Optimal Prevention Of Hospital-Acquired Venous Thromboembolism

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Purpose:
Optimize prevention of hospital-acquired venous thromboembolism (HA VTE) via effective implementation of a VTE prevention protocol.

Scope:
Adult inpatients on all services (excluding OB, Psychiatry) of a 325-bed university hospital over 36 months.

Methods:
We implemented a simple VTE prevention protocol using proven performance improvement techniques. Each patient was stratified on each admission and transfer for VTE risk, with each level linked to a menu of acceptable prophylaxis options in structured order sets. We assessed the protocol's impact on the prevalence of adequate VTE prophylaxis with 2,894 random-sample audits and the incidence of HA VTE via concurrent review of radiology reports.

Results:
The VTE risk assessment model had a very high inter-observer agreement (kappa > 0.8 for VTE risk level, 0.9 for judgment of "adequate" prophylaxis).

The percent of patients on adequate prophylaxis improved by each calendar year (67%, 76%, 92%; $p < .001$ chi-square) and reached 98% in the last 6 months of 2007.

HA PE were reduced by over 50% and HA DVT were reduced by 35% in 2007 compared with 2005-06 (chi-sq < .05).

A web-based tool kit is available at http://www.hospitalmedicine.org.

Key Words
Venous thromboembolism, deep vein thrombosis, pulmonary embolus, prevention, protocol

Purpose (Objectives of Study).

Our long-term objective was to optimize prevention of hospital-acquired venous thromboembolic events (HA VTE) at our hospital and to use our experience to develop implementation techniques allowing other institutions to achieve the same objective.

Specifically our objectives were to:

1) Implement a VTE prophylaxis protocol and order set that mandated VTE risk assessment and provided a menu of recommended VTE prophylaxis options for each level of VTE risk *and* to prospectively validate the risk assessment model/ VTE prevention protocol by assessing the impact of this intervention on the prevalence of adequate VTE prophylaxis and the incidence of hospital-acquired VTE.

2) Create a modifiable toolkit that could be disseminated to healthcare systems caring for patients at risk of VTE, facilitating successful interventions similar to those validated in the “model hospital.”

By demonstrating optimal prevention of hospital-acquired VTE, and by collaborating to create and disseminate a toolkit assisting other institutions to do the same, we wished to reduce the morbidity, mortality, and costs associated with hospital-acquired VTE.

Scope

Venous thromboembolic disease (VTE) is a significant cause of morbidity and mortality in hospitalized patients. Despite significant advances in our ability to recognize, diagnose, and treat VTE, this spectrum of disease continues to threaten the safety of hospitalized patients. Pulmonary embolism (PE) is recognized as the cause of death for more than 100,000 hospitalized patients in the United States every year and is considered a contributing factor in the death of 100,000 more patients. In the United States alone, approximately 250,000 hospitalized patients will require anticoagulation for symptomatic deep venous thrombosis (DVT) every year. Approximately 50% of venous thromboembolism (VTE) is acquired in the hospital[1]. Because VTE is often undiagnosed, even in its most severe forms, the actual impact of the spectrum of VTE is likely to be much greater than this.

On a review of the practices and impact of this problem at our institution, our hospital information system revealed more than 100 cases of pulmonary embolism and more than 400 cases of DVT diagnosed over a 14-month period. The associated cost of these events, in morbidity, mortality, and patient care dollars, is immense. Studies from other centers suggest that this rate of VTE is representative of a widespread problem across the United States[2-4]. A substantial proportion of these events are hospital acquired [1] and constitute an unacceptable risk to hospitalized patients.

Despite significant progress in the understanding of the pathogenesis of DVT and PE, and despite specific recommendations for VTE prophylaxis, venous thromboembolic disease remains a significant cause of morbidity and mortality in hospitalized patients.

