).4 Of note, UFH can be an attractive option for thromboprophylaxis because of its relatively low cost and ease of reversibility.

**Low-Molecular-Weight Heparin.** LMWH has a number of clinical advantages over UFH. First, its longer half-life and greater bioavailability allow for once-daily dosing. In addition, LMWH is less likely than UFH to cause heparin-induced thrombocytopenia, and therapeutic drug monitoring is not normally required, except in patients who have a high bleeding risk (eg, renal failure, pregnancy, morbid obesity).

Of the commercially available LMWHs, only enoxaparin and dalteparin are approved for use as VTE prophylaxis in surgical patients, specifically in THA (both), TKA (enoxaparin), and abdominal surgery (both).47,48 Both drugs carry a boxed warning regarding the increased risk of epidural and spinal hematomas in patients receiving neuraxial anesthesia or undergoing spinal puncture. These hematomas may result in long-term or permanent paralysis. Risk factors include the use of an indwelling epidural catheter, concomitant use of other drugs that affect hemostasis, history of traumatic or repeated epidural or spinal punctures, and history of spinal deformity or spinal surgery. Hematoma risk must be considered when scheduling patients for spinal procedures, and, if performed, patients should be monitored frequently for symptoms and signs of neurologic impairment, which would require urgent treatment.49

Another important consideration with the use of LMWH is renal function. These agents are eliminated renally and, therefore, accumulate to potentially dangerous levels in patients with impaired renal function, thereby increasing patients’ bleeding risk.2 It is particularly important to assess renal function in the elderly, in patients with diabetes, and in those who have an increased risk of bleeding. The ACCP recommends using lower doses of the anticoagulant in these patients, monitoring drug levels and/or biologic effect, or choosing another anticoagulant that does not bioaccumulate in renal dysfunction.2

**Factor Xa Inhibitors.** Although several new potential agents are in later stages of development, as of November 2010, fondaparinux is the only commercially available factor Xa inhibitor in the US. Specifically, it is indicated for VTE prophylaxis in HFS, THA, TKA, and abdominal surgery.50 Like LMWH, it is administered subcutaneously, and product labeling includes a boxed warning about the risk of epidural and spinal hematomas in patients receiving neuraxial anesthesia or undergoing spinal puncture. As with LMWH, renal function must be considered before prescribing fondaparinux. Unlike LMWH, fondaparinux is specifically contraindicated in severe renal dysfunction, defined as a creatinine clearance of less than 30 mL/min.51

**Vitamin K Antagonists.** Warfarin is an attractive anticoagulant option because of its oral dosing, but it has disadvantages that include a slow onset of action, narrow therapeutic window, variable dose-response curve, and potential for numerous drug-drug and drug-food interactions. The intensity of warfarin therapy is measured by the international normalized ratio (INR). Although an ideal INR for VTE prophylaxis has not been established, it is known that an INR less than 2.0 is generally ineffective and an INR greater than 4.0 seriously increases the risk of intracranial hemorrhage.52 The ACCP recommends an INR target of 2.5 (range 2.0-3.0), while the AAOS recommends that the INR not exceed 2.0.53

**Aspirin.** Aspirin is not FDA-approved for thromboprophylaxis, and key organizations disagree on its role in VTE prophylaxis. The ACCP recommends against the use of aspirin as the sole agent for any class of patient, noting that more effective agents are readily available.1 In contrast, the AAOS supports aspirin 325 mg twice a day as an option for all orthopaedic surgery patients, except those with an elevated risk of PE and a standard risk of major bleeding.7 The AAOS also supports the use of low-dose aspirin (81 mg/day) if patients develop gastrointestinal symptoms during treatment.7 Although support for both positions can be found in the literature, two recent systematic reviews have found no significant difference in the VTE rate among orthopaedic patients treated with aspirin, warfarin, LMWH, or fondaparinux (with the exception of symptomatic DVT in an aspirin vs. warfarin comparison).54,55 Moreover, bleeding risk was not shown to increase with the use of aspirin in these studies.54,55 Still, the efficacy of aspirin as a sole means of thromboprophylaxis has not been confirmed in prospective randomized
controlled trials, and the ACCP guidelines have a class 1A-recommendation against its use for this indication.3

