Strategies to Optimize the Prevention of Venous Thromboembolism: Process Improvement Practices

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ABSTRACT

• **Objective:** To identify processes that may help hospitals and health care professionals optimize current venous thromboembolism (VTE) prophylaxis practices.
• **Methods:** Review of the literature.
• **Results:** Consistent with other sectors of society, the application of business models and improvement tools, such as PDCA (Plan, Do, Check, Act), Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control), root cause analysis, and Corrective Actions Programs may help direct quality improvement processes for VTE prevention in individual hospitals or institutions. Several real-world examples are described using these quality improvement process models for identifying and implementing active VTE prevention strategies, such as computer-based clinical decision support systems, risk assessment forms, and educational interventions.
• **Conclusion:** Each hospital should undergo a process of quality improvement to identify needs for optimizing VTE prevention, and to select a strategy that is most appropriate for their local needs. Despite the clear gap between current practice and guideline-recommended practice, substantial improvements in VTE prevention can be made.

INTRODUCTION

Patients hospitalized for medical illness or for surgical procedures are at risk of developing deep vein thrombosis (DVT), which may also lead to potentially fatal pulmonary embolism (PE). Evidence-based guidelines, such as those from the American College of Chest Physicians (ACCP) [1] and the International Union of Angiology [2], recommend the use of prophylactic methods to reduce the risk of venous thromboembolism (VTE). Despite these guidelines and the risks posed by VTE, several large multicenter studies have highlighted that thromboprophylaxis is still underused and there is a need to improve prescribing practices [3–6]. In a large US registry study (n = 5451), 71% of patients with a symptomatic DVT event had not received prophylaxis within the previous 30 days [3]. Furthermore, the International Medical Prevention Registry on Venous Thromboembolism (IMPROVE) found that any prophylaxis was given to 61% of at-risk acutely ill hospitalized medical patients in the United States [4]. Although in-hospital prophylaxis rates may have increased over the past few years, several recent studies report that current VTE prophylaxis practices are still suboptimal and frequently do not adhere to ACCP guideline recommendations [7–10]. In the Venous Thromboembolism Study to Assess the Rate of Thromboprophylaxis (VTE START) (n = 258,556), over one-quarter of hospitalized patients were at risk of VTE, and two-thirds of these patients received some form of prophylaxis. However, fewer than 1 in 7 received VTE prophylaxis that met ACCP criteria for the recommended type, dose, and duration [10].

In order to minimize preventable VTE events and to increase awareness of the risk of DVT/PE, several quality improvement initiatives have been developed. For example, the Centers for Medicare and Medicaid Services (CMS) have announced that they will no longer pay for certain hospital-acquired conditions, so-called “never events,” which include DVT and PE after total knee replacement and hip replacement surgery [11]. In addition, CMS along with the Joint Commission have initiated the Surgical Care Improvement Project (SCIP), which focuses on decreasing the number of postoperative com-
plications and improving postoperative outcomes. Two performance measures, SCIP-VTE-1 and SCIP-VTE-2, developed by SCIP and endorsed by the National Quality Forum (NQF), specifically focus on ordering and providing surgical patients with appropriate and timely VTE prophylaxis [12–14]. The NQF, in collaboration with the Joint Commission, has also recently developed and endorsed 6 VTE-related measures relating

