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Venous Thromboembolism Safety Toolkit: A Systems Approach to Patient Safety

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Abstract

The current culture in health care is focused on patient safety and on delivering quality health care across the continuum of care. However, a culture of safety by itself cannot create change within an organization. Venous thromboembolism (VTE) requires coordination of care across multiple providers supported by a system that assists in the process of delivering and tracking outcomes of care. In this paper, we describe the implementation and use of safe practice interventions for patients who have been diagnosed with VTE or are at risk for VTE. In particular, we describe the use of the evidence-based, system-supported, interactive *VTE Safety Toolkit*—which includes diagnostic, preventive, and therapeutic algorithms—and the *On-line Provider Training Module on VTE Prophylaxis*, which is a mandatory Web-based VTE educational intervention for all providers. We describe how organizations and providers can use the *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis* to identify business process that can be changed and create a mechanism to track provider and system performance and thereby improve patient safety and accountability around VTE.

Introduction

Venous thromboembolism (VTE) encompasses deep vein thrombosis (DVT) and pulmonary embolism (PE). VTE is one of the most common clinical disorders among both inpatients and outpatients, and PE is the most common preventable cause of death among hospitalized patients in the United States.¹ Approximately 2.5 million cases of DVT and 600,000 cases of PE are diagnosed per year in the United States. About 30 percent to 40 percent of postoperative patients will develop some form of DVT, and VTE is associated with more than 300,000 hospitalizations annually.^{2, 3, 4} Approximately two-thirds of patients with symptomatic VTE manifest DVT alone, whereas one-third of patients manifest PE.

Appropriate prophylactic regimens for many different patient groups have been determined by randomized clinical trials, as has the appropriate treatment of established DVT.^{5, 6} Errors from omission of prophylaxis or objective diagnostic testing, or inadequate treatment are estimated to result in significant harm to hospitalized patients. A fundamental understanding of prophylaxis, diagnosis, and treatment is necessary for providers throughout the continuum of patient care. Given the magnitude of the problem, it is not surprising that the diagnosis and management have been better defined for VTE than for other common diseases.

Patient safety has been a major focus of the Agency for Healthcare Research and Quality (AHRQ). Several clinical guidelines for patient safety have been developed and implemented in health care organizations.^{7, 8, 9, 10, 11} Diverse approaches to organizational change have also been introduced.^{7, 8, 9, 10, 11} However, patient safety remains a challenge because of the difficulty in sustaining organizational change to support new initiatives. Patient safety issues associated with the prevention and management of VTE continue to pose a challenge in most U.S. hospitals.

The purpose of this project was to increase the implementation of safe practice interventions for patients at risk for or diagnosed with VTE using the evidenced-based and system-supported interactive *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis*. Multidisciplinary clinical and research teams in partnerships among the University of Washington Medical Center (UWMC), UW School of Nursing, and the Center for Health Sciences Interprofessional Education and Research have developed and implemented the *VTE Safety Toolkit* locally through a public Web site (<http://vte.washington.edu/>) for providers and patients.

This project was intended to inform providers, patients, payers, policymakers, and the public about how these safe practice interventions can be implemented successfully in diverse health care settings, leading to safer and better health care for all Americans. In this paper, we discuss the development of evidence-based tools and educational interventions around the clinical diagnosis of VTE. The processes for implementation and the plans for local, regional, and national dissemination are also discussed. The dissemination of results for the pre-implementation data collection period of the *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis* will be reported in peer review journals.

VTE Safety Toolkit: What Is It?

The *VTE Safety Toolkit* consists of diagnostic, preventive, and therapeutic algorithms; a mandatory Web-based VTE educational intervention for all providers; patient educational materials; and provider communication strategies to promote continuity of care. The toolkit is divided into provider, patient, and system sections. The provider component includes educational tools for increasing knowledge on the assessment of risk for developing VTE, using VTE prophylaxis strategies, understanding diagnostic strategies for VTE, treating acute VTE in inpatients and outpatients, and managing patients after treatment. The patient component consists of educational tools for improving knowledge about the prevention of VTE and about outpatient treatment options. Systems components include clinical tools, infrastructure support, and expert consultants for improving communication between providers and patients and for improving the coordination of care throughout the continuum. Although they are not “tools” *per se*, the infrastructure support consists of an integrated clinical database, standardized reporting strategies, quality improvement tools, and computerized logbooks. Each element of the *VTE Safety Toolkit* was designed to address a specific safety issue related to VTE diagnosis, prevention, and management.