In numerous studies, it is noted that venous thromboembolism prophylaxis is underutilized[5-7]. This chronic underutilization of prophylaxis indicates that a percentage of these hospital-acquired DVTs and PEs are preventable. The use of primary prophylaxis has been shown to decrease VTE [8]. As stated in the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy, multiple clinical trials have provided irrefutable evidence that primary thromboprophylaxis reduces DVT, PE, and fatal PE[8]. PE is the most common preventable cause of hospital death; according to the AHRQ's publication *Making Healthcare Safer: A Critical Analysis of Patient Safety Practices*, appropriate VTE prophylaxis is ranked as a patient safety practice with the greatest strength of evidence regarding impact and effectiveness, with low complexity and cost of implementation. This recommendation was based on overwhelming evidence that thromboprophylaxis reduces adverse patient outcomes while decreasing overall costs[9].

For example, the American College of Chest Physicians Consensus Statement provides clear guidelines for VTE prophylaxis[8], drafted through a formalized, multidisciplinary approach to evidence evaluation and recommendation grading[10].

Despite the strength of the evidence and the widespread acceptance of these guidelines, there is a notable underutilization of appropriate prophylaxis. For example, in a recent survey of 2,726 patients with hospital-associated DVT, only 1,147 (42%) received prophylaxis within 30 days of diagnosis[1]. More effective models to implement VTE prevention programs are desperately needed.

Methods

Study Design

We prospectively observed adult inpatients for the prevalence of adequate VTE prophylaxis and for the incidence of hospital-acquired VTE for a 36-month period from calendar year 2005 through 2007. We examined the impact of our efforts as we developed, implemented, and refined our VTE prevention protocol.

We included all hospitalized adult patients at our medical center in our observations and interventions, including geriatric patients, patients of all ethnic groups, prisoners, and the socially and economically disadvantaged in our population. Exclusion criteria were age under 14 years, psychiatric inpatients, and Obstetrics/Gynecology service patients.

Development of a VTE Risk Assessment Model (RAM) and VTE Prevention Protocol

We worked with medical staff leaders to gain consensus on a VTE prevention protocol for all medical surgical areas. A VTE prevention protocol includes the elements of VTE risk stratification, definitions of adequate VTE prevention measures linked to the level of VTE risk, and a definition of contraindications to pharmacologic or mechanical prophylactic measures. We piloted the risk assessment model for ease of use and accuracy. Models often cited in the literature[11, 12] that included point-based scoring and math were rejected based on the pilot experience. We adopted a simple three-risk-level model that could be completed in seconds. We integrated this risk assessment model into standardized data collection instruments and eventually into a computerized provider order entry (CPOE) order set. Each level of VTE risk was firmly linked to a menu of acceptable prophylaxis options. Intermittent pneumatic compression devices

were used as an adjunct in all patients in the highest risk level and as the primary method in patients with contraindications to pharmacologic prophylaxis. The CPOE VTE prevention order set was integrated into all admission and transfer order sets, essentially ensuring that all patients admitted or transferred within the medical center would benefit from the protocol. The order set was monitored for proper use and modified occasionally on the basis of subjective and objective feedback.

Data from 150 randomly selected patients from the audit pool were abstracted by the nurse practitioner in a detailed manner. Five independent reviewers assessed each patient for VTE risk level and for a determination of whether or not they were on adequate VTE prophylaxis on the day of the audit, per protocol. Inter-observer agreement was calculated for these parameters using kappa scores.

Longitudinal monitoring of protocol adherence, and the percentage of inpatients on adequate VTE prophylaxis regimens

A daily medical center inpatient census report of patients in the medical center with > 48 hours of meeting study criteria, was downloaded into an Excel spreadsheet, with each patient assigned a consecutive number. The Microsoft Excel random number generator plug-in function was used to generate an average of four patients to audit per weekday (80 randomly sampled inpatients/month). The research nurse practitioner targeted serial patients on the list for additional study, excluding patients on therapeutic anticoagulation, until she accomplished the requisite number of audits each day.

The data collected on each patient randomly selected for audit included demographic parameters including age, sex, location, service, date and time of review, and date of admission. The VTE risk assessment model (RAM), derived from the Seventh ACCP Consensus Conference on Antithrombotic Therapy and identical to the VTE RAM incorporated into the intervention prophylaxis order set, was used to classify each patient's VTE risk as low, moderate to high, or very high. For each audit, we determined if the patient was on an "adequate" VTE prevention regimen consistent with our protocol, given their VTE risk level, demographics, and absence or presence of contraindications to pharmacologic prophylaxis, at the time the audit took place.