Table 1. Quality Improvement Processes

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<thead>
<tr>
<th>Quality Improvement Process</th>
<th>Description</th>
<th>Advantages</th>
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<tr>
<td>FOCUS-PDCA (Find, Organize, Clarify, Understand/Uncover, Select/Start – Plan, Do, Check, Act)</td>
<td>Extension of one of the earliest models of quality improvement and management, the PDCA cycle [45–49]</td>
<td>Helps the most appropriate solution to be addressed in the PDCA cycle [46] Offers optimal tools for continuous development and regular improvement of an existing product or practice Offers optimal tools for the development of new products or practices Allows daily routine management</td>
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<td>Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control)</td>
<td>Uses data and statistical analysis to measure and improve quality and productivity by indentifying and eliminating variation and defects [50–52,54]</td>
<td>Offers a tool box heavily oriented to use of statistics and logical planning or decision making [54] Effective at problem solving and defect elimination Offers a clear focus on achieving measurable and quantifiable financial outcomes Has an increased emphasis on strong management leadership and support Special infrastructure cuts across the entire hierarchy of a business to lead and implement the model’s approach Decisions are made based on verifiable data rather than assumptions [51]</td>
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<td>Lean</td>
<td>Focuses on improving processes by identifying and eliminating “waste”: defects, overproduction, waiting, not utilizing employees, transportation, inventory, motion, excess processing [53] Associated with speed, efficiency, streamlining</td>
<td>Strong philosophy Tools available that allow for process streamlining Inexpensive to implement</td>
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<td>FMEA (Failure Mode and Effects Analysis)</td>
<td>Method for analyzing reliability problems early in the development cycle [58]</td>
<td>Structured and detailed approach Considers all known or suspected potential failures Catalyses team work by relying on collective expertise and stimulating open communication Results in actions Includes a follow-up system and re-evaluation</td>
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<tr>
<td>FRACAS (Failure Reporting, Analysis, and Corrective Action System)</td>
<td>Identify and correct deficiencies in a system and prevent further occurrence [60] Closed-loop feedback path where the system’s user and supplier work together to collect, record and analyze failures within strategies [57]</td>
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<td>Root Cause Analysis</td>
<td>Acknowledges the fact that people make mistakes and tries to understand how people can be prevented from making such mistakes [56,59]</td>
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<td>Lean Six Sigma</td>
<td>Hybrid of Lean and Six Sigma [54,55]</td>
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Disadvantages

Implementation could lead to a waste of resources [47]

Key performance indicators must be identified and measured correctly in order to successfully complete the cycle [47]

Tool box does not provide a universally effective approach for making processes efficient

Designed for fixing existing processes and generally does not allow for introduction of new products or approaches [52]

Concerns with the validity and fit of the statistical model (no explanation for justification by 6 standard deviations)

Model assumes normal distribution of data and has not been shown to be effective for data displaying other than a normal distribution

Will eliminate defects, but will not address speed or optimize flow

Lacks clear structure for decision making or project management

Lacks strong tool set for simple and focused problem solving

Reduced/eliminated creativity and lacks the ability to cope with the unexpected

Time consuming and follow-up sessions are required for effectiveness

Causes of problems are assumed to be single events in nature and combinations of events are captured as a single initiating event

Requires open communication and cooperation

Process relies on recruiting the right participants

Examination of human error is limited

to the prevention and treatment of VTE that are aligned with the CMS [15,16]. Hospitals will need to develop quality improvement policies in order to meet these measures. This article aims to help hospitals and health care professionals with the practical process of implementing quality improvement strategies that optimize VTE prophylaxis practices.

VTE QUALITY IMPROVEMENT IN CLINICAL PRACTICE

Various strategies for improving physician VTE prophylaxis prescribing behavior have been described in the literature. The simplest approach involves passive dissemination of guideline recommendations [17–21], although this strategy appears insufficient to ensure that the majority of patients receive appropriate prophylaxis [22]. A more effective alternative is to use an active strategy. Such active strategies include computer-based clinical decision support systems [23–26], documentation aids (e.g., risk assessment forms) [27,28], audit and feedback cycles [29–31], and quality assurance activities, such as active enforcement of hospital protocols [32]. However, several active strategies used in combination may be more effective than any single active strategy used alone [22]. Components that may be combined include continuing medical education, quality assurance activities, audit and feedback, appointment of specialist implementation staff, local change agents/opinion leaders, advertising, and documentary aids such as paper-based reminder systems [32–43]. To date, no single initiative has proven to be effective, sustainable, and widely applicable to medical centers, despite several initiatives for improving the prevalence of VTE prophylaxis at the level of individual hospitals or institutions having been shown to be successful [44]. Therefore, each hospital will need to assess their own VTE prevention processes and needs for quality improvement strategies.

