Using a Framework for Spread of Best Practices to Implement Successful Venous Thromboembolism Prophylaxis Throughout a Large Hospital System

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Abstract

Best practices take time to spread passively, at times contributing to suboptimal results in health care. Managed diffusion, often referred to as "spread," may hasten broad-scale implementation of best practices. At our institution, appropriate use of venous thromboembolism (VTE) prophylaxis had been markedly improved in select areas by independent quality improvement teams. We wanted to accelerate the adaptation of those locally learned best practices across our entire institution and did so by following an explicit framework for spread. We report our experience using this framework, noting both how the framework helped anticipate needs and what challenges we encountered that were not anticipated based on the spread plan. Using our framework, we were able to spread the changes across more than 79 distinct hospital services, improving use of appropriate VTE prophylaxis to more than 95%. Use of an explicit, well- constructed spread plan allows for an orderly management of diffusion of best practices.

Keywords

safety, venous thromboembolism prophylaxis, spread, diffusion

It is widely recognized in health care that there is a significant chasm between accepted best practices and the broad and reliable implementation of those practices.1 Knowledge gained by research typically is disseminated via peer-reviewed publication, national presentations, peer-to-peer networks, and marketing, whereas innovations and solutions born at local levels (that are nonetheless applicable to the problems faced by others) have few established communication channels for dissemination. Furthermore, the connection between dissemination of knowledge gained and validated at a local level through quality improvement (QI) efforts and implementation of the same at distant sites is weak. One estimate suggests that, on average, it takes as long as 17 years for conclusions from research to reach clinical practice.2 Recent experience shows that the diffusion of innovation through active management and organized frameworks is superior to passive or less structured means.3,4

Herein we explore the practical application of a framework for spread to enhance the provision of venous thromboembolism (VTE) prophylaxis for hospitalized patients in our institution.5 We hope to contribute to the science of diffusion by identifying elements of the framework that worked well, suggesting improvements where we encountered difficulties in execution.

Methods

Our diffusion project was performed at 2 Mayo Clinic hospitals in Rochester, MN, which together serve as

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tertiary teaching hospitals with 1951 licensed beds staffed by a 1717-physician group practice. The framework we use in our institution (Figure 1) has been adapted from a framework proposed by Nolan et al. and Massoud et al. The main components of the framework include (a) identification of diffusion ideas from local successful implementations, (b) development of a spread leadership team to spearhead diffusion efforts, (c) setup of the spread plan, (d) enhancement of social systems to foster spread, and (e) local adaptation of the QI interventions to enhance local workflow. Our goal was to develop an institution-wide VTE prophylaxis program based on 2 pilots that had successfully improved appropriate use of VTE prophylaxis.

The Diffusion Ideas

Background and successful pilot projects. VTE is considered to be the most common preventable cause of hospital death in the United States and the third most common cause of all hospital-related deaths. Without VTE prophylaxis, deep venous thrombosis occurs in 10% to 40% of general medical or surgical patients and in up to 60% of orthopedic surgery patients; one third of these may progress to pulmonary embolism. Effective VTE prophylaxis reduces VTE by 60% or more, yet in a recent multicenter international study, it was used appropriately in only 33% of patients in whom VTE prophylaxis was indicated. Improving appropriate use of VTE prophylaxis has been a major emphasis of recent efforts to improve patient safety, earning the highest rating of 79 patient safety practices evaluated by the Agency for Healthcare Research and Quality. Improving VTE prophylaxis was selected as a high-priority safety project at our institution.

Two teams working independently in selected surgery and medicine services had completed pilot projects to improve VTE prophylaxis. Each independent team’s work resulted in the reduction of defect rates on pilot hospital services to <10% (Figure 2) prior to our diffusion project. Key learning points from both the pilots were the following: (a) 98% of inpatients had at least 1 risk factor for VTE and (b) when physicians explicitly determined a VTE prophylaxis plan (by ordering prophylaxis or by
Figure 2. Medicine and surgery pilot projects reduced defect rates to <10%

Pilot projects were conducted independently in the Department of Medicine and in selected services in the Department of Surgery to improve the rate at which prescribers assessed risk for and prescribed appropriate prophylaxis against venous thromboembolism (VTE).

denoting that VTE prophylaxis had been considered but was not indicated), they made the correct decision 98% of the time. The pilot teams learned that it was critical for providers to be reliably prompted to make a VTE prophylaxis plan for each patient.