The *VTE Safety Toolkit* contains 10 components that are evidence-based guidelines for preventing, diagnosing, treating, and educating patients and providers about VTE. The components are as follows:

- VTE prophylaxis guidelines.
- VTE risk assessment tool.
- DVT diagnostic algorithm.
- PE diagnostic algorithm.
- HIT (heparin-induced thrombocytopenia) assessment.
- VTE treatment pathway.
- DVT outpatient treatment order set.
- Vascular laboratory requisition.
- Neural-axial anesthesia guidelines.
- Patient education (prevention and treatment) pamphlets.

Due to space constraints, a brief description of 4 of the 10 tools—including the VTE prophylaxis guidelines, VTE risk assessment tool, DVT and PE diagnostic algorithms, and the VTE treatment pathway—are presented here. The remaining guidelines and information about the toolkit can be found at <http://vte.washington.edu/>.

The VTE Prophylaxis Guidelines are used to assess every patient upon admission and discharge for their risk of developing VTE and for recommending the type, dose, timing, and duration of anticoagulants. If a patient presents with contraindications to pharmacologic prophylaxis (e.g., heparin, warfarin), mechanical prophylaxis—such as sequential compression devices or graduated compression stockings—is recommended. If a patient presents with signs and symptoms of DVT, the DVT diagnostic algorithm can be utilized. Before objective diagnostic studies are ordered, providers must complete a history and physical examination and a DVT risk assessment, and they must rate the clinical probability of DVT using the Wells scoring system.¹²

The PE diagnostic algorithm is very similar to the acute DVT algorithm. The provider first obtains the patient's history and physical examination, a chest x-ray, and arterial blood gases; completes the PE risk factor assessment; and rates the clinical probability of PE using the Wells PE scoring algorithm.¹³ If a patient suspected of PE presents with leg symptoms, then a venous duplex ultrasound is ordered. If no leg symptoms are present, a spiral computed tomography (CT) scan is recommended as the first diagnostic test. For patients who cannot receive contrast dye, a ventilation and perfusion scan can replace the spiral CT scan.

The VTE treatment pathway is utilized when a patient has been diagnosed with acute DVT or PE. After the initial diagnosis is made, baseline blood tests—including prothrombin time (PT) with international normalized ratio (INR), partial thromboplastin time (PTT), and complete blood count (CBC)—are obtained to ensure correct dosage of anticoagulation. If a patient is eligible for outpatient treatment, low molecular-weight heparin is recommended; inpatients are typically treated with unfractionated heparin, intravenously or via subcutaneous injections, and transitioned to warfarin following discharge. Warfarin is subsequently used for several months after the initial diagnosis of DVT or PE to prevent recurrent VTE.¹⁴ In addition to pharmacologic

treatment, compression stockings with a pressure of 30 to 40 mm Hg at the ankle are used for 2 years to prevent post-thrombotic syndrome.

Methods

VTE Diagnostic and Treatment Standards

Even though strong direct evidence is available to guide the management and prevention of VTE, morbidity and mortality remain high.^{15, 16,17} A considerable body of literature informs practice about VTE risk assessment, prophylaxis, diagnosis, and treatment.^{14, 18, 19, 20, 21, 22, 23, 24} Evidence-based guidelines, graded by strength of evidence and methodologic quality of evidence, have been established by the American College of Chest Physicians (ACCP) Conference on Antithrombotic and Thrombolytic Therapy.^{14, 19} These guidelines, in their seventh edition in 2004, served as the basis for the development of the *VTE Safety Toolkit* and the *Online Provider Training Module on VTE Prophylaxis*.^{14, 19, 25}