The physician and nursing feedback elicited regarding reasons for nonadherence with the protocol, confusion regarding the VTE RAM, and other barriers to effective prophylaxis were communicated to the multidisciplinary team on a regular basis and were used to guide revision and education efforts.

Finding and Investigating New Diagnoses of Hospital-Acquired VTE, Trending the Incidence of Hospital-Acquired VTE

The research nurse practitioner used the PACS radiology reporting and archival system (IMPAX™ version 4.5, AGFA Healthcare Informatics, Greenville, South Carolina) to identify all new diagnoses of VTE in the process described below.

Procedure codes for following studies were entered into the IMPAX™ search engine to locate all such exams performed in the prior 1-3 days:

1. Ultrasound exams of the neck, upper extremities, and lower extremities
2. CT angiograms of the chest
3. Ventilation/perfusion nuclear medicine scans
4. Pulmonary angiograms

Negative studies and studies that revealed unchanged chronic thromboses were excluded, whereas clots with a chronic appearance but no evidence of prior diagnosis were included. Therefore, ileofemoral, popliteal, calf vein, subclavian, internal and external jugular vein, and axillary vein thromboses were included, as were all pulmonary emboli. Less common locations, such as renal vein thromboses and cavernous sinus thromboses, were thereby excluded.

Each new diagnosis of VTE was then classified as hospital-acquired VTE (HA VTE) or community-acquired VTE. A new VTE was classified as hospital acquired if the diagnosis was first suspected and made in our hospital. A newly diagnosed VTE was also classified as hospital acquired if the VTE was suspected in the ambulatory setting, but the patient was in the hospital in the preceding 30 days, unless the patient suffered some obvious precipitant of thromboses in the ambulatory setting. All questionable classifications were reviewed by at least two physician team members for final consensus classification.

Each new diagnosis of hospital-acquired VTE was reviewed with a root cause analysis (RCA)-like investigation by core members of the multidisciplinary support team. This investigation included a determination of whether the patient was on an adequate VTE prophylaxis regimen at the time of the hospital-acquired VTE, using the same RAM and linked prophylaxis menu described above. Patients with HA VTE were classified as adherent or nonadherent to the UCSD protocol when they developed their VTE: patients who developed VTE when on suboptimal prophylaxis per protocol had the VTE classified as “preventable.”

All data were entered into a Microsoft Access™ database for ease of retrieval and reporting. The project adhered to the HIPAA requirements for privacy involving health-related data from human research participants, and IRB approval was obtained, along with a waiver for individual patient informed consent.

Results

Inter-observer agreement: The VTE risk assessment model was tested for inter-observer agreement on 150 patients with five observers. The kappa scores for VTE risk level was > 0.8. The kappa score for the judgment of whether the patient was on adequate prophylaxis or not was > 0.9.

Percent of patients on adequate prophylaxis:
Our audits assessed the VTE risk level and adequacy of prophylaxis on 2,894 patients over the 36-month study period. The percent of patients on adequate prophylaxis improved markedly over the course of our interventions, from a baseline of 50-55% to over 98% in the last 6 months of 2007. The percent of patients on adequate prophylaxis improved significantly by each calendar year (67%, 76%, 92%; $p < .05$, chi-square).