Many quality improvement models are being applied in different industries to improve business processes and quality control. Models that may be relevant for VTE prevention improvement in everyday hospital practice include PDCA (Plan, Do, Check, Act), Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control), root cause analysis, and Corrective Actions Programs and are described in Table 1 [45–60]. Table 2 illustrates how steps of the FOCUS-PDCA and the RCA processes may be relevant to optimizing VTE prophylaxis practices. Real-life examples of hospitals implementing quality improvement strategies to optimize VTE prevention are discussed below [43,61–63].
A strategy resembling the PDCA cycle has been implemented at the Brookdale University Hospital and Medical Center, a 530-bed non-profit teaching hospital and regional tertiary care center. The problem at baseline—the low VTE prophylaxis rate—was defined (“Plan”), an improvement strategy was implemented (“Do”), and outcomes were assessed (“Check, Act”). After an initial audit, a mandatory VTE prophylaxis order form based on ACCP guidelines was developed, and an educational program for medical residents and attending physicians was implemented, comprising lectures, posters, and handouts. At baseline, 71.5% of patients were receiving a form...
of prophylaxis and 49.5% were prescribed ACCP-recommended prophylaxis. Reasons for underprophylaxis at baseline were: no prophylaxis ordered (20.2%), intermittent compression systems unavailable although ordered (8.3%), and underdosing of pharmacological prophylaxis (22.0%; 15.7% patients received unfractionated heparin [UFH] 5000 units twice daily, 4.8% UFH 3500 units twice daily, and 1.5% enoxaparin 30 mg once daily). After 6 months of intervention, the proportion of patients receiving any form of prophylaxis significantly increased to 91.9% \((P < 0.001)\), with a significant increase also observed in patients receiving appropriate prophylaxis (83.3%; \(P < 0.001\)) [61]. The authors concluded that compulsory implementation of the VTE prophylaxis order form and educational interventions were effective at increasing VTE prophylaxis in medical patients.

**Brigham and Women’s Hospital**

The strategy used at the Brigham and Women’s Hospital, a 777-bed teaching affiliate of Harvard Medical School, resembles the Corrective Actions Program in that physicians were alerted when they did not prescribe prophylaxis therapy to patients at risk. Hospitalized medical and surgical patients at increased risk of VTE and for whom prophylaxis was not prescribed by a physician were identified using a computer program [62]. These patients were then randomized either to an intervention group for whom an electronic alert was issued to the physician \((n = 1255)\) or a control group where no electronic alert was issued \((n = 1251)\) [62]. Physicians could choose to withhold or order prophylaxis upon receiving the alert. Patients in the intervention group compared with patients in the control group were more likely to receive mechanical prophylaxis (10.0% versus 1.5%, respectively; \(P < 0.001\)) or pharmacologic prophylaxis (23.6% versus 13.0%; \(P < 0.001\)). Furthermore, clinically diagnosed, objectively confirmed DVT or PE at day 90 occurred in 4.9% of the intervention group and 8.2% of the control group, representing a significant 41% risk reduction in the risk of DVT/PE (hazard ratio 0.59; 95% confidence interval, 0.43–0.81; \(P = 0.001\)). A follow-up nonrandomized study investigated prophylaxis prescribing in real-world practice in 866 unprophylaxed patients whose physician had been alerted to their risk and had been