**Investigational Agents.** There are several antithrombotic agents in late-stage clinical development for the prevention of VTE in surgical patients. Three of these investigational agents are administered orally, and—unlike warfarin—do not require routine anticoagulation monitoring (Table 2).5 All have been compared directly to enoxaparin in phase III surgical prophylaxis trials that have been completed to date, although only rivaroxaban has consistently been demonstrated to be noninferior to enoxaparin.5 The FDA is currently reviewing the New Drug Application for rivaroxaban for the prevention of VTE after THA or TKA surgery, and, in October 2010, the FDA approved dabigatran for stroke prevention in atrial fibrillation, though its use in VTE prophylaxis is still off label.6

### TABLE 2. Oral Antithrombotic Agents in Late-Stage Clinical Development for Surgical VTE Prophylaxis in the US

<table>
<thead>
<tr>
<th>DRUG CLASS</th>
<th>AGENT</th>
<th>PHASE III SURGICAL PROPHYLAXIS TRIALS</th>
</tr>
</thead>
</table>
| Factor Xa inhibitor | Apixaban | ADVANCE-1, completed trial in TKR  
ADVANCE-2, on-going trial in TKR  
ADVANCE-3, on-going trial in THR |
| Rivaroxaban | RECORD-1, completed trial in THR  
RECORD-2, completed trial in THR  
RECORD-3, completed trial in TKR  
RECORD-4, completed trial in TKR |
| Direct thrombin (II) inhibitor | Dabigatran | RE-NOVATE, completed trial in THR  
RE-MOBILIZE, completed trial in TKR  
RE-MODEL, completed trial in THR |

THR = total hip replacement surgery; TKR = total knee replacement surgery.

**Initiation and Duration of Prophylaxis.** When initiating thromboprophylaxis, decisions must be made about the timing and duration of administration. The ACCP recommendations specify that the first dose of anticoagulant can be administered either before or after surgery and note that clinical data indicate little apparent advantage to preoperative administration.2 The advantages of postoperative initiation include:

- No interference with decisions about the use of regional anesthesia
- Facilitation of same-day admission
- No contribution to intraoperative bleeding

The ACCP offers several agent-specific recommendations for the timing of prophylaxis:

- **LMWH**—Start either preoperatively or postoperatively
- **LMWH in THA**—Start LMWH at high-risk dose 12 hours before or 12 to 24 hours after surgery, or start LMWH at half high-risk dose 4 to 6 hours after surgery and increase to full dose the following day
- **LMWH in High–Bleed-Risk Patients**—Delay prophylaxis until 12 to 24 hours after surgery and hemostasis at the surgical site is confirmed
- **Fondaparinux**—Start either 6 to 8 hours after surgery, or the next day
- **Fondaparinux in THA**—Start 6 to 24 hours after surgery
- **Fondaparinux in High–Bleed-Risk Patients**—Delay prophylaxis until 12 to 24 hours after surgery and hemostasis at the surgical site is confirmed
- **Warfarin**—Start either before surgery or in the evening of the surgical day

The 2008 ACCP guidelines recommend continuing prophylaxis through discharge for all major general and gynecologic surgeries and considering extending LMWH prophylaxis is for up to 28 days after discharge in select high-risk patients (eg, major cancer surgery, prior VTE).3 For high-risk orthopaedic surgeries (hip fracture and hip/knee arthroplasty), the guidelines recommend postoperative thromboprophylaxis for no less than 10 days and up to 35 days.1

**Bleeding Risk.** Clinicians often have concerns about the risk of bleeding when considering pharmacologic VTE prophylaxis, particularly the potential for surgical-site bleeding, which can necessitate re-operation, prolong hospital stay, and complicate rehabilitation after orthopaedic surgery.2 When evaluating the literature and interpreting the reported bleeding event rates, it is critical to assess how bleeding was defined in the study. For example, a recent systematic review found that published major bleeding rates for enoxaparin prophylaxis in orthopaedic surgery ranged from 0.1% to 3.1% in THA and from 0.2% to 1.4% in TKA.5 However, when surgical-site bleeding was excluded from the definition, major bleeding rates were as much as 10 times lower (eg, 0.1% to 0.2% with enoxaparin in THA).2 The ACCP reports that pooled results of randomized trials in THA patients reveal major bleeding rates of 3.3% with warfarin, 5.3% with LMWHs, and 4% with placebo, although, again, it must be pointed out that different studies used different definitions of major bleeding.2 A meta-analysis of randomized trials comparing fondaparinux to enoxaparin in orthopaedic surgery found major bleeding rates of 2.7% with fondaparinux and 1.7% with enoxaparin (P = 0.008), although rates of clinically significant bleeds (fatal events, bleeding leading to re-operation, and bleeding in a critical organ) did not differ.2