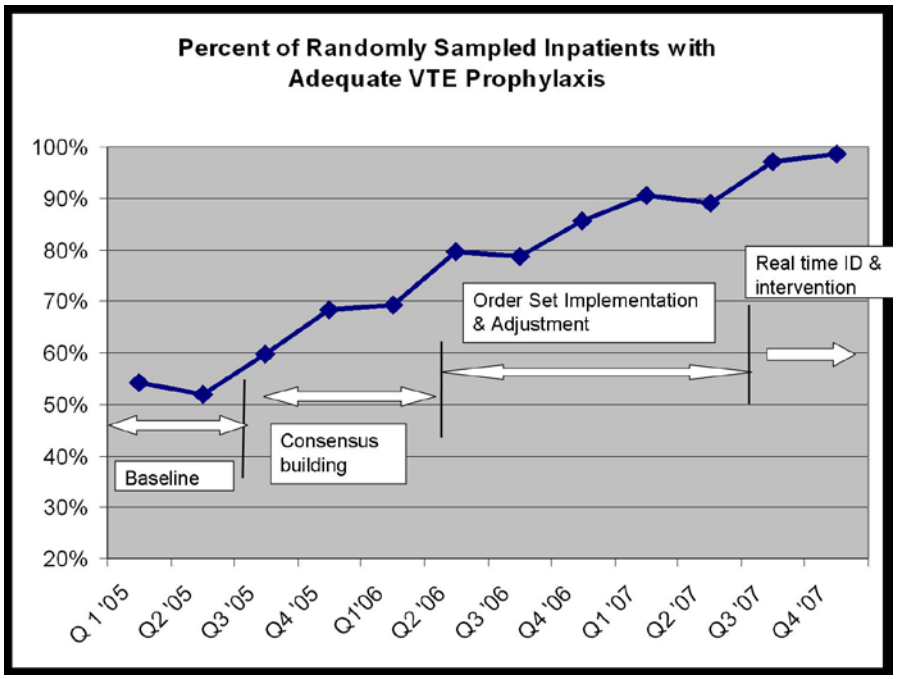

Figure 1. 2,894 randomly sampled adult inpatients (mean 242 patients per quarter) audited for adequacy of VTE prophylaxis regimen on the day of audit.

An examination of Figure 1 is instructive in following the timeline of interventions and the impact on the prevalence of adequate VTE prophylaxis. The first 7 to 8 months represent the baseline rate, 50-55%, of VTE prophylaxis. In this period, the improvement team was meeting but had not yet begun meeting with the large variety of med/surg service leaders, and there was a varied approach to VTE prophylaxis. In the latter part of 2005 through mid-2006, the improvement team was meeting with service leaders and key faculty to gain support for a consensus VTE prevention protocol in anticipation of the "go-live" date of a modular order set that was incorporated into all admit and transfer order sets, often replacing pre-existing orders referring to VTE prevention measures. The order set resulted in an improvement to 80% adequate prophylaxis immediately. Monitoring of the order set use confirmed that it was easy and efficient to use but also revealed that physicians were at times classifying patients as low VTE risk inaccurately, when they possessed qualities that actually qualified them for moderate to high risk status by our protocol. We therefore inserted a secondary CPOE screen when patients were categorized as low VTE risk, asking the physician to deny or confirm that the patient had no risk factors that qualified them for moderate to high risk status. This confirmation screen essentially just acted as a gentle way to ask "Are you sure this patient doesn't need VTE prophylaxis?" This minor "tweak" of the CPOE order set improved adequate VTE prophylaxis rates to 90%. Finally, we asked nurses to evaluate patients who were not on therapeutic or prophylactic doses of anticoagulants with a series of basic questions regarding the presence of any VTE risk factors and active bleeding or obvious bleeding risks. Patients with VTE risk factors but no obvious contraindications generated a note from the nurse to the doctor, prompting the doctor to reassess VTE risk and potential contraindications. This simple intervention raised the percent of audited patients on adequate VTE prophylaxis to 98% in the last 6 months of 2007.

Age, ethnicity, and gender were not associated with differential rates of adequate VTE prophylaxis.

VTE Occurrence:
We identified 730 cases with VTE over the 36-month observation period, 345 of which were HA VTE cases (47%). These 345 HA cases represented 71 HA PE in 53 cases and 388 HA DVT in 292 cases (some cases suffered from more than one clot). Medical and Surgical services each had approximately half of the HA VTE cases, echoing results from registries[1].

By our risk assessment model, 4% of the general patient population was at low risk, 85% was at moderate to high risk, and 11% were at very high VTE risk. No HA VTE cases occurred in patients in the low-risk category, 81% of HA cases occurred in patient with medium-risk characteristics, and 19% were in the high-risk category. The distribution of VTE risk, severity of illness, and patient days of the population at risk were stable over the study periods.

