QUALITY IMPROVEMENT REPORT

Lessons from the Johns Hopkins Multi-Disciplinary Venous Thromboembolism (VTE) Prevention Collaborative

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Abstract

Problem Venous thromboembolism (VTE) is a common cause of potentially preventable mortality, morbidity, and increased medical costs. Risk-appropriate prophylaxis can prevent most VTE events, but only a small fraction of patients at risk receive this treatment.

Design Prospective quality improvement programme.

Setting Johns Hopkins Hospital, Baltimore, Maryland, USA.

Strategies for change A multidisciplinary team established a VTE Prevention Collaborative in 2005. The collaborative applied the four step TRIP (translating research into practice) model to develop and implement a mandatory clinical decision support tool for VTE risk stratification and risk-appropriate VTE prophylaxis for all hospitalised adult patients. Initially, paper based VTE order sets were implemented, which were then converted into 16 specialty-specific, mandatory, computerised, clinical decision support modules.

Key measures for improvement VTE risk stratification within 24 hours of hospital admission and provision of risk-appropriate, evidence based VTE prophylaxis.

Effects of change The VTE team was able to increase VTE risk assessment and ordering of risk-appropriate prophylaxis with paper based order sets to a limited extent, but achieved higher compliance with a computerised clinical decision support tool and the data feedback which it enabled. Risk-appropriate VTE prophylaxis increased from 26% to 80% for surgical patients and from 25% to 92% for medical patients in 2011.

Lessons learnt A computerised clinical decision support tool can increase VTE risk stratification and risk-appropriate VTE prophylaxis among hospitalised adult patients admitted to a large urban academic medical centre. It is important to ensure the tool is part of the clinician’s normal workflow, is mandatory (computerised forcing function), and offers the requisite modules needed for every clinical specialty.

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Extra material supplied by the author (see http://www.bmj.com/content/344/bmj.e3935?tab=related#webextra)

Appendix 1: Example of paper order set for prevention of venous thromboembolism in surgery departments (includes general surgery, surgical oncology, urology, and vascular surgery)

Appendix 2: Example of computer algorithm for prevention of venous thromboembolism in general surgery department
Background

Venous thromboembolism (VTE) is a silent health risk for many inpatients, causing deaths, complications, and increased medical costs.1 In the US almost 800,000 patients have a VTE and 25% die from pulmonary embolism before medical intervention every year.1 Treatment is expensive; each deep venous thrombosis or pulmonary embolism costs an estimated $10,000 (£6466; €8076) and $16,000 (£10,345; €12,921), respectively.2 Complications such as post-thrombotic syndrome affect as many as 60% of patients with deep venous thrombosis and result in annual socioeconomic costs of $200m.3,4

Evidence based consensus guidelines recommend prophylaxis for many hospitalised patients to prevent VTE.3 Assessment of each patient’s risk for bleeding and thrombosis is essential to ensure selection of the optimal prophylaxis strategy. Anticoagulant prophylaxis should be selectively administered given the associated risk of bleeding, cost, and modest benefits for some patients.5,7 In the UK, the National Institute for Health and Clinical Excellence (NICE) has established guidelines for risk adjusted VTE prevention. However, many patients who would benefit from prophylaxis do not receive it. In a multinational study, only 58.5% of surgical patients and 39.5% of medical patients received appropriate VTE prophylaxis.8 Another study found that only 42% of patients with deep venous thrombosis had received prophylaxis before its diagnosis.9 A 2012 study reported that only 40% of Austrian patients in intensive care received prophylaxis in line with guidelines.10 Some agencies are measuring VTEs as preventable complications to drive quality and pay for performance. The NICE quality standard requires that “all patients, on admission, receive an assessment of VTE and bleeding risk” using their criteria,11 although this requirement is controversial.12 Not all VTEs are preventable,13 which raises concern about using VTE rates as a measure of healthcare quality.14

In September 2005, patient safety and quality leaders at the Johns Hopkins Hospital conducted a random chart audit in several high risk patient populations and found that only 33% of 322 patients received appropriate VTE prophylaxis. The Venous Thromboembolism (VTE) Prevention Collaborative was established to improve the use of risk-appropriate prophylaxis at the Johns Hopkins Hospital. This paper describes the VTE Prevention Collaborative and the methods used to develop and implement a clinical decision support tool for VTE prophylaxis.

Strategy for change

This prospective quality improvement activity was conducted by a multidisciplinary team comprised of a haematologist, trauma surgeon, critical care intensivist, intensive care nurse, pharmacist, several information technology specialists, an administrative coordinator, and several quality and safety clinical researchers. The Johns Hopkins Center for Innovation in Quality Patient Care helped coordinate the collaboration and involvement of all clinical departments. The Johns Hopkins University Institutional Review Board approved the retrospective collection and analysis of data from this quality improvement project.