Based on heightened concern in orthopaedic surgery, the AAOS provides additional guidance about managing bleeding risk in these patients.2 First, all patients should be assessed for bleeding risk prior to surgery. The AAOS notes that patients with an elevated risk include those with a history of a bleeding disorder, recent gastrointestinal bleed, or recent hemorrhagic stroke. They also recommend that patients with a contraindication to anticoagulation should be considered for vena cava filter placement.2

**Mechanical Devices**

Mechanical methods of prophylaxis encourage venous blood
flow in the legs; reduce venous stasis by applying pressure to the foot, calf, and/or thigh; and include the following options:

- **Graduated compression stockings (GCS)**—Heavily elasticized stockings that apply pressure to the lower leg; a range of gradients are available, but a typical stocking applies 18 mm Hg of pressure at the ankle, 14 mm Hg at the calf, and 8 mm Hg at the knee.

- **Intermittent pneumatic compression (IPC)**—These devices use pumps powered by batteries or line current to intermittently inflate and deflate leg cuffs of various lengths (eg, calf only, calf plus thigh); they differ in mode of operation (eg, single-chamber versus sequential compression or asymmetric compression versus circumferential compression), and operational parameters (duration of compression, frequency of compression) are variable.

- **Venous foot pumps (VFPs)**—These devices artificially stimulate a physiologic pumping mechanism in the foot that is activated by walking; they include an inflatable pad fitted to the sole of the foot and an air pump that rapidly inflates and deflates the pad in a regular cycle to simulate the effect of normal ambulatory circulation; they have proven to be the equivalent of walking for maintaining venous circulation.

The main benefit of mechanical devices is the lack of bleeding risk. However, these devices are less well-studied than pharmacologic prophylaxis, and they appear to be less effective. As a result, the ACCP recommends mechanical methods of thromboprophylaxis primarily in patients who have a high risk of bleeding, to be replaced or augmented with pharmacologic prophylaxis when bleeding risk abates.

**Conclusion**

Data clearly show that rates of thromboprophylaxis are sub-optimal. Fortunately, recommendations for risk assessment and prophylaxis set forth by organizations such as the ACCP are available to help physicians apply evidence-based recommendations to practice. In addition, a multitude of thromboprophylaxis options have been shown to effectively reduce rates of VTE in surgical patients. By following guideline recommendations and applying effective strategies, clinicians can ensure that their at-risk patients are appropriately screened and treated to prevent this potentially devastating complication of surgery.

