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Original Article

Venous Thromboembolism Prophylaxis Compliance Before and After Electronic Health Record Implementation

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ABSTRACT

Background: Adherence to American College of Chest Physicians (CHEST) and National Comprehensive Cancer Network (NCCN) guidelines for venous thromboembolism (VTE) prophylaxis helps avoid thromboembolic complications during hospitalization. Electronic health records (EHR) have the potential to make an impact on guideline adherence, but data are lacking.

Objectives: To determine compliance with VTE prophylaxis guidelines in internal medicine and oncology populations and to determine whether EHR implementation had any effect on the rate and appropriateness of prophylaxis practices.

Methods: A retrospective chart review was conducted on medical and oncology patients admitted to the hospital for a 2-month period pre-EHR and post-EHR implementation. Risk assessment tools were available pre and post, however they were not mandatory. The rate of VTE prophylaxis was compared between the 2 time periods, with appropriateness assessed in a subgroup of participants without prophylaxis.

Results: A total of 2,423 patients on the oncology and internal medicine floors were identified during the pre-EHR (n = 1,171) and post-EHR (n = 1,252) time periods. Patients in the post-EHR group were less likely to be prescribed prophylaxis as compared to those in the pre-EHR group (43% vs 50%; P = .001). In the patients audited for proper prophylaxis use (n = 750), significantly more patients in the post-EHR group had risk factors (84% vs 53%; P < .001) and contraindications (23% vs 8%; P = .001) than in the pre-EHR group. Noncompliance to prophylaxis in patients who were candidates (positive risk factors without contraindications) occurred more often in the post-EHR group (51% vs 39%; P < .001).

Conclusion: Implementation of an EHR was associated with an increase in the documentation of risk factors and contraindications; however, there was a significant decrease in VTE prophylaxis utilization after EHR implementation.

Key Words—compliance, electronic health record, venous thromboembolism prophylaxis

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Venous thromboembolism (VTE) is a common occurrence in both internal medicine and oncology patients, and VTE during hospitalization accounts for one-fourth of all VTE events.[1] Hospitalization alone is associated with an 8-fold increased risk of VTE, and 50% to 75% of these events occur in patients on the internal medicine floor.[1] In a study of 1,180 inpatients, of whom 60.3% were categorized as low risk and 39.7% as high risk, it was found that VTE occurred in 11% of high-risk patients who did not receive prophylaxis. Only 0.3% of low-risk patients who did not

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receive prophylaxis experienced a VTE (hazard ratio [HR], 32.0; 95% CI, 4.1-251.0).[2]

The American College of Chest Physicians (ACCP) recommends the Padua Prediction Score to assign risk stratification for VTE in hospitalized internal medicine patients to either high or low risk.[1] This stratification is based on factors such as active cancer, previous VTE, reduced mobility for at least 3 days, known thrombophilic condition, recent trauma, recent surgery, heart failure, respiratory failure, acute myocardial infarction, acute ischemic stroke, acute infection, obesity, and ongoing hormonal treatment.[2] Because cancer is a major risk factor, oncology patients are at an even greater risk of VTE during hospitalization; 3% to 12% experience VTE in their first hospitalization.[3] VTE increases the likelihood of death by 2- to 6-fold and is the most common cause of death at 30-day follow-up in cancer patients undergoing surgery.[3] The National Comprehensive Cancer Network guideline identifies additional risk factors based on cancer- and treatment-related factors. The specific cancers with the highest risk include pancreatic, brain, stomach, kidney, uterus, lung, ovary, bladder, and testis tumors. Treatment with certain antineoplastic (diethylstilbestrol, thalidomide, or lenalidomide) and hormonal compounds is also associated with an increased VTE risk in patients with cancer.

The risk for VTE must outweigh the risk of a major bleeding event in order for a patient to receive prophylaxis. For internal medicine patients, the major risk factors for a major bleeding event are active gastroduodenal ulcer, bleeding in the 3 months before admission, and platelet count less than 50 x 10^9/L.[1] Oncology patients are typically at a higher risk of bleeding than internal medicine patients. In one study comparing 181 oncology patients and 661 non-oncology patients all receiving VTE prophylaxis, the 12-month cumulative incidence of major bleeding was 12.4% and 4.9%, respectively.[4]

With the implementation of electronic health records (EHRs) and the ability to create VTE prophylaxis order sets, there is a more uniform and easily accessible way for physicians to order anticoagulation for their patients. To date, there are no studies that have examined the impact of EHR implementation on VTE prophylaxis.

