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QUALITY IMPROVEMENT

Implementing a Clinical Decision Tool to Improve Oncologic Venous Thromboembolism Management

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Authors' disclosures of conflicts of interest are found at the end of this article.

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Abstract

Background: Cancer patients with venous thromboembolic (VTE) disease are complex, and many factors must be considered when initiating anticoagulation management. Clinical decision support systems can aid in decision-making by utilizing guidelines at the point of care. **Objectives:** The purpose of our project was to develop, implement, and evaluate an electronic clinical decision tool (CDT) utilizing evidence-based guidelines to aid in decision-making for adult oncologic patients who present with new VTE to symptom care clinics. **Methods:** We compared a pre-intervention group of patients who were prescribed anticoagulation (n = 98) with two post-intervention groups: CDT applied (n = 96) and not applied (n = 46). Outcomes included whether the CDT anticoagulation recommendations were followed and if the tool was perceived to be helpful or improve confidence in initiating management for new VTE by the SCC advanced practitioners and physicians. **Results:** There was no significant difference between the pre- and post-intervention groups in how many of the CDT anticoagulation recommendations were followed (68.8% pre-intervention, 60.8% post-intervention tool applied, and 63.5% post-intervention tool not applied; χ^2 [2, N = 161] = .921, p = .631). However, the tool was found to be helpful and improved confidence of the providers in initiating management for new VTE (pre median = 3, interquartile range [IQR] = 2, 3.5; post median = 3, IQR 3, 4; p = .033). **Conclusion:** This CDT provided evidence-based anticoagulation recommendations for cancer-associated VTE and enhanced familiarity with the standard of care. Further development of the CDT will be required to account for situations that resulted in deviation from the recommendations.

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Venous thromboembolic (VTE) disease in cancer patients is associated with significant morbidity, mortality, and cost (Seroussi et al., 2019). Cancer patients are also at greater risk for hospitalization and bleeding compared with non-cancer patients (Frere et al., 2019; Nene & Coyne, 2017). Pharmacological anticoagulation treatment is complex and multiple factors need be considered, including bleeding risk, cancer type and stage, ongoing cancer therapy, and contraindications to initiating anticoagulation management. The emergence of new direct oral anticoagulants (DOACs) has increased the available options for most patients. However, low-molecular-weight heparins are preferred over oral anticoagulants for cancer patients with gastrointestinal or genitourinary lesions because of the risk of bleeding (Soff, 2018). Further, DOACs have been associated with adverse events due to inappropriate prescribing and dosing due to lack of knowledge among prescribers (Paravattil & Elewa, 2018; Seroussi et al., 2019).

Patients often present to Memorial Sloan Kettering Cancer Center (MSKCC) ambulatory symptom care clinics (SCCs) with a new diagnosis of VTE. The front-line providers in the SCC, physicians and advanced practitioners (APs), consisting of nurse practitioners (NPs) and physician assistants (PAs), need to make complex decisions for oncologic patients with new VTE. There is an established MSKCC adult anticoagulation guideline for VTE management; however, it does not offer algorithmic steps in choosing the appropriate anticoagulant nor are providers confident in using it to guide decisions.

Advanced practitioners are also playing an important role in delivering care for patients in oncology (Bruinooge et al., 2018; Cairo et al., 2017). Evidence-based guidelines are designed to deliver the highest standard of care, and translating evi-