**References**


### TOOL 1. ACCP Thromboprophylaxis Recommendations by Surgery Type

<table>
<thead>
<tr>
<th>SURGERY TYPE</th>
<th>ACCP RECOMMENDATION</th>
</tr>
</thead>
</table>
| **Bariatric** | • Low risk: LMWH, UFH every 8 hours, fondaparinux, or one of these pharmacologic methods with IPC (all Grade 1C)  
• Note that higher-than-usual doses of LMWH and UFH may be necessary for obese patients (Grade 2C) |
| **Coronary Artery Bypass Graft (CABG)** | • Low risk: LMWH, UFH, or optimally used bilateral GCS or IPC (Grade 1C)  
• LMWH is recommended over UFH (Grade 2B)  
• High bleeding risk: bilateral GCS or IPC (Grade 1C) |
| **Elective Hip Replacement** | • The following anticoagulant options are recommended (all Grade 1A):  
  - LMWH at high-risk dose, 12 hours prior to or 12 to 24 hours after surgery, or at half high-risk dose 4 to 6 hours after surgery, increasing to high-risk dose the following day  
  - Fondaparinux: 2.5 mg at 6 to 24 hours after surgery  
  - Adjusted-dose VKA prior to surgery or the evening of the surgical day (INR target = 2.5; INR range = 2.0 to 3.0)  
• The following are NOT recommended as the sole method of prophylaxis: aspirin, dextran, UFH, GCS, or VFP (all Grade 1A)  
• High bleeding risk: VFP or IPC (Grade 1A) with pharmacologic thromboprophylaxis substituted or added when risk decreases (Grade 1C)  
• Duration of thromboprophylaxis ≥ 10 days (Grade 1A), up to 35 days (Grade 1A) with LMWH (Grade 1A), VKA (Grade 1B), or fondaparinux (Grade 1C) |
| **Elective Knee Replacement** | • LMWH at high-risk dose, fondaparinux, or adjusted-dose VKA (INR target = 2.5; INR range = 2.0 to 3.0) (all Grade 1A)  
• IPC can be used as an alternative to anticoagulants (Grade 1B)  
• The following are NOT recommended as the sole method of prophylaxis: aspirin (Grade 1A), UFH (Grade 1A), or VFP (Grade 1B)  
• High bleeding risk: IPC (Grade 1A) or VFP (Grade 1B) with pharmacologic thromboprophylaxis substituted or added when risk decreases (Grade 1C)  
• Duration of thromboprophylaxis ≥ 10 days (Grade 1A), up to 35 days (Grade 1A) with LMWH (Grade 1A), VKA (Grade 1C), or fondaparinux (Grade 1C) |
| **General** | • Low-risk patients undergoing minor procedures with no additional VTE risk factors: early and frequent ambulation (Grade 1A)  
• Moderate-risk patients undergoing major procedure for benign disease: LMWH, UFH, or fondaparinux (all Grade 1A); continue until hospital discharge (Grade 1A)  
• Higher-risk patients undergoing major procedure for malignancy: LMWH, UFH every 8 hours, or fondaparinux (all Grade 1A); continue with LMWH up to 28 days postdischarge (Grade 2A)  
• Patients with multiple VTE risk factors: LMWH, UFH every 8 hours, or fondaparinux and GCS and/or IPC (Grade 1C); continue with LMWH up to 28 days postdischarge (Grade 2A)  
• High bleeding risk: GCS or IPC (Grade 1A) with pharmacologic thromboprophylaxis substituted or added when risk decreases (Grade 1C) |
| **Gynecologic** | • Low risk, including laparoscopic procedures, with no additional VTE risk factors: early and frequent ambulation (Grade 1A; Grade 1B for laparoscopic procedures)  
• Laparoscopic procedures with additional VTE risk factors: one or more of LMWH, UFH, IPC, or GCS (Grade 1C)  
• Major surgery, including benign disease, but no additional VTE risk factors: LMWH (Grade 1A), UFH (Grade 1A), or IPC prior to surgery and continued until patient is ambulatory (Grade 1B); continue thromboprophylaxis until discharge  
• Surgery for extensive malignancy or patients with VTE risk factors: LMWH (Grade 1A), UFH every 8 hours (Grade 1A), or IPC prior to surgery and continued until patient is ambulatory (Grade 1A), or LMWH or UFH with either GCS or IPC, or fondaparinux (Grade 1C); continue thromboprophylaxis with LMWH up to 28 days postdischarge (Grade 1C) |
| **Hip Fracture** | • Fondaparinux (Grade 1A), LMWH (Grade 1B), UFH (Grade 1B), adjusted-dose VKA (INR target = 2.5; INR range = 2.0 to 3.0) (Grade 1B)  
• The following is NOT recommended as the sole method of prophylaxis: aspirin (Grade 1A)  
• For patients with delayed surgery: LMWH or UFH should be initiated between hospital admission and surgery (Grade 1C)  
• High bleeding risk: mechanical prophylaxis (Grade 1A) with pharmacologic thromboprophylaxis substituted or added when risk decreases (Grade 1C)  
• Duration of thromboprophylaxis ≥ 10 days (Grade 1A), up to 35 days (Grade 1A) with fondaparinux (Grade 1A), LMWH (Grade 1C), or VKA (Grade 1C) |

*continued on next page*
### TOOL 1. ACCP Thromboprophylaxis Recommendations by Surgery Type (Continued)