An essential element was to position a requirement for a VTE prophylaxis selection into the workflow of the standardized admissions/transfer and selected postoperative order sets. This section of the order sets was called the “VTE Prophylaxis Tollgate” (Figure 3). Adding this “tollgate” resulted in marked and sustained improvement in appropriate VTE prophylaxis use in patients served by providers who used those order sets. It was noted that, although the correct initial VTE prophylaxis plan was selected most often, a small number of defects arose when VTE prophylaxis was held or cancelled for procedures or bleeding complications and then inadvertently not restarted. Alternatively, defects occurred when patient status dictated a change in the need for prophylaxis (eg, if a patient was admitted originally without risk factors and with a planned stay of less than 24 hours, but clinical circumstances subsequently changed and engendered increased risk for VTE). Defects noted during the pilots are shown in Figure 4.

**Ideas to spread.** The addition of the VTE prophylaxis tollgate concept within key order sets improved the reliability of VTE prophylaxis and was the focus of the diffusion project. Furthermore, because a patient’s status may change during a hospitalization, the team designed and implemented computerized clinical decision support (CDS) logic to alert the clinician if a patient did not have a VTE prophylaxis plan in place within 24 hours of admission, if VTE prophylaxis was not in place for 24 hours at any time during hospitalization, or if “low risk” status was selected but the patient had been hospitalized for more than 3 days. Finally, to avert increased rates of bleeding that might arise from more liberal use of anticoagulants (a common pharmacologic means of VTE prophylaxis), CDS algorithms were designed to remind clinicians to discontinue anticoagulant therapy when scheduling procedures with high risk for bleeding.

**Spread Leadership Team**

Consistent with the framework for spread, our spread team included physician champions, a project manager, a pharmacist, a nurse who creates computerized physician order entry (CPOE) system content, and the institutional quality office personnel who assisted with the measurement, analysis, and display of data. To emphasize the engagement of institutional leadership, the project was commissioned by the institution’s Clinical Practice
Figure 3. The “VTE Prophylaxis Tollgate”
Admitting patients to the hospital or transferring between services represents a key opportunity to prompt the clinician to evaluate the need for venous thromboembolism (VTE) prophylaxis. We designed order set segments that required the clinician to select either that VTE prophylaxis is not indicated at this time (list of risks is available by clicking the “Additional Information” tab in upper right), a form of pharmacologic prophylaxis, or mechanical prophylaxis. We called these order segments (contained in the dotted rectangle) “tollgates” because, like those encountered on toll roads, the clinician must pass through this to continue the workflow. Note: in this example, selecting Knee-high Antithromboembolic stockings (which are not effective as VTE prophylaxis when used alone) requires additional selection of sequential compression devices to clear this order screen.

Quality Oversight Committee and was cochaired by the Department of Medicine Associate Chair for Quality and the Chair of the Surgical Quality and Safety Subcommittee. The team was kept small, consulting content and practice group experts when needed, and thus was able to meet with sufficient frequency to maintain the momentum and direction of the project.

Setup for Spread

**Target population.** In our institution, patient care is organized by “services” or teams that render care across various nursing units. Overall, there are 79 distinct services, including general internal medicine, pulmonary, cardiovascular, gastrointestinal disease, critical care, and multiple surgical services. Because teams care for distinct patient types and are led by content experts for those patient types, some care components and hence order sets are highly evolved and specialized to those services, whereas others are shared across the institution. We aimed to spread the use of VTE tollgates to all key order sets serving adult inpatients.

**Key partners and initial spread plans.** After studying the patient populations and workflow, we determined that 90 order sets would require the insertion of a VTE tollgate. The critical order sets differed between services based on workflow (eg, the critical decision point for medical patients may be at admission, while for surgical patients, it may be when completing postoperative order sets). We realized that because the various service order sets had been developed by local champions lending specific practice groups, they would be our best partners to spread the tollgates to all key order sets. Reminders to restart VTE prophylaxis were communicated as pop-up
alerts to the provider during interaction with the electronic medical record. To optimize the pop-up alerts for maximum meaning and minimal bother, we performed Plan-Do-Study-Act (PDSA) tests using surveys of the users to obtain feedback regarding the usefulness of the pop-ups with respect to content and intrusion into the workflow.