HA VTE cases were reduced in 2007 compared with 2005-06, as were the preventable HA VTE cases (see Table 1, below). HA PE were reduced by over 50% in 2007, and a 35% reduction was enjoyed in HA DVT, whereas community-acquired VTE did not change. We detected no increase in HIT or prophylaxis-related bleeding using queries of coding data.

A more sophisticated analysis of our results is in development.

	2005 - 2006	**2007**	Chi sq
Community VTE Cases/year	123 - 129	133	NS
Hospital-Acquired (HA) VTE Cases/year	128 - 135	82	$p < .05$
"Preventable" HA VTE Cases/year	43 / 22	6	$p < .05$
HA Pulmonary Emboli	27 - 31	13	$p < .05$
HA Deep Venous Thrombi	137 - 158	93	$p < .05$
Patients at Risk	9,720 - 9,923	10,620	
Patient-days at Risk	59 - 62,000	62,505	

Table 1. Impact of VTE Prevention Protocol on VTE at UCSD in 2005-06 compared with 2007

Toolkit development, dissemination, and key lessons learned are incorporated into the discussion below.

Discussion
Venous thromboembolism (VTE) is a common preventable inpatient condition. Hospital-acquired pulmonary embolus (PE) is a primary source of preventable iatrogenic mortality, and deep venous thromboses (DVT) incur a huge morbidity and economic toll. Proven prophylactic measures are available and grossly underutilized in the inpatient setting, but available risk assessment models and VTE prevention protocols have not been rigorously prospectively validated until now. Developing reliable methods to improve prophylaxis rates is a national health system imperative.

We have validated our risk assessment model/protocol in several ways. First, we verified that the RAM was easy and efficient to use and had a high inter-rater reliability. Second, incorporation of the VTE RAM into the flow of work via modular order sets led to a sustainable increase in the use of proven prophylaxis methods. Third, implementation of the protocol led to marked decreases in the incidence of HA VTE though the number of patient days at risk stayed constant or increased.

Lessons Learned
The UCSD VTE prevention team used a proven performance improvement framework modeled after the Plan-Do-Study-Act rapid-cycle model popularized by the Institute for Healthcare Improvement (IHI) and additionally modified by our experience. Some key components we used, and that we promote for others, include:

- Forming a multidisciplinary team
- Gaining institutional support
- Identifying best practices
- Building the best practices into protocols and order sets
- Making certain the protocols and order sets are inserted into the flow of work
- Using good metrics that are amenable to formulating specific aims
- Identifying nonadherents to your protocol and intervening in real time.

We think the simple VTE RAM/protocol that we used is more user-friendly and reliable than point-based, complicated systems and is therefore more amenable to being placed in the flow of work via order sets. The RAM/order set need not be identical to ours to be effective, and some tweaking is necessary to gain key medical staff support, but the simple “no-math” approach is important to keep.

It is not enough to build a good protocol; the guidance inherent in the order set must be invoked upon virtually every patient admission and transfer. This may well require that pre-existing prompts/orders for VTE prophylaxis be removed so that the standardized protocol will replace them.

We endorse designing a VTE RAM that can be used as part of the intervention (order set) as well as part of the measurement of process (VTE prophylaxis audit tool) and outcome (review of VTE cases). The audits for adequacy of VTE prophylaxis take about 20 minutes per audit, and 20 audits per month is probably enough of a sample to accurately reflect practice.

Also, our experience (and the toolkit we built) reflects our opinion that concurrent monitoring for VTE cases is vastly superior to using administrative data that is reliant on coding. The recent University Healthsystem Consortium (UHC) benchmarking data results were sobering but instructive. UHC used administrative discharge code for VTE in a secondary position to identify patients with HA VTE, which is a common strategy to follow the incidence of HA VTE. The accuracy of identifying surgical patients with a HA VTE was only 60%. Proper use of the “present on admission” (POA) designation would have improved this to 83%, but 17% of cases either “did not occur” or had “history only,” with a labor-intensive manual chart review. Performance was even worse in medical patients, with only a 30% accuracy rate, potentially improved to 79% if accurate POA designation had been used; 21% of cases identified by administrative methods

either “did not occur” or had “history only.” In essence, unless an improvement team uses chart review of each case potentially identified as an HA VTE case, the administrative data are so inaccurate as to be worthless. Concurrent discovery of VTE cases allows for a more accurate and timely chart review and allows for near real time feedback to the responsible treatment team.