The VTE Prevention Collaborative applied the “translating research into practice” (TRIP) model15 to implement a mandatory clinical decision support tool for VTE risk stratification and risk-appropriate prophylaxis for all adult inpatients. The TRIP model has four steps: summarise the evidence, identify local barriers to implementation, measure performance, and ensure patients receive the interventions.

Step 1. Summarise the evidence and identify quality improvement interventions

After reviewing the VTE prevention guidelines of the American College of Chest Physicians (ACCP)16 and the Eastern Association for the Surgery of Trauma (EAST),17 the collaborative team identified three pertinent prevention practices: identification of patient risk factors for VTE and bleeding, stratification of patients into VTE risk categories with corresponding recommendations for prophylaxis, and provision of alternatives for patients with contraindications to drug prophylaxis.

Checklists have proved effective in other areas of healthcare, having helped improve safety attitudes and evidence based practices for infection control and reduce postoperative complication rates and infection rates.18,19 Thus, in early 2006, paper order sets were developed to standardise the VTE prevention process (see appendix 1 on bmj.com). A one page paper order set was created for each of six clinical services with high patient throughput (such as orthopaedics, medicine, surgery, trauma, and neurology and neurosurgery) that were willing to participate in the collaborative. We hypothesised that specific forms for each service would increase provider buy-in. Clinician researchers from the VTE collaborative met with representatives from each clinical service to explain the collaborative’s aims and gain consensus from both administrative and frontline staff.

Step 2. Identify local barriers to implementation through pilot testing

The paper order set for surgery was pilot tested in 2006 to determine the feasibility and usability of the form. The form guided clinicians through the risk stratification process and recommended appropriate VTE prophylaxis. Once completed, the sheet was deposited in a designated box for collection by the collaborative’s coordinator. Some surgical services required individual physicians to complete the form, whereas others designated one provider to complete all the forms. Although the latter strategy ensured consistent risk assessments, this approach also posed problems. For example, order set compliance was nearly 100% on one service where a single, dedicated nurse practitioner assessed patients, but this plummeted to nearly zero compliance when she was on vacation. Clinicians found the paper order set time consuming to locate and complete, and it was not part of their normal workflow for order entry. Also the collaborative team found it resource intensive to track provider performance given the large patient volume. The paper forms were visually challenging for users given the large number of risk factors for VTE and bleeding and the corresponding variety of prophylaxis options (see appendix 1 on bmj.com). In a systematic review, Tooher et al concluded that a combination of active reminders and prophylaxis recommendations was the most effective strategy to increase the use of VTE prophylaxis.20

Given this information and the hospital’s transition to computerised physician order entry (CPOE), the collaborative team approached the hospital’s information technology department in 2006 to design a CPOE based clinical decision support tool. The VTE clinical decision support tool included a forcing function to make risk assessment mandatory, a default feature that recommended risk-appropriate prophylaxis, and an auto-populate feature that displayed relevant medical information from the patient’s electronic medical record (such
as age, weight, haemostatic parameters, estimated creatinine clearance). We made the VTE prophylaxis module a mandatory field in CPOE admission and transfer order sets because evidence suggests technology based change is difficult if it is not hardwired into the clinical workflow. Once risk stratification is complete, clinicians can order the recommended prophylaxis or a different prophylaxis option. As some physicians had complained that the paper order sets were too general for their specialised patient population, we developed 16 evidence based, specialty specific VTE order sets in collaboration (appendix 2 on bmj.com shows the general surgery module).

The first VTE prophylaxis order set was pilot tested in July 2007 on the orthopaedic spine surgery service. The order sets for internal medicine, general surgery, trauma surgery, orthopaedic hip and knee replacement, orthopaedic shoulder replacement, and orthopaedic trauma were activated in December 2007. Subsequent order sets for cardiac surgery, otolaryngology, neurology, neurosurgery, and obstetrics and gynaecology were debuted at three month intervals throughout 2008. Medical oncology was brought online in 2009. From an informatics and user perspective, the collaborative found it much easier to develop and implement multiple specialty-specific order sets rather than one large complex order set. For example, if one large surgery order set was designed, we found that the risk stratification process would be too cumbersome and time consuming for providers. Designing specialty-specific order sets allowed us to customise and condense the risk stratification and prophylaxis selection process.

Step 3. Measure performance

The collaborative team initially focused on measuring process measures such as the percentage of patients risk stratified within 24 hours of admission and ordered risk-appropriate VTE prophylaxis. Reports were generated monthly and distributed to departmental leaders and quality management staff. To facilitate data analysis and distribution, a web based VTE prophylaxis database was constructed that allowed performance assessments on institutional, departmental, divisional, service, and individual provider levels.