**Strengthening the Social System**

We used the hospital practice chairs, clinical nurse specialists, nurse managers, pharmacists, and resident program directors to help communicate the key messages regarding the project to caregivers. To facilitate this, we created standardized announcements and PowerPoint presentations to be used by these individuals as communication/education aids. Messages also addressed common concerns about workload and identifying eligible patients. We provided each service with their measurements of appropriate VTE prophylaxis prior to, just after, and 30 days after rollout of the new order set modifications to help create the sense of need and to reinforce successful gains.

**Local Adaptation**

For most services, the practitioners were able to arrive quickly at a consensus regarding applicability of VTE prophylaxis guidelines to their individual practices, and the accepted version of the VTE prophylaxis tollgate was negotiated by taking into account the primary patient population, services provided, and local logistics of patient flow. This resulted in minor but important variations to the VTE prophylaxis tollgate. For example, cardiology practices were adversely affected by having low-molecular-weight heparin (LMWH) started at the time of admission for some of their patients because within 24 hours of admission it was determined that cardiac catheterization was desirable. They found that procedural delays caused by the increased risk imposed by LMWH were not in the best interests of the patient. Therefore, extra instructions and a change in the “preferred” pharmacologic prophylaxis choice were added to the tollgate to modulate choice of VTE prophylaxis.

Differences in preferred prophylaxis practices in urologic and neurosurgery also required slight modification of the VTE prophylaxis tollgates to make it easy for those
clinicians to make the correct choice for their patients. The uniqueness of pediatric practice, where there were no widely acceptable guidelines or consensus for VTE prophylaxis, offered challenges. Communications with that practice began early in the spread project as we knew that experience-based consensus rather than robust published data would drive decision making. Ultimately, they were not able to arrive at consensus in time for this spread project, and thus our target population was confined to adult inpatients. Ongoing discussions and work continue in these areas.

Quality Measurement and Analysis
We measured process and outcome variables for the VTE spread project. A VTE prophylaxis plan was considered appropriate if either a or b were present: (a) VTE risk factors were present and either pharmacologic or mechanical VTE prophylaxis measures were ordered within 24 hours of admission or reasons that neither method could be used were documented, or (b) VTE risk factors were not present and the decision that VTE prophylaxis was not indicated was documented within 24 hours of admission. The primary process measure was the percentage of key order sets that contained finished VTE prophylaxis tollgates expressed as a percentage. The primary outcome measure was percentage of adult inpatients with an appropriate VTE prophylaxis plan.

Countermeasures (undesirable outcomes of the intervention) were sampled by chart review and survey and included the rates of clinically significant bleeding (defined as bleeding and a need for blood products) and of procedures cancelled as a result of VTE prophylaxis. For outcome measures, a statistically valid sample of inpatients on a given day was randomly selected and a manual chart review was performed to determine the percentage of patients on an appropriate VTE prophylaxis plan and the number of patients with clinically significant bleeding after initiation of VTE prophylaxis. We sought a 95% power ($\beta = .95$) to detect a compliance change from the baseline 79.2% to our goal of 95% compliance with an $\alpha$-error estimate of no more than 5%. We determined that we needed at least 112 charts; we reviewed 125 charts. The number of procedures cancelled was solicited by a manually completed survey of interventional radiology, cardiac catheterization laboratories, and endoscopy areas. These measures were repeated after each major implementation phase: (a) Phase I, baseline; (b) Phase II, after 100% of identified key order sets had the VTE tollgate inserted, which was accomplished by month 7; and (c) Phase III, after the CDS surveillance system was implemented for all patients throughout the hospital (12 months after commencement of the project). To see if the changes were sustained and to calibrate ongoing automated measures, we reviewed a sample of patients again 8 months after the sample in Phase III (Phase IV), 20 months after project start.