<table>
<thead>
<tr>
<th>SURGERY TYPE</th>
<th>ACCP RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee Arthroscopy</td>
<td>• Low-risk patients with no additional VTE risk factors: early and frequent ambulation (Grade 2B)</td>
</tr>
<tr>
<td></td>
<td>• Patients with VTE risk factors or following a complicated procedure: LMWH (Grade 1B)</td>
</tr>
<tr>
<td>Laparoscopic</td>
<td>• Low-risk patients with no additional VTE risk factors: early and frequent ambulation (Grade 1B)</td>
</tr>
<tr>
<td></td>
<td>• Patients with additional VTE risk factors: LMWH, UFH, fondaparinux, IPC, or GCS (all Grade 1C)</td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>• Thromboprophylaxis (Grade 1A) with IPC (Grade 1A); alternatively, postoperative LMWH (Grade 2A) or UFH (Grade 2B) can be used</td>
</tr>
<tr>
<td></td>
<td>• Patients with VTE risk factors: postoperative LMWH or UFH combined with GCS and/or IPC (Grade 2B)</td>
</tr>
<tr>
<td>Spine (Elective)</td>
<td>• Low-risk patients with no additional VTE risk factors: early and frequent ambulation (Grade 2C)</td>
</tr>
<tr>
<td></td>
<td>• Patients with VTE risk factors: postoperative UFH (Grade 1B), postoperative LMWH (Grade 1B), perioperative IPC (Grade 1B), or GCS (Grade 2B)</td>
</tr>
<tr>
<td></td>
<td>• Patients with multiple VTE risk factors: UFH or LMWH combined with GCS and/or IPC (Grade 2C)</td>
</tr>
<tr>
<td>Thoracic</td>
<td>• Low-risk: LMWH, UFH, fondaparinux (all Grade 1C)</td>
</tr>
<tr>
<td></td>
<td>• High bleeding risk: GCS and/or IPC (Grade 1C)</td>
</tr>
<tr>
<td>Urologic</td>
<td>• Low risk or transurethral: early and frequent ambulation (Grade 1A)</td>
</tr>
<tr>
<td></td>
<td>• Major, open procedures: UFH every 8 to 12 hours (Grade 1B), GCS and/or IPC prior to surgery and continued until patient is ambulatory (Grade 1B), LMWH (Grade 1C), fondaparinux (Grade 1C), or pharmacologic methods with GCS and/or IPC (Grade 1C)</td>
</tr>
<tr>
<td></td>
<td>• Actively bleeding or high bleeding risk: GCS and/or IPC (Grade 1A) with pharmacologic thromboprophylaxis substituted or added when risk decreases (Grade 1C)</td>
</tr>
<tr>
<td>Vascular</td>
<td>• Low risk: early and frequent ambulation (Grade 2B)</td>
</tr>
<tr>
<td></td>
<td>• Patients with additional VTE risk factors: LMWH, UFH, fondaparinux (Grade 1C)</td>
</tr>
</tbody>
</table>

GCS = graduated compression stockings; IPC = intermittent pneumatic compression; LMWH = low-molecular-weight heparin; UFH = low-dose unfractionated heparin; VFP = venous foot pump; VKA = vitamin K antagonist.