Step 4. Ensure patients receive the intervention by engaging staff, executing the intervention, and evaluating performance

The collaborative used multiple methods to engage and educate stakeholders throughout the organisation. Departmental meetings were held to summarise the evidence for VTE prophylaxis and to demonstrate the order sets. Annual hospital-wide symposia were held featuring world renowned VTE experts, personal stories from individual patients with VTE, and the latest results from the Johns Hopkins VTE Prevention Collaborative. The collaborative has worked closely with local service champions (such as in hospital medicine, plastic surgery, medicine) to catalyse improvement on a local level. For example, the physician champion from hospital medicine has developed a “pay for performance” initiative linking individual performance on VTE prophylaxis with bonus compensation. On the medicine service, the physician champion has organised a competition among the house staff services, awarding a pizza party to the service with the best VTE prophylaxis performance at year’s end. On a departmental level, monthly audits of VTE prophylaxis performance were conducted to motivate continual performance improvement.

Changes after interventions

The paper based order sets increased VTE risk assessment and risk-appropriate prophylaxis (fig 1). Among surgical patients, orders for risk-appropriate prophylaxis increased from 26% (42/161 patients sampled) at baseline to 68% (178/262) over a 12 month period. In 2008, the first year after the CPOE modules were installed, risk-appropriate prophylaxis was ordered for 72% of surgery patients and 80% of medicine patients (fig 1). In 2011 risk-appropriate prophylaxis was ordered for 80.2% (5159/6433) of surgery patients and 92.2% (10 162/11 024) of medicine patients. A more than threefold improvement in prophylaxis compliance was seen between baseline and the most recent year (2011) of the computerised decision support tool.

In a recently published before and after study of adult trauma patients, we showed that compliance increased significantly (66.2% v 84.4%, P<0.0001) and preventable harm from VTE decreased dramatically (1.0% v 0.17%, P=0.037).

Changes after interventions have improved compliance in UK hospitals, we found that a bottom-up approach was more effective and sustainable in our work environment.

We also learnt that institution-wide involvement was imperative because of the large number of patients at risk for VTE. This necessitated a team with broad and varied expertise (including administration, informatics, medicine, patient safety, and quality leaders) and buy-in from all levels of the organisation, from frontline care providers to the president of the hospital and chief executive officer of the health system. Our multidisciplinary collaborative team allowed us to garner the necessary support from leadership and provided the credibility to engage providers and convince them of the need for change across the organisation. We engaged clinical champions in each specialty to ensure that our prevention strategies were congruent with current clinical practice and best practices.

We found that education helped convince providers of the need for change, but a forcing function was also necessary to ensure consistent performance. The VTE prophylaxis order sets had to be efficient, evidence based, user friendly, and firmly integrated into routine workflow, and had to allow for real-time performance assessment and feedback. The paper order sets provided standardisation of VTE prevention but were labour intensive for users, lacked a forcing function, and made compliance assessment difficult. These shortcomings were eliminated with our computerised VTE prophylaxis order sets.

Moving forward, we will continue to monitor the literature on VTE prophylaxis to ensure our decision support modules remain current. We are also considering switching from an “opt in” system (prophylaxis is suggested and provider must select it) to an “opt out” system (provider must actively decline the default
Avoiding Common ICU Errors: randomised controlled trial of two bundles of transfusion practice for patients undergoing major surgery.

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Page 4 of 5

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prophylaxis and possibly give a reason) in an attempt to further increase compliance with risk-appropriate prophylaxis. Opt-out orders have increased compliance rates with evidence based guidelines in other inpatient settings. We are also considering the feasibility of reminder alerts to prompt providers who initially documented contraindications to drug prophylaxis to reconsider these contraindications at a later point in the hospital stay and perhaps start drug prophylaxis. In addition, we plan to roll out the computerised VTE prophylaxis modules to other hospitals in Johns Hopkins Medicine.

Future research will focus on evaluating the impact of our modules on risk-appropriate prophylaxis, rates of symptomatic VTE, and cost savings. VTE in hospitalised patients is a global health issue, and standardised methods of risk assessment and appropriate prophylaxis are needed. We implemented a VTE prevention collaborative in a large academic medical centre that was adequately resourced to develop and implement a computer based tool. We are confident this model would work in similar hospitals around the world. Smaller hospitals and hospitals with limited resources could use mandatory paper based order sets.

Consort authors: MBS conducted the baseline evaluation, designed the paper order sets, developed the computerised order sets, conceived the research question, and interpreted the results. He is the guarantor for the article. DBH conducted the baseline evaluation, designed the paper order sets, developed the computerised order sets, conceived the research question, collected the data, and interpreted the results. PSK developed the computerised order sets, conceived the research question, and interpreted the results. AMD conducted the baseline evaluation and designed the paper order sets. BDL collected the data, designed the data analysis, and interpreted the results. PBH conducted the baseline evaluation and designed the paper order sets. CGH helped draft and revise the manuscript and interpreted the results. PJP conceived the research question and interpreted the results. RTC conceived the research question, provided administrative support, and interpreted the results.

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Figures

**Fig 1** Changes in venous thromboembolism (VTE) risk assessment for medical and surgical inpatients at key points in the implementation of a clinical decision support tool for VTE risk stratification.

**Fig 2** Changes in venous thromboembolism (VTE) risk assessment for medical and surgical inpatients since implementation of a computerised clinical decision support tool for VTE risk stratification.