Results
At baseline (Phase I), we found appropriate VTE prophylaxis in 79.2% of patients (Figure 5) and use of VTE prophylaxis tollgates in 62% of candidate order sets.
After baseline measures, we verified causes of defects by direct review, categorizing according to failure to use tollgates versus other various reasons, as had been done in the pilot projects, and modified our approach based on our findings.

Nearly all defects occurred in clinical areas not served by tollgate-bearing order sets. For some of these areas, such as pediatric surgery, neither extant evidence-based guidelines nor clinical consensus existed. In certain clinical practices, such as urology, there was disagreement about applicability of existing VTE prophylaxis recommendations. In other areas there were inexplicit trade-offs related to logistical issues, such as delays in tests that might be caused by VTE prophylaxis. This served as information for discussion of local adaptations and acceptance of VTE prophylaxis tollgates.

At 7 months into the spread project, 100% of all key order sets had an adapted VTE prophylaxis tollgate inserted (Phase II). An ongoing plan with the Order Set and Proposal Approval Group was set such that all new order sets would undergo VTE prophylaxis tollgate assessment. There was a concurrent improvement in appropriate VTE prophylaxis to 93.6% (Figure 5). After deploying the CDS tools (Phase III), the rate of appropriate VTE prophylaxis further improved to 96.8%. Clinically significant bleeding complications were measured for Phases I to III, and none were detected. At Phase I, 1% of procedures were rescheduled or cancelled due to anticoagulation conflicts, whereas at phases II and III there were none. At the close of the spread project (Phase IV), there was a statistically significant improvement in appropriate VTE prophylaxis to 98.4%.

Discussion

We used the Framework for Spread, adapted from the Institute for Healthcare Improvement,9 to plan and organize the diffusion of best practices regarding VTE prophylaxis across our entire hospital. The explicit choice to use an established theory for diffusion of practices is advocated but rarely done. One systematic review found that only 22.5% of dissemination and implementation studies explicitly used cognitive, behavioral, or organizational theories of change.13 An overarching advantage of adopting the framework was that its use avoided the need to newly invent an approach to spreading best practices honed in pockets of excellence throughout the organization and to rightly anticipate needs for the project. Our diffusion process took 7 months and resulted in a greater than 14% improvement in the proportion of patients receiving appropriate VTE prophylaxis. The improvements were furthered by addition of CDS rules that generated reminder prompts to clinicians to reassess VTE prophylaxis plans. The gains, also facilitated by the CDS rules, were sustained over the subsequent 8 months. A control plan for ongoing maintenance and review was established. Apart from succeeding in our overall goal to lower our defect rate to less than 5%, we learned lessons regarding implementation of diffusion in our institution. We found that the critical aspects of success included locating and exploiting critical pathways in patient care (in this case, the process of writing admitting, transferring, or postoperative orders), involvement of key local practice champions who had ownership of those critical pathways, and adaptation of the spreading practice to the new context to create a new “best practice variant.” We believe that the institutional shift to CPOE also facilitated the gains by creating common workflows and by enabling electronic reminders via CDS.

Because of our institution’s size and evolution, most services did not share similar workflows or order sets. At the start of our project, each surgical and medical specialty service had nearly unique order sets and practices. Standardization of work is necessary and difficult to achieve. For our project, a working knowledge of the clinical practices was needed to identify the key order sets and stakeholders for this project. Because of this, successful spread required a wise choice of team members who could liaise with the practices, customizing VTE prophylaxis to be culturally sensitive to each practice and yet remain evidence based. The spread team needed detailed knowledge regarding practice committee structure and champions and had to aggressively pursue agreements. These factors might be expected to surface during a RACIVD (responsible/accountable/consulted/informed/veto/devil’s advocate) and stakeholder analysis.

Team composition was very important to our successes. In our project, an executive physician process owner (in this case, shared between the Associate Chair for Quality, Department of Medicine, and the Chair of the Surgical Quality Committee) was empowered to deploy the spread and was provided adequate resources and time, including necessary information technology resources and a project manager to oversee day-to-day operations and address concerns that were key parts of the dissemination framework. These physicians had direct access and were empowered by department and institutional leadership to approach practice chairs for each hospital service to discuss goals. The practice chairs then served as the champions within their hospital services to gain consensus regarding VTE prophylaxis tollgates and use of order sets. They were excellent messengers (Figure 1) for the needed changes to practice. The physician process owners and champions also had ready access to colleagues who were experts in the area of VTE prophylaxis and who served as content experts.