Working with other VTE and performance improvement experts from SHM, and using the lessons promoted by IHI, we formulated a valuable construct that we call the “Hierarchy of Reliability.” This construct can be helpful for predicting the performance of almost any important process.

Hierarchy of Reliability

Level		Predicted Prophylaxis rate
1	No protocol (“State of Nature”)	40%
2	Decision support exists but not linked to order writing; or prompts exist within orders but no decision support at hand	50%
3	**Protocol well-integrated into orders at point-of-care**	65-85%
4	Protocol enhanced (by other QI and high reliability strategies)	90%
5	Oversights identified and addressed in real time	95+%

As an example of how the hierarchy predicts performance with VTE prevention:
Level 1: State of Nature
In the “unimproved” modern hospital patients receive care that depends solely on the knowledge, skills, and memory of their physicians. There is no standardized assessment for VTE risk, and there are no reminders within the real-time flow of care delivery to prompt physicians to order VTE prophylaxis. In this ‘state of nature,’ expect approximately 40% of your patients to be on appropriate VTE prophylaxis at any given moment.

Level 2: Average
Many hospitals that have tried to improve VTE prophylaxis find themselves at Level 2, with only partially effective forays into the following two elements of a VTE protocol:

i. A *standardized VTE risk assessment* to guide choice of VTE prophylaxis, but it is not well integrated into admission and transfer order sets (i.e., it may exist as a stand-alone form or pocket card, etc.), or
ii. A *prompt* to order VTE prophylaxis is nested within admission and transfer order sets, but no VTE risk assessment to guide choice of VTE prophylaxis is available.

Level 3: VTE Protocol
Level 3 is the entry point for most serious QI efforts – a complete VTE protocol. All three elements of a complete VTE protocol are combined within a paper order set or CPOE. The more effective VTE protocols also have a visual aid that links the VTE risk level to the option(s) for appropriate prophylaxis; this visual link enables providers to make a rapid decision about an appropriate prophylaxis choice.

In other words, in a Level-3 VTE prevention program, not only are providers *prompted* to order VTE prophylaxis when completing admission or transfer orders, they also have a *standardized VTE risk assessment* immediately available to support medical decision-making. Level 3 makes it possible for providers to have what they need, when and where they need it (i.e., at the point of care), to make an appropriate prophylaxis choice.

Expect 60-70% of your patients to be on appropriate VTE prophylaxis with the Level-3 VTE protocol.

Remember that providers should always retain the freedom to deviate from the protocol when meeting the needs of a given patient. The protocol, with successive refinements, eventually should drive management choices in the great majority of patients.

Level 4: Layers of QI Strategies that Leverage the VTE Protocol
All of the conditions of Level 3 exist, but the use of the VTE protocol at admission and transfer is enhanced by additional QI strategies. At Level 4, you are using high-reliability mechanisms to make it a rare event for a patient to enter the hospital without going through your VTE protocol. Other high-reliability strategies include making preferred choices for prophylaxis the default, scheduling reassessments, and rapid-cycle feedback to providers.

Level 5: Oversights “Identified and Mitigated”[13]
Level 5 represents a profound leap in quality. Strategies that “identify and mitigate” these oversights are critical for achieving prophylaxis rates over 90%. Level 5 can be supported by an electronic reporting mechanism. We believe that an electronic reporting mechanism is feasible in almost any medical center and that this reporting mechanism can spur immediate intervention. A description of how this works in more concrete terms is in order. A census of all ward patients, sorted by ward location, could be merged with a pharmacy-generated listing of patients on any prophylactic or therapeutic anticoagulant. Each day, every ward is therefore provided with a report that gives them a denominator (all patients on their ward), and a numerator (all patients on any anticoagulation), thus providing a crude measure of VTE prophylaxis prevalence. All patients on no anticoagulation are quickly screened for the presence of any VTE risk factors and for the presence or absence of contraindications for pharmacologic prophylaxis (usually by nursing or pharmacy). A simple intervention consisting of a templated note or a phone call to the physician is initiated for patients who seem at risk for VTE and have no obvious bleeding or bleeding risk. This approach has proven powerful at our center and several others. Essentially, it incorporates an automated measurement, which spurs a daily intervention---hence, the newly coined term “measure-vention.”