## TOOL 2. Thromboprophylaxis Options for Surgical Patients

<table>
<thead>
<tr>
<th>AGENT</th>
<th>CLASS</th>
<th>INDICATION</th>
<th>DOSING</th>
<th>SPECIAL CONSIDERATIONS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalteparin</td>
<td>LMWH</td>
<td>Abdominal surgery</td>
<td>• 2,500 U SC per day; initiate therapy 1-2 hours prior to surgery</td>
<td>• The risks of epidural and spinal hemato-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• High-risk patients (eg, malignancy) should receive either 5,000 U</td>
<td>ma are significantly increased when neuraxial</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SC per day, beginning the evening before surgery, OR, 2,500 U SC</td>
<td>anesthesia or spinal puncture is employed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>given 1-2 hours preoperatively, then 2,500 U SC 12 hours later,</td>
<td>in patients receiving or about to receive</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>followed by 5,000 U SC per day thereafter</td>
<td>LMWH therapy; clinicians are urged to</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>• Usual duration of therapy is 5-10 days; up to 14 days of therapy</td>
<td>consider the potential risks versus benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>was well tolerated in clinical trials</td>
<td>in this situation</td>
</tr>
<tr>
<td>Enoxaparin</td>
<td>LMWH</td>
<td>Abdominal surgery</td>
<td>• 40 mg SC per day, starting 2 hours preoperatively; the usual duration</td>
<td>• Dosage adjustment is required for pa-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>of administration is 7-10 days; up to 12 days of therapy has been</td>
<td>tients with severe renal impairment (CrCl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hip replacement</td>
<td>administered in clinical trials</td>
<td>&lt; 30 mL/min) as follows: 30 mg SC once</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 30 mg SC every 12 hours for up to 14 days; initiate 12-24 hours</td>
<td>daily</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>postoperatively as long as hemostasis has been established</td>
<td>• The risks of epidural and spinal hemato-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Alternate regimen: 40 mg SC once daily, given initially 12 (±3)</td>
<td>ma are significantly increased when neuraxial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hours prior to surgery</td>
<td>anesthesia or spinal puncture is employed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Following the initial phase of thromboprophylaxis, it is</td>
<td>in patients receiving or about to receive</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>recommended that continued prophylaxis with enoxaparin 40 mg daily</td>
<td>LMWH therapy; clinicians are urged to</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>be administered for 3 weeks</td>
<td>consider the potential risks versus benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Knee replacement</td>
<td>• 30 mg SC every 12 hours; initiate 12-24 hours postoperatively</td>
<td>in this situation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>as long as hemostasis has been established; the usual duration of</td>
<td>• Value in hip surgery has not been estab-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>of administration is 7-10 days; up to 14 days administration</td>
<td>lished</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>has been administered in clinical trials</td>
<td></td>
</tr>
<tr>
<td>Fondaparinux</td>
<td>Factor Xa</td>
<td>Surgery for hip fracture; hip replacement</td>
<td>• 2.5 mg SC per day, starting 6-8 hours postoperatively, after</td>
<td>• Fondaparinux is contraindicated in severe</td>
</tr>
<tr>
<td></td>
<td>antagonist</td>
<td>and abdominal surgery</td>
<td>hemostasis is established; Treatment is continued for 5-9 days; for</td>
<td>renal impairment (CrCl &lt; 30 mL/min) and in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>patients undergoing hip fracture surgery, extended prophylaxis up to</td>
<td>patients with body weight &lt; 50 kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24 additional days is recommended</td>
<td>• Use with caution in patients with CrCl 30-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Alternate regimen: 40 mg SC once daily, given initially 12 (+3)</td>
<td>50 mL/min due to reduced clearance</td>
</tr>
<tr>
<td>Heparin Sodium</td>
<td>UFH</td>
<td>General prophylaxis for major abdomino-</td>
<td>• Low-dose regimen: 5,000 U SC given 2 hours preoperatively then every</td>
<td>• Value in hip surgery has not been estab-</td>
</tr>
<tr>
<td>Injection</td>
<td></td>
<td>thoracic surgery as well as other patients</td>
<td>8-12 hours for 7 days or until the patient is fully ambulatory,</td>
<td>lished</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>whichever is longer</td>
<td></td>
</tr>
<tr>
<td>Warfarin</td>
<td>VKA</td>
<td>General VTE prophylaxis</td>
<td>• Dosing must be individualized based on patient’s PT/INR response;</td>
<td>• Can cause major or fatal bleeding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>initial dose is usually 2 to 5 mg per day; typical maintenance doses</td>
<td>• Bleeding is more likely during the starting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>are 2 to 10 mg per day</td>
<td>period and with higher doses/INRs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• For patients undergoing hip fracture surgery, extended prophylaxis</td>
<td>• Consider potential risk factors for bleed-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>up to 24 additional days is recommended</td>
<td>ing before prescribing; monitor INR regu-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Following the initial phase of thromboprophylaxis, it is</td>
<td>larly in all patients and more frequently in</td>
</tr>
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<td>recommended that continued prophylaxis with enoxaparin 40 mg daily</td>
<td>those with high bleeding risk</td>
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<td>be administered for 3 weeks</td>
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CrCl = creatinine clearance; LMWH = low-molecular-weight heparin; PT = prothrombin time; SC = subcutaneously; U = units; UFH = unfractionated heparin; VKA = vitamin K antagonist.

Data derived from prescribing information; please see full documents for a complete listing of warnings, precautions, and contraindications.
Participate before these activities expire!

VTE is one of the most common postoperative complications in surgical patients and the most common preventable cause of hospital death in the United States.

Med-IQ currently offers additional complimentary, certified CME activities related to VTE risk assessment and prevention. Review the current evidence to discover strategies for improving outcomes for patients with, or at risk of developing, VTE.

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