The pharmacist was an invaluable asset. She had detailed knowledge of ordering and prescribing patterns
across services. She also possessed the clinical training that allowed accurate assessment of ordering patterns in the context of the medical situation. Financial concerns regarding therapeutic choices gained input via her knowledge of pharmaceutical costs.

Project management was necessary to remove scheduling barriers, serve as liaison with institutional quality initiatives, and organize the implementation and retention of records. The project manager also facilitated the development of a control plan for the project. Data and statistics specialists contributed by development and implementation of the measurement plans, data analysis, and data display that enhanced problem solving and communication of results to providers and leadership.

Several members of the spread project team had served previously on the VTE prophylaxis pilots and they drew on that experience, lessons learned, and their already well-established organizational ties from the pilots to help avoid pitfalls previously encountered and to accelerate decision making. The importance of adapting locally developed solutions to new contexts has been emphasized by the suggestion that “spread” might better be termed “reinvention” in the sense that it takes creativity and discipline to change new ideas into new and accepted processes. A shorter time frame with PDSA cycles to adapt the change to local specialties or clinics is important for safety, efficiency, and buy-in. Involving the local practice in the design of the content and defaults of their VTE prophylaxis tollgates and reminder pop-ups earned buy-in and enthusiasm for doing the right thing. This benefit of buy-in was weighed against the extra time it took to meet with each practice to discuss the project goals and details. One important lesson from these meetings was that gaining agreement on order sets and pop-ups was far easier when actual mock-ups were available during discussions than when only principles were discussed.

The success of the diffusion needs to be tracked in the same way as any improvement project would be. Timely and frequent feedback to the leadership and other stakeholders on measurements and barriers is important to highlight what the barriers are and if there are unanticipated consequences of the implementation of change. We found that reporting process and outcome data for Phases I to III to the practices helped sell the importance of making the needed changes.

Using the Framework for Spread model (Figure 1) helped us plan and anticipate needs and barriers for our project. However, unexpected barriers did arise, which included unanticipated strains on information technology (IT) resources and gaps in scientific evidence. In retrospect, inclusion of a member from IT, rather than communication with IT, may have improved coordination and avoided delays. When electronic media is expected to play a role, early involvement with IT personnel may prevent unnecessary delays. If an IT member is not able to be part of the spread team, a contract for service with IT that clearly outlines timelines and consequences if timelines are not met may be an option for some institutions.

We originally had planned to include pediatric practice groups in the spread, but found there was too little in the scientific literature and not enough consensus among the varied pediatric services to include them in the ultimate plan. In future projects, we will take care during the development of diffusion ideas and the setup phase to determine whether the needed science or consensus is established enough to enable spread (Figure 1).

Development and execution of a diffusion plan may not be needed in all institutions or situations. For example, if there already is a high degree of standardization of work across an institution, changes to the work might be quite modular and implemented more quickly than would occur using a spread plan. Perhaps a hospital with less varied practices and patient populations might be able to mandate the use of a common admissions order set, to be completed for anyone admitted. Practice changes then could be made easily by changing the one order set. In our facility, one order set would not best suit the needs of the wide variety of patients and subspecialty needs, so the spread process was needed to add even the highly modularized change of including a VTE prophylaxis tollgate in key order sets.

Conclusions

The explicit choice to use an established theory for diffusion of practices is advocated but rarely done. We described using an explicit Framework for Spread to diffuse a method for improving VTE prophylaxis. We reflect that key aspects of the diffusion framework that contributed to success included (a) selection of members of the spread team who have access and intimate knowledge of the areas into which spread is planned, (b) willingness to engage the diffusion population in local adaptation to create new best practice variants, (c) provision of visual/graphical feedback regarding planned changes and results of change, and (d) commitment from the institution to time and resources to complete the diffusion. Problems encountered but not well anticipated included strains on IT resources and gaps in science or consensus that precluded the development of the new best practice variants in certain areas.

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