The objective of this study was to determine compliance with VTE prophylaxis guideline recommendations in the internal medicine and oncology populations, and to determine whether the implementation of an EHR has any effect on the rate and appropriateness of exclusion of VTE prophylaxis use at St. Vincent Indianapolis Hospital. Our customizable EHR includes computer physician order entry and an electronic medication administration record with barcode verification. During the study period, the EHR was not used routinely for physician documentation, however it was used for allied health services documentation.

METHODS

A retrospective, institutional review board–approved chart review was completed to meet the study objectives. All medical and oncology patients admitted to a community teaching hospital in a 2-month period pre-EHR implementation (November 1, 2011 to December 31, 2011) and a 2-month period post-EHR implementation (November 1, 2012 to December 31, 2012) were evaluated for compliance with VTE prophylaxis guidelines. The EHR was implemented in February 2012, allowing for a 9-month lead in period prior to evaluation of the post-EHR period. Patient treatment was classified as either compliant or noncompliant based on the CHEST guidelines for nonsurgical internal medicine patients and the NCCN guidelines for oncology patients (**Table 1**).

Compliance rates were compared between the 2 groups to determine whether the implementation of the EHR had any effect on the use of proper VTE prophylaxis. This compliance rate was calculated based on the entire population (pre-EHR and post-EHR). If a patient was prescribed VTE prophylaxis, it was assumed to be appropriate. A random sampling of 750 patients without prophylaxis, split between the 2 groups, was conducted to further determine the appropriateness of the lack of pharmacologic prophylaxis. Each patient eligible for evaluation was assigned a number, and our sample was determined using a random number generator. Electronic and paper charts were manually evaluated for the study endpoints in this sampling of patients. Patients were labeled as candidates for pharmacologic prophylaxis if they had positive risk factors for VTE without contraindications to pharmacologic prophylaxis. Contraindications to pharmacologic prophylaxis were based on drug, patient, and specific guideline factors (**Table 2**).

Eligibility Criteria

The study included all patients admitted to the oncology unit with an oncology diagnosis or seen by an oncology attending physician or patients admitted to the internal medicine units during the 2-month

Table 1. Recommended venous thromboembolism prophylactic regimens for hospitalized patients

Internal medicine population		
Increased thrombosis risk	**Low thrombosis risk**	**Contraindications to pharmacologic prophylaxis**
Enoxaparin 40 mg SQ daily	None	Graduated compression stockings
Enoxaparin 30 mg SQ q12h		Intermittent pneumatic compression
Enoxaparin 30 mg SQ daily (in renal impairment)		
Fondaparinux 2.5 mg SQ daily		
UFH 5000 units q8-12h		
Oncology population		
Without contraindications to pharmacologic prophylaxis	**With contraindications to pharmacologic prophylaxis**	
Enoxaparin 40 mg SQ daily	Graduated compression stockings	
Enoxaparin 30 mg SQ daily if CrCl < 30 mL/min	Intermittent pneumatic compression	
Fondaparinux 2.5 mg SQ daily		
UFH 5,000 units SQ q8-12h		

Note: CrCl = creatinine clearance; SQ = subcutaneous; q = every; UFH = unfractionated heparin.

Table 2. Oncology and internal medicine patients: Contraindications to prophylaxis

Anticoagulation	**Mechanical**
• CNS bleed, intracranial bleed, or spinal lesion at high risk for bleeding within 30 days • Active major bleeding (more than 2 units transfused in 24 hours) • Spinal anesthesia/lumbar puncture • Chronic, clinically significant measurable bleeding > 48 hours • Platelets < 50,000/mcL • Severe platelet dysfunction • Major operation at high risk for bleeding within 24 hours • Underlying coagulopathy	• Acute DVT • Large hematoma • Skin ulceration or wounds • Platelets < 20,000/mcL or petechiae • Severe arterial insufficiency (GCS only) • Mild arterial insufficiency (GCS only) • Peripheral neuropathy (GCS only)

Note: CNS = central nervous system; DVT = deep vein thrombosis; GCS = graduated compression stockings.

periods. Patients excluded were those younger than 18 years old, prisoners, and pregnant women.