The ACCP guidelines summarize the full body of evidence regarding the risk of VTE associated with various medical illnesses and surgical procedures and have established a clear set of risk factors that can be used for stratifying VTE risk in individual patients.¹⁹ Strategies for prophylaxis in various clinical settings are defined, including mechanical and pharmacologic methods, with appropriate dose and duration of therapy. Treatment standards have also been clearly defined for both inpatients and outpatients, based on a complete review of all available evidence.^{14, 19, 25}

Development of the VTE Safety Toolkit

Despite substantial literature concerning appropriate management, VTE has been identified as an area of concern by several national groups involved with patient safety or quality improvement (i.e., Surgical Care Improvement Projects, National Quality Forum, The Leapfrog Group for Patient Safety, and The Joint Commission). When the UWMC found an increased incidence of postoperative VTE, addressing this clinical problem became a major priority. Data from previous VTE studies at UWMC, including a 15-year natural history of DVT study, demonstrated multiple problems with the diagnosis, management, and prevention of VTE at the level of the provider, patient, and system.

VTE is not a new clinical problem, but it is a unique clinical problem that requires coordination of care across multiple locations (in hospitals, in outpatient clinics, at home) by multiple providers (nursing, medicine, pharmacy, and surgery) and is supported by a system that assists in the process of delivering care. A group of interprofessional providers and researchers were responsible for the development of the pathways, order sets, guidelines, and patient handouts that make up the *VTE Safety Toolkit*. Local experts in thrombosis, vascular diagnostics, and anticoagulation were called upon in this process. The *VTE Safety Toolkit* was developed based on clinical evidence and established guidelines.

Results

Issues and Challenges of the *VTE Safety Toolkit*

The *VTE Safety Toolkit* has faced and will continue to face various issues and challenges during the development and implementation stages. In prior studies of VTE management led by our lead author, Dr. Zierler, the most common challenges were related to changing individual provider behavior, rather than changing business practices within organizations. Integrated pathways for DVT management, which were developed prior to the development of the *VTE Safety Toolkit*, were disseminated to multiple groups of providers without a plan to provide infrastructure support for use of the pathways. Although providers were given physician order sets, there was no efficient way to determine utilization of the order set, except to physically review paper records. The original pathways did not include risk assessment or prophylaxis pathways for preventing acute VTE because they focused on the outpatient treatment of acute DVT.

The risk for VTE rises during illness and during treatment for illness. Prevention, diagnosis, and treatment of VTE should occur not only during acute hospital care, but also before and after hospitalization. Patients are often referred to the UWMC and Harborview Medical Center (HMC) for only a portion of their care, and they return to their communities for further treatment. Thus, plans to reduce VTE risk should also involve external community providers. This issue has been addressed. Plans for implementation of the *VTE Safety Toolkit* include providing access to external community providers and patients. Patients need to be recruited to participate in their care, and they can be taught to identify risks, signs, and symptoms of VTE; adhere to the appropriate dose of anticoagulation; and seek medical care in a timely fashion.

In order to achieve the goal of increasing the implementation of safe practice interventions for VTE in the clinical setting, the *VTE Safety Toolkit* was developed with these significant changes from the preliminary studies. However, the *VTE Safety Toolkit* has proceeded with some expected challenges that simply cannot be addressed without institutional changes. The lack of an integrated clinical information system to view a patient's complete medical record needs to be addressed. The documentation of care and clinical outcomes are located in several different computer-based programs, one for providers, one for nurses, one for pharmacists, etc. The lack of integration of the existing information systems requires multiple steps to abstract comprehensive patient data and makes it difficult to track changes related to care in an efficient manner. A new integrated clinical information system is being programmed and piloted within small groups of providers at UWMC and HMC, but neither system has a fully integrated information component.

A goal to improve the standards of care for hospitalized patients at risk for VTE has been to create one admissions assessment form. Currently, each discipline creates an intake assessment form specific to their unit. The VTE clinical and research team has suggested the development of one form that could be standardized for use across the organization. Currently, not every unit requires that a patient be assessed for VTE risk. This is because the form that they use does not include the question of VTE risk, and changing the form incurs a substantial cost. As the organization moves toward adopting an integrated information system, it should be possible to include a standard form that requires a response to whether a patient has been assessed for VTE risk. This will be necessary because assessing each patient for VTE risk and prescribing

appropriate pharmacologic prophylaxis for VTE are now incorporated into the Center for Medicare & Medicaid's (CMS) pay-for-performance initiative (as of July 1, 2007), giving providers and health care organizations a financial incentive to document these procedures.