Toolkit Development

National contributions have largely been channeled via the Society of Hospital Medicine (SHM). UCSD team members worked with great collaborators like Jason Stein (Emory) and Sylvia Mckean (Brigham and Women's); Janet Nagamine (Kaiser), Kathleen Kerr (UCSF), and Alpesh Amin (UCI); Tina Budnitz; and a host of other talented people to create resources/toolkits promoting wider adaptation of these principles and strategies.

Three venues UCSD has influenced include:
1. SHM Quality Improvement "Resource Rooms"
2. SHM VTE Prevention Collaborative, and
3. SHM Quality Improvement course.

The Quality Improvement Course is a full 1-day experience that covers many of the principles and the framework for performance improvement described above, with afternoon sessions that allow participants to focus on any of three focus areas, one of which is VTE Prevention.

The SHM VTE Prevention Resource Room is a web-based toolkit that incorporates a QI primer, educational slideshows that can be downloaded free of charge, an annotated bibliography with an outline of key literature, and a detailed step-by-step guide to assist improvement teams in effectively implementing a VTE prevention protocol. The template generated by our efforts has been used for all subsequently developed SHM Resource Rooms on other important areas, such as CHF, Transitions in Care, and Glycemic Control.

The SHM VTE Prevention Collaborative is especially noteworthy in terms of demonstrating that the innovative application of this framework as it applies to VTE prevention can be generalized to other hospital systems. Minor variants of the UCSD prevention protocol and strategies are being implemented or considered at multiple mentee sites and other health systems. Several VA sites are joining the VA Prevention collaborative. Jason Stein and I are acting as advisors to a VA Task Force on VTE Prevention. These VA sites will be implementing order sets and measurement systems similar to those pioneered at UCSD in preparation to roll out a standardized process across all 130 VA sites.

In recognition of these accomplishments, the UCSD VTE Prevention team was just awarded the first annual Team Improvement Award.

Conclusion and Implications

We believe that the UCSD VTE Prevention team has developed scalable, portable methods to make a large impact on hospital-acquired VTE with convincing results and a prospectively validated model. The potential benefit is enormous, especially if the spread to healthcare systems with a common information database can be leveraged to generate "measure-vention" strategies more widely.

Publications and Products Generated by this effort

Society of Hospital Medicine VTE Resource Room. Last Accessed February 12, 2008 http://www.hospitalmedicine.org/AM/Template.cfm?Section=Quality_Improvement_Resource_Rooms&Template=/CM/HTMLDisplay.cfm&ContentID=631246.

Quality Improvement in the Hospital: A QI Primer - Society of Hospital Medicine Resource Room Presentation. Last Accessed February 12, 2008 http://www.hospitalmedicine.org/AM/Template.cfm?Section=Quality_Improvement_Resource_Rooms&Template=/CM/HTMLDisplay.cfm&ContentID=631246.

Preventing Hospital-Acquired Venous Thromboembolism: A Guide for Effective Quality Improvement Society of Hospital Medicine website, VTE Quality Improvement Resource Room. Maynard G, Stein J. Available as a pdf. Last accessed February 12, 2008 http://www.hospitalmedicine.org/AM/Template.cfm?Section=Quality_Improvement_Resource_Rooms&Template=/CM/ContentDisplay.cfm&ContentID=6092

Society of Hospital Medicine VTE Prevention Collaborative Web Site/Toolkit. Last accessed February 12, 2008 http://www.hospitalmedicine.org/AM/Template.cfm?Section=VTE_Prevention_Collaborative1&Template=/CM/HTMLDisplay.cfm&ContentID=11323

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