Data Collection

Data collected included hospital room number, age, sex, receipt of anticoagulants, and receipt of mechanical VTE prophylaxis. Patients were evaluated to determine whether or not they received pharmacologic VTE prophylaxis. Subsequently, data were collected in a random sampling of patients not receiving pharmacologic prophylaxis and included demographics (pertinent diagnosis, history of bleeding and/or clotting disorders, age, sex, height, weight), indications for VTE prophylaxis, renal function (serum creatinine

and creatinine clearance as calculated by the Cockcroft-Gault equation), use of mechanical prophylaxis, risk factors for VTE, and contraindications for pharmacologic VTE prophylaxis. This random sampling was evaluated to determine whether there was an appropriate reason for not initiating pharmacologic prophylaxis per CHEST and NCCN guidelines.

Data Analysis

The primary endpoint of the study was to determine the rates of VTE prophylaxis (pharmacologic or mechanical) pre- and post-EHR implementation. Secondary endpoints included the rate of noncompliance with pharmacologic prophylaxis (risk factors for VTE present, no contraindications present) in a random sampling of patients not receiving pharmacologic prophylaxis and the rate of risk factor and contraindication documentation. Subgroup analyses based on service (hematology/oncology, internal medicine, other) were conducted utilizing the above outcomes. Patients were placed into 2 groups (pre- and post-EHR implementation), and data were compared via the chi-square test for nominal data and Mann-Whitney *U* test for continuous, nonparametric data. Data were tested for normality via the Shapiro-Wilk test. Data were evaluated using IBM SPSS, version 22 (IBM Corp., Armonk, NY).

RESULTS

A total of 2,475 patients on the oncology and internal medicine floors were identified. Fifty-two patients were excluded due to incomplete data, which left an included population of 2,423 during the pre-EHR (n = 1,171) and post-EHR (n = 1,252) time periods. Overall, the median age of the population was 63 years, and the majority of the population was female (57% in the pre- and post-EHR groups). Prophylaxis (mechanical and pharmacologic) was utilized in 584 (50%) of the pre-EHR group and 539 (43%) of the post-EHR group (P < .0001) (**Table 3**).

In the analysis of the random sampling of patients receiving no pharmacologic prophylaxis (n = 750), 195 (53%) of the pre-EHR patients and 326 (85%) of the post-EHR patients had risk factors present that made them candidates for VTE prophylaxis (P < .001). Of these patients, 30 (10%) in the pre-EHR group and 90 (23%) in the post-EHR group had contraindications to pharmacologic prophylaxis (P < .001). Candidates for pharmacologic prophylaxis without contraindications who did not receive prophylaxis included 142 (39%) patients in the pre-EHR group and 195 (51%) patients in the post-EHR group (P < .001). Candidates for pharmacologic prophylaxis receiving mechanical prophylaxis were 34 (24%) in the pre-EHR group and 61 (31%) in the post-EHR group (P < .001) (**Table 4**).

In the internal medicine subgroup of patients not receiving pharmacologic prophylaxis (n = 431; 185 pre-EHR, 246 post-EHR), risk factors were present in 75 (41%) and 204 (83%) patients in the pre- and post-EHR groups, respectively (P < .001) (**Table 4**). Statistically significant differences in the contraindications present before and after EHR implementation were found within the internal medicine subgroup (6.5% vs 27%; P < .001). Patients who were VTE candidates based on positive indications for pharmacologic prophylaxis without contraindications were less prevalent in the pre-EHR group than the post-EHR group (24% vs 45%; P < .001).

Likewise, in the hematology/oncology subgroup of patients not receiving pharmacologic prophylaxis (n = 186; 97 pre-EHR, 89 post-EHR), 64 (66%) patients in the pre-EHR group and 84 (94%) patients in the post-EHR group had risk factors present (P < .001), while 13 (13%) and 19 (21%) had contraindications, respectively (P = .151) (**Table**

Table 3. Demographics of patients identified for study inclusion: Pre- and post-implementation of electronic health records (EHRs)

Demographics	Pre-EHR	Post-EHR	*P* value*
No. of participants	1,171	1,252	
Received pharmacologic VTE prophylaxis	584 (50%)	539 (43%)	<.001
No pharmacologic VTE prophylaxis received	587 (50%)	713 (57%)	
Age, median years (IQR)	63 (29)	63 (29)	.621
Male	505 (43%)	541 (43%)	.97

Note: EHR = electronic health record; IQR = interquartile range; VTE = venous thromboembolism.
*Level of significance: P < .05, chi-square test.