Online Provider Training Module on VTE Prophylaxis

As part of the patient safety movement, the UWMC and HMC administration decided that all resident and attending physicians needed training relative to VTE, since VTE was the single most preventable condition in U.S. hospitals. Moreover, less than 30 percent of eligible UWMC patients were actually receiving VTE prophylaxis.

This training has been designed as a randomized trial comparing the addition of interactive VTE case studies with an online standard didactic training module on VTE prophylaxis. All UW providers—residents and attending physicians—will participate in this quality improvement intervention and education evaluation study. Providers will receive an e-mail from the office of the Center for Clinical Excellence with instructions and the rationale for completing the online VTE prophylaxis training. Providers will log in to a protected Web site using their personal hospital username and password. A brief statement on the log in site (front page) explains that the VTE prophylaxis training module involves a research component (survey) and that we will be testing two different methods of online educational training that will affect future training module designs. All participants in this study will be aware of how collected data will be used; they will be able to opt out of having their data included in the research database; but they will not be permitted to opt out of the training.

Randomization will occur at the time of log in, and the provider will be assigned to either the control (passive didactic training only) group or the intervention (passive didactic training and interactive case studies) group. After logging in, all providers will be asked to complete a brief demographic questionnaire and pretest to measure their knowledge about VTE prophylaxis and prevention.

The pretest comprises 10 questions relating to the content of the passive and interactive “training slides” on VTE prophylaxis. All providers in the control and intervention groups will be shown nine (tutorial) passive, didactic slides with information on VTE prevention [similar to Health Insurance Portability Accountability Act (HIPAA) training—information with no immediate feedback]. Providers who are randomized to the intervention group will then review interactive case studies followed by the postassessment test. The total number of interactive cases depends on the number they answer correctly. There are four content areas and four cases for each content area, for a total of 16 interactive slides. The providers need to pass one from each content area correctly; the pass rate is a score of 80 percent or higher. Providers in the control group will complete the postassessment test following the tutorial slides.

The Director of the Center for Clinical Excellence will ask for resident (champion) physician volunteers to begin piloting the *On-line Provider Training Module on VTE Prophylaxis*, and it became mandatory in spring 2008, with post-implementation data collection planned to begin in September 2008. The goal of this research is to increase the percentage of hospitalized patients without contraindications who receive anticoagulation prophylaxis by increasing provider knowledge about VTE prophylaxis. After the evaluation, the training module will be added to the

VTE Safety Toolkit and will be available to other academic medical centers for provider training on VTE prophylaxis.

The implementation of the *On-line Provider Training Module on VTE Prophylaxis* demonstrates a change in business practices at UWMC and HMC. The VTE training module is the first mandatory education module (similar to HIPAA training) to be implemented for providers using a new Web-based learning management tool. Both medical centers are planning three mandatory educational provider training modules to address concerns about standardized training and patient safety; the VTE prophylaxis module is the first of these. Researchers with training in educational psychology and evaluation assisted with the development of the training module, including the pre- and post-assessment questions.

Implementation and Dissemination of Interventions

Implementation Plan

Provider education is a key component of the “preadoption stage” as outlined by Greenhalgh, et al.²⁶ In order for individuals involved in a system-level adoption to fully participate, they must be aware of the innovation, have adequate information to see how it affects their practice and how they would use it, and have access to support systems to help them use it. The clinical experts who finalized the *VTE Safety Toolkit* elements provided the didactic content and references for educational modules about each aspect of risk, diagnosis, management, and prophylaxis (see “About Us” on *VTE Safety Toolkit* Web site: <http://vte.washington.edu/>).