**SUNY–Downstate Medical Center–University Hospital of Brooklyn**

A study from the State University of New York–Downstate Medical Center–University Hospital of Brooklyn, an urban university teaching hospital of approximately 400 beds, has been published involving a multifaceted VTE prophylaxis quality improvement intervention [43]. The intervention combined regular provider education with dissemination of a decision support tool and with regular audit-and-feedback—giving a composite strategy resembling the Six Sigma DMAIC model. Provider education consisted of a monthly orientation talk by the chief resident, information provided to the nursing staff, and the display of large posters showing VTE risk factors and prophylaxis. The decision support tools were pocket cards containing information on VTE risk factors and prophylaxis options, which aimed to help physicians in the selection of prophylaxis. Monthly random audits were performed by the division chief of General Internal Medicine in order to evaluate the type and appropriateness of VTE prophylaxis prescribed. Physicians also received feedback on VTE risk category, prophylaxis, and appropriateness of prophylaxis treatment of their patients. Before the quality improvement intervention, retrospective assessment of 49 hospitalized medical patients indicated that 46.9% of patients received a form of prophylaxis and 42.9% received appropriate prophylaxis according to the 2001 ACCP guidelines [65]. A year after the intervention \((n = 116)\), the proportion of patients receiving any prophylaxis had significantly increased to 86.2% \((P < 0.01)\), with a significant rise in the number of patients receiving appropriate prophylaxis (68.1%; \(P < 0.01\)). At 18 months after the intervention \((n = 147)\), the proportion of patients that received any prophylaxis was maintained at 86.4%, and 85.0% of patients now received appropriate prophylaxis. The authors noted that the combination of several elements was likely to be more powerful than each component used alone. They also postulated that the large, sustained effect may be as a result of the multifaceted and ongoing nature of the interven-
tion, with reintroduction of the educational material to all incoming house staff each month. The authors concluded that the implementation of the multifaceted intervention was practical and had a significant effect on the VTE prophylaxis prescription rate in their teaching hospital.

King Faisal Specialist Hospital and Research Centre

King Faisal Specialist Hospital and Research Centre, an 800-bed, multifacility, multi-entity tertiary-care medical center in Riyadh, Saudi Arabia, aimed to improve VTE prophylaxis practices by adopting a multidisciplinary approach. The strategies used to facilitate performance improvement included nursing screening for risk factors, electronic reminders for physicians, preprinted admission order forms, user-friendly tools to summarize guidelines, developing a hospital policy for VTE prophylaxis, awareness events, and provider-specific feedback on performance. A multidisciplinary team was responsible for developing and implementing the changes, and they continued to meet regularly to assess performance and make system changes, indicative of a PDCA cycle-type approach. The intervention increased hospital-wide compliance with ACCP guidelines from 68% at baseline in 2006 to more than 90% in 2007 and 2008 [63].

University of California, Irvine Medical Center

The strategies used at the University of California, Irvine Medical Center (UCIMC), a 400-plus-bed teaching hospital, represent a FOCUS-PDCA approach and Corrective Actions Program, in utilizing a mandatory physician order entry system for VTE prophylaxis. UCIMC was one of the first Californian hospitals to implement mandatory physician order entry in the early 2000s, and this has enabled a system to be designed and incorporated for improving VTE prophylaxis prescribing. The system requires that VTE prevention is considered and addressed before admitting orders can be completed and signed off. Backup screens are also in place for physicians to easily access information about VTE risk factors. As UCIMC is a Level 1 trauma center, there is an option for physicians to initially bypass the system without addressing VTE for acute trauma patients; however, physicians are required to consider the VTE prevention needs of the patient the next time they log on. Based on internal review and data analysis within 6 months of implementing the mandatory physician order entry process, VTE prevention rates have increased from approximately 30% to more than 90% for both medical and surgical patients.

CONCLUSION

Despite the gap between current practice and best practice in VTE prevention, the examples shown demonstrate that substantial improvements can be made. Using strategies and tools already embedded in health care or by importing processes from other sectors, hospitals have a wide range of approaches available that can be tailored specifically for their local needs to create a successful VTE prevention strategy. Before implementation of these strategies, hospitals need to develop a culture of safety and prevention, and engage all relevant health care professionals to ensure the implementation of an integrated, institution-wide approach.

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REFERENCES


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