Table 4. Sampling of patients not receiving pharmacologic VTE prophylaxis: Pre- vs postimplementation of electronic health records (EHRs)[a]

	All patients			Internal medicine population			Oncology population		
	Pre-EHR	Post-EHR	*P* value*	Pre-EHR	Post-EHR	*P* value*	Pre-EHR	Post-EHR	*P* value*
N	366	384	—	185	246	—	97	89	—
Age, median years (IQR)	64 (28)	63 (28)	.562	69 (33)	66 (31)	.566	64 (28)	63 (28)	.524
Male, *n* (%)	160 (44)	180 (47)	.385	78 (42)	124 (50)	.090	44 (45)	33 (37)	.252
Receiving mechanical prophylaxis (IPC or GCS), *n* (%)	107 (29)	134 (35)	.097	77 (42)	124 (50)	.709	18 (19)	23 (26)	.231
At least 1 risk factor present, *n* (%)	195 (53)	326 (84)	<.001	75 (41)	204 (83)	<.001	64 (66)	84 (94)	<.001
Therapeutic anticoagulation, *n* (%)	71 (19)	71 (19)	.751	44 (24)	54 (22)	.653	20 (21)	10 (11)	.082
Contraindications, *n* (%)	30 (8)	90 (23)	<.001	12 (6.5)	66 (27)	<.001	13 (13)	19 (21)	.151
Candidates for pharmacologic prophylaxis, *n* (%)	142 (39)	195 (51)	<.001	45 (24)	110 (45)	<.001	47 (48)	57 (64)	.032
Candidates for pharmacologic prophylaxis receiving mechanical prophylaxis, *n* (%)	34 (9)	61 (16)	<.001	19 (10)	38 (15)	.012	9 (9)	16 (18)	.063

Note: EHR = electronic health record; GCS = graduated compression stockings; IPC = intermittent pneumatic compression; IQR = interquartile range; VTE = venous thromboembolism

[a]Patients included in this analysis are from a random sampling of patients included in the study and not receiving pharmacologic VTE prophylaxis.

*Level of significance: $P < .05$, chi-square test.

4). Candidates for pharmacologic prophylaxis without contraindications who did not receive prophylaxis included 47 (48%) patients and 57 (64%) patients in the pre- and post-EHR groups, respectively ($P = .032$).

DISCUSSION

The results of this study indicate that the implementation of an EHR at a community teaching hospital was associated with a decrease in the use of VTE prophylaxis. Before this study, no studies evaluated the compliance rates of VTE prophylaxis before and after EHR implementation. There are data supporting the utilization of clinical decision support tools (CDST) within the EHR and their impact on VTE prophylaxis compliance.[5-7] Haut and colleagues conducted a study to examine documentation and compliance to guidelines in a trauma population before and after a mandatory risk factor stratification tool and orderset.[6] They found that both documentation and compliance increased following implementation (3% vs 97.8% and 66.2% vs 84.4%, respectively; $P < .001$). Novis and colleagues found a significant increase in compliance in a surgical population, however not to the same extent as the study by Haut and colleagues (14% vs 36%; $P < .001$).[4] Compared to the previous 2 studies, MaCauley and associates evaluated VTE prophylaxis compliance rates in a broader patient population that included medicine patients.[7] They

assessed VTE prophylaxis compliance rates in patients categorized as low risk from their clinical decision support tool. Similar to surgical and trauma patient populations, there was a significant increase in the compliance rates after implementation (27% vs 34%; $P < .0001$). There is currently no published literature to support the use of CDST in the hematology and oncology population.