The educational component of the toolkit will be introduced through special grand rounds presentations by opinion leaders/champions for each of the clinical services that will become end-users. Because all of the medical services grand rounds include providers from the community and other UW teaching hospitals, these will also serve as initial dissemination vehicles to providers outside of UW Medicine. Nursing, pharmacy, and other relevant provider professions also have grand rounds or monthly meetings that will be accessed for the “kick-off” presentations.

UWMC and HMC providers receive continuing education credit for the grand rounds attendance, and we are currently investigating whether providers can receive additional continuing education credits for completing the *On-line Provider Training Module on VTE Prophylaxis*. These modules will be organized around illustrative cases so they actively apply evidence-based practices and engage in higher level learning activities, rather than simply reviewing the content. These modules also will be tied to appropriate UWMC intranet sites to assist providers when they are faced with retrieving appropriate evidenced-based practice guidelines in the course of patient care. In addition, a quarterly newsletter produced by the UWMC Pharmacy will provide up-to-date information on the implementation process.

Individual providers will be asked to provide feedback to the UW Center for Clinical Excellence’s reporting mechanism throughout the process to assess the effectiveness of dissemination and implementation. UWMC will continue to benchmark the incidence of VTE

quarterly, and research assistants will continue to monitor data on the incidence of VTE and the adequacy of prophylaxis and management of VTE.

External providers will have access to the *VTE Safety Toolkit* through the use of a Web-based program sponsored by the UWMC called ULINK, a referral program called MEDCON, and from the discharge summary that will have a URL linking the referring physician to a UWMC Web page that will house the *VTE Safety Toolkit*. The ULINK program gives referring providers instant access to patient information and updated records from the UWMC, HMC, and the Seattle Cancer Care Alliance, as long as their patients give permission. MEDCON is a toll free consultation and referral service of the UW School of Medicine and its primary teaching hospital. As a major resource for medical education, research, and patient care, the UW School of Medicine places particular importance on its communication with the practicing physicians in the Pacific Northwest and the WWAMI (Washington, Wyoming, Alaska, Montana, and Idaho) region. We will link the *VTE Safety Toolkit* to the UWMC patient care Web page under “Refer a Patient” so that external providers can have access to the educational tools.

Dissemination Plan

Internal dissemination target audiences are inpatient and clinic providers. The dissemination plan has been developed using the planning tool developed by the AHRQ Patient Safety Research Coordinating Committee.²⁷ The AHRQ Dissemination Planning Tool is an integral part of dissemination for the *VTE Safety Toolkit* within UWMC; it will be utilized for regional and national dissemination in the years following the end of the funded project. The AHRQ Dissemination Planning Tool is grounded in research regarding effective dissemination of innovations discussed in the background of this proposal. The AHRQ Dissemination Planning Tool helps researchers consider six elements of effective dissemination: packaging of results, identifying endusers, engaging connector organizations, identifying and overcoming barriers to implementation, developing success measures, and allocating resources to implement the plan.

The plan also has two phases. Phase I involves dissemination of the *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis*, which is an integral part of implementation to internal users. Phase II involves dissemination to more distant external users. These phases are iterative in that the initial implementation strategies and tools will be revised based on initial Phase I findings. The dissemination plan was developed within the framework proposed by Greenhalgh, et al.,²⁶ and is positioned between the “help it happen” and the “make it happen” ends of the continuum.

The six key components of the Dissemination Planning Tool can be briefly described as follows:

1. **Research findings and products:** What is going to be disseminated? The products to be disseminated are the *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis*. As described earlier, these Phase I products are based on research findings.^{14, 19} The Phase II products will be accomplished following the analysis of the post-implementation period and will be disseminated at national meetings, on the AHRQ Patient Safety Research Coordinating Center site, and through publications. Phase II products will consist of implementation strategies (based on lessons learned) and the two interventions *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis*.

2. **End-users:** Who will apply the findings and products in practice? For the implementation in Phase I, the clinical providers and their patients in the UWMC and HMC inpatient and ambulatory care sectors are the endusers. The providers come from the full range of clinical services and specialties where patients are at risk for or develop VTE as described earlier in the application. Providers are health care professionals involved in directly or indirectly providing care to these patients at any phase: prevention through management. They include physicians, nurses, and pharmacists. Patients include any recipients of assessment, treatment, or preventive measures for VTE from either UWMC or HMC providers.