The VTE risk assessment tool and order set included in our EHR were not mandatory upon the implementation of the EHR, and this may explain the differences in compliance rates between our study and published literature. This same assessment tool was available to be used both pre- and post-EHR implementation on either paper or in the EHR, respectively. The assessment tool included a list of common risk factors for VTE and placed the patients into a low-, moderate-, or high-risk category. There was space available for documentation of contraindications to pharmacologic VTE prophylaxis on both versions. Upon further investigation, we discovered that the VTE risk assessment tool in the EHR was not provider-friendly during the study period. This may have led to decreased pharmacologic prophylaxis orders in our post-EHR time period. We tried to eliminate any initial EHR difficulties and growing pains by starting our post-EHR time period 8 months after the system was adopted.

This was a single-center study with two, 2-month time frames. Because the data were collected over a short time frame, it is possible that many of the same physicians were working during both periods; the study may have missed the practice habits of physicians not on either service during the 2-month period. This could have introduced bias into the results, because some physicians may be more likely than others to prescribe VTE prophylaxis to their patients; however, it is unlikely that varying practice patterns would have resulted in a significant increase in the use of VTE prophylaxis. In future studies, it is recommended that data be collected over a longer period of time or that a random sampling of patients who were treated by different physicians be taken.

The percentage of patients who received mechanical prophylaxis may be falsely high. Often times when mechanical prophylaxis is ordered, the patients refuse to wear them. That being said, that percentage of patients who did not receive any prophylaxis, including mechanical, may be falsely low due to the possible lack to documentation of noncompliance. Unless it was documented in a clinical note that a patient was not using mechanical prophylaxis, we made the assumption that the patient was compliant.

Although rates of VTE prophylaxis decreased, after implementation of the EHR there was a statistically significant increase in the identification of contraindications to VTE prophylaxis and risk factors for development of VTE. We expected to see this increase but cannot conclude that the EHR makes it easier to identify risk factors and contraindications. Without further data collection on the entire population, we cannot determine whether the patient populations had similar baseline risk factors and contraindications or if the postimplementation group had a statistically significant difference in risk factors. Despite the increase in documented risk factors post-EHR implementation, the rate of prophylaxis decreased. We were also unable to determine whether or not the physicians viewed the risk factors and contraindications or whether they were aware of all the risk factors and contraindications to prophylaxis.

CONCLUSION

Implementation of the EHR at a community teaching hospital was associated with a decreased overall rate and appropriateness of VTE prophylaxis practices and an increase in risk factor and contraindication documentation. The implementation of an EHR with computerized physician order entry in itself will not ensure an increase in VTE prophylaxis rates. The passive availability of an order set without a mandatory risk assessment followed by CDSTs allowed practice to continue unchanged with a decline in prophylaxis rates. To increase the likelihood of success, CDSTs and mandatory assessment should be implemented within the EHR.

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REFERENCES

1. Kahn SR, Lim W, Dunn AS, et al. Prevention of VTE in nonsurgical patients: Antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence based clinical practice guideline. *Chest.* 2012;141(2 suppl):e195S-e226S.

2. Barbar S, Noventa F, Rossetto V, et al. A risk assessment model for the identification of hospitalized medical patients at risk for venous thromboembolism: The Padua Prediction Score. *J Thromb Haemost*. 2010;8(11):2450-2457.

3. Streiff MB, Bockenstedt PL, Cataland SR. Venous thromboembolic disease. National Comprehensive Cancer Network website. http://www.nccn.org/professionals/physician_gls/pdf/vte.pdf. February 2014. Accessed April 28, 2015.

4. Prandoni P, Lensing AWA, Piccioli A, et al. Recurrent venous thromboembolism and bleeding complications during anticoagulant treatment in patients with cancer and venous thrombosis. *Blood*. 2002;100:3483-3488.

5. Novis SJ, Havelka GE, Ostrowski D, et al. Prevention of thromboembolic events in surgical patients through the creation and implementation of a computerized risk assessment program. *J Vasc Surg*. 2010;51:648-654.

6. Haut ER, Lau BD, Kraenzlin FS, et al. Improved prophylaxis and decreased rates of preventable harm with the use of a mandatory computerized clinical decision support tool for prophylaxis for venous thromboembolism in trauma. *Arch Surg*. 2012;147(10):901-907.

7. MaCauley MJ, Showalter JW, Beck MJ, Chuang CH. The effect of a provider-enhanced clinical decision support tool for guiding venous thromboembolism pharmacoprophylaxis in low-risk patients. *Hosp Pract*. 2012;40(3):7-12. ■