End-users for Phase II expand to AHRQ, to providers nationally, and to actual and potential patients nationally. AHRQ is committed to national dissemination, and we will provide the materials in forms that can be disseminated widely, in a variety of technical formats, and using a variety of technologic means.

3. **Dissemination partners:** Dissemination partners include individuals and organizations through which endusers can be reached. Phase I partners are the UWMC, HMC, Center for Clinical Excellence, UW Center for Health Science Education & Research, and the providers and patients involved in the implementation. During Phase II, AHRQ will be added as a dissemination partner. Other national organizations through which we might reach endusers include the National Patient Safety Organization, AHRQ-funded dissemination centers, National Quality Forum, and the network of patient safety researchers.
4. **Communication strategies:** What is the best ways to convey the research findings and products to end users? For Phase I, these involve a variety of in-person and online means to reach individual patients and providers, who ultimately are the adopters of this innovation in terms of choosing to use the recommendations or not. Research has shown that a variety of strategies are needed to link this systematic change with individual users and their perceived needs for information and tools. As noted in the Methods section, we will have formal didactic sessions in the form of grand rounds within and among the professional provider groups; written newsletters and e-mail notices; provider supports, reminders and forms within the electronic medical record; champions and dedicated support to the users; Web sites with factual and case-based material. Printed summaries of recommendations or prescriptions will also be available, along with Web-based materials, informative posters and buttons, and other visual displays. Phase II will add a package of implementation strategies based on our lessons learned and the evaluation of Phase I implementation strategies.
5. **Dissemination Plan.** As described earlier, we used the evidence-based planning tool developed by the AHRQ Patient Safety Research Coordinating Committee²⁷ to develop our dissemination plan. According to our plan, Phase 1 will reach internal users, and Phase II will target external, distant users. The AHRQ Dissemination Planning Tool will be used to guide regional and national dissemination in future years.
6. **Evaluation:** The evaluation will determine what did and did not work with respect to dissemination. The outcomes described in the specific aims are the primary method of evaluating actual usage and the effect of the Phase I dissemination. These outcomes include: (1) an increased percentage of hospitalized patients whose VTE risk factors are assessed and documented upon admission and on discharge; (2) an increased percentage of hospitalized patients without contraindications who receive prophylaxis for VTE; (3) a decreased volume of inappropriately ordered venous duplex scans, along with an increased rate of duplex scans

ordered for patients for whom it is appropriate; (4) an increased percentage of patients with a diagnosed VTE who receive appropriate therapy in the hospital and are discharged with appropriate outpatient therapy; and (5) improved provider knowledge about VTE prophylaxis and improved satisfaction with mandatory educational interventions through the use of interactive case studies. All of these evaluations can be extracted from the computerized record, quality improvement data (results of provider educational intervention), and provider surveys.

Discussion

Translation of Science Into Practice (Diffusion and Dissemination)

Although the evidence that should inform multidisciplinary practice in prophylaxis, diagnosis, and treatment of VTE is abundant, the adoption of relevant evidence-based guidelines into practice is limited. Why then do we think that implementation of the *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis* will result in a higher rate of adoption than that achieved with prior efforts?

The strong commitment of the UWMC and HMC to improving patient safety provides a context in which multiple determinants of successful adoption exist.²⁶ Namely, these organizations see the goals of this project as compatible with their organizational goals of reducing VTE and of improving safe practice interventions with this patient population.

Observable and achievable outcomes directly related to the clinical work of the multiple disciplines involved in the care of this patient population will be measured. The *VTE Safety Toolkit* will be integrated into the normal working tools of the providers and will be “augmented” with customization, training, and the clinical equivalent of a “help desk.” The implementation of the *On-line Provider Training Module on VTE Prophylaxis* is an innovative method to change the business practices for providers at UWMC and HMC. The fact that senior administrators at both medical centers have agreed to implement the *On-line Provider Training Module on VTE Prophylaxis* as the first mandatory educational intervention (similar to HIPAA training) for an identified patient safety problem signals to providers that VTE prevention is a problem that has been recognized as an organizational one and, therefore, requires an organizational solution. Withholding patient care privileges for providers pending the successful completion of the *On-line Provider Training Module on VTE Prophylaxis* is evidence that the organization is looking for measurable changes and accountability.

The patient safety movement has, in large part, promised changes in the delivery of care based on an organization adopting a “culture of safety.” In 2007, at the National Patient Safety Foundation’s annual meeting in Washington, DC, a panel of experts commented on the fact that change will occur only when the business practices of an organization change, and only then, perhaps, a change in the culture will follow.

These leaders also said that the patient safety movement will not be successful unless providers are held accountable for knowing the latest standards of care and for monitoring the outcomes of the care they provide. The development of a mandatory provider educational intervention for

VTE prophylaxis represents a change in business practices for both UWMC and HMC. Whether this change has an effect on patient safety will be measured in the post-implementation data collection period.

Greenhalgh and colleagues' recent systematic review of the diffusion of innovation literature emphasized that adoption is a process, not a one-time event, and that it is an interaction among the innovation, the intended adopter(s), and the context.²⁶ Furthermore, they emphasized that adoption is “an organic and often rather messy model of assimilation in which the organization moves back and forth between initiation, development, and implementation, variously punctuated by shocks, setbacks, and surprises.”

The VTE interventions were officially implemented on March 12, 2008, during a ceremony on VTE prevention. Guest speakers from the VTE Safety Toolkit team, along with national spokesperson Melanie Bloom (coalition to Prevent DVT) also presented at the ceremony. Proclamations to support March as VTE prevention month in the State of Washington were signed by the Governor and the King County Council chair. Post-implementation data collection will begin in September 2008. The conceptual model put forth by Greenhalgh and colleagues²⁶ guides the implementation content and processes for this study.

Network Structures

Various influences are involved in the spread of innovation, such as social network structures,^{28, 29, 30} similarities in backgrounds between potential and current users of the innovation,^{28, 30, 31} opinion leaders,^{31, 32} organizational champions (e.g., physician champions, nurse champions),³³ boundary spanners (i.e., individuals with ties both inside and outside the organization in relation to the innovation),³⁴ and formal dissemination programs within organizations.³⁴ The structure and quality of social networks greatly influence the adoption of innovation by individuals, and these social networks vary by different groups of individuals and by the types of influence used within the groups.²⁶ These groups may be formal or informal, and the social networks can be described as horizontal or vertical. Physicians typically operate in formal, horizontal networks, which are considered more effective for supporting the construction and meaning and for spreading peer influence (peer to peer).³⁴ On the other hand, nurses operate more commonly in informal, vertical networks, which are considered more effective for passing on authoritative decisions and for organizing codified information.^{30, 34}

The UWMC and HMC are academic medical centers with hierarchies within services. The network structures might be described as a combination of informal and formal and horizontal and vertical structures. Multiple providers—including nurses, physicians, and pharmacists—will be involved in the care of VTE patients, and understanding the network structures and cultures within these groups will aid in the successful dissemination and diffusion of the innovation. Physician, pharmacy, and nurse champions, expert opinion leaders, boundary spanners, and a formal dissemination program supported by UWMC and HMC will provide the context in which the innovation will be disseminated and diffused. After successful dissemination and evaluation of the post-implementation data, the interventions (*VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis*) will be made available nationally.

The *VTE Safety Toolkit* and *On-line Provider Training Module for VTE Prophylaxis* were not customized to be institution-specific, so that they would be applicable elsewhere after their effectiveness is tested at UWMC and HMC. Also, the processes and models for implementing the interventions and the dissemination strategies for translating the tools into practice will be shared.

Conclusion

VTE continues to be a national patient safety issue, and we have developed two educational interventions and recommendations for system changes that support the prevention and management of this clinical problem. The support of the administrations at both medical centers and the changes in the way training will be carried out for high-risk patient safety issues (VTE prophylaxis) is a change in business practices that hopefully will change the culture of safety. The organizational changes that support the *VTE Safety Toolkit* and *On-line Provider Training Module on VTE Prophylaxis* will improve patient safety and accountability around VTE.

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