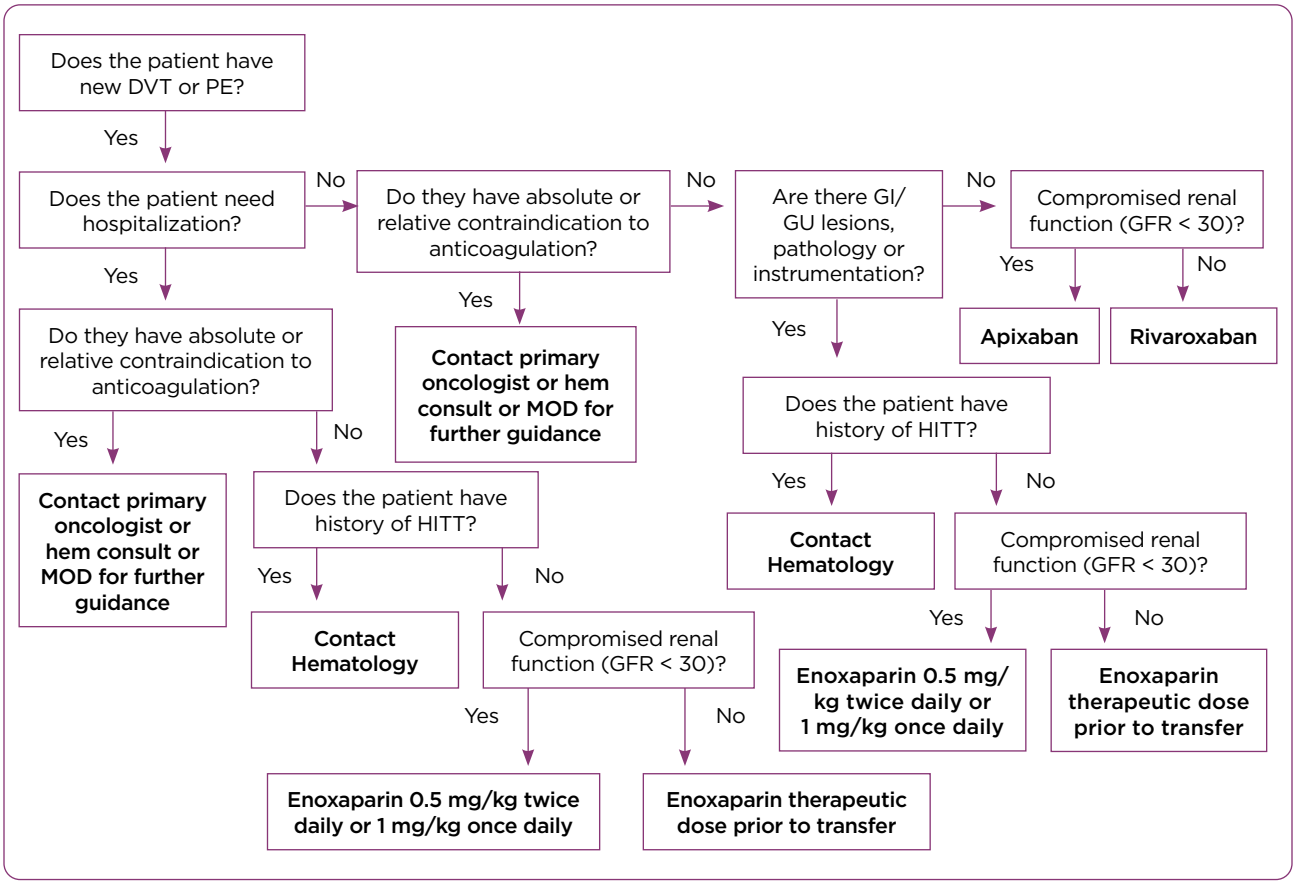

Figure 1. Oncologic VTE tool algorithm. HITT = heparin-induced thrombocytopenia; GFR = glomerular filtration rate; MOD = medical oncologist of the day. Refer to Appendices A and B for absolute and relative contraindications.

dence into practice is one of the core competencies of NPs and PAs. Guidelines are often underutilized due to lack of awareness on the part of providers and time constraints during an active medical visit (Keiffer, 2015).

RATIONALE

Clinical decision support systems (CDSS) have been defined as computerized systems that utilize protocol, guidelines, or various logics to aid in decision-making using individual patient specific characteristics (Bright et al., 2012; Jia et al., 2016; Patterson et al., 2019; Vinson et al., 2018). Although there is heterogeneity in the type of CDSS tools and limited studies on patients with VTE, their use has been associated with improved adherence to guidelines, reducing medication errors, and reducing the risk of bleeding (Jia et al., 2016; Karlsson et al., 2018). In addition to patient care, CDSS can also be used to capture data for evaluation and improve the process of care (Kwan et al., 2020).

Table 1. Provider Demographics (N = 21)

Variable	n	%
Discipline		
MD	3	14.3
NP	16	76.2
PA	2	9.5
Amount of time working in the SCC		
Less than 6 months	2	9.5
6–12 months	10	47.6
> 1 year	9	42.9
Length of time practicing as a physician or NP/PA		
> 1 year to 5 years	9	42.9
> 5 years	12	57.1
Primary work facility		
Westchester	4	19.0
BSK	4	19.0
Bergen	3	14.3
Monmouth	6	28.6
Commack	1	4.8
Nassau	3	14.3
Prescribed any anticoagulation for a patient with new DVT or PE in the SCC?		
No	1	4.8
Yes	20	95.2

AIMS

The purpose of this quality improvement (QI) project was to develop, implement, and evaluate an electronic oncologic VTE clinical decision tool (CDT; Figure 1) utilizing evidence-based guidelines (National Comprehensive Cancer Network [NCCN], 2020) to aid in decision-making for adult oncologic patients who present with new VTE to the SCC. We hypothesized that implementing this tool would improve adherence to VTE guidelines, aid in clinical care, and improve the confidence of the SCC APs and physicians when initiating anticoagulation management for patients with new VTE.

METHODS

Innovation and Implementation

Roger's work on diffusion of innovation was used to guide the strategic planning and implementation of the innovative oncologic VTE tool (Mohammadi et al., 2018). The goal was to convert current NCNN guidelines (NCCN, 2020), along with recent pertinent articles, into a tool that was easy to use at the point of care. The current guidelines are 133 pages long and are understandably difficult to reference during an SCC visit. Prior to implementation, multidisciplinary meetings were held with the Hematology Service chief (Soff) for his expertise, along with two front-line SCC providers to develop the algorithm for the tool. Once the computerized algorithm was finalized (Figure 1), the electronic tool was developed on a web-based platform by the Digital, Informatics, and Technology Solution Team at MSKCC. The oncologic VTE tool offered algorithmic steps on choosing the appropriate anticoagulation medication based on individual patient characteristics or recommended seeking further expert advice of the hematologist or medical oncologist of the day (MOD) for anticoagulation recommendation. A link to the oncologic VTE tool was placed on the MSKCC internal SCC website for easy access.

Before initiation of the tool, surveys were distributed to all the front-line providers who worked in the SCC to assess their experience and confidence in management of new VTEs, including their comfort level with the available antico-

Table 2. Provider Type and VTE Diagnosis

		Post-intervention		
Variable	**Pre-intervention, n (%)**	**N**	**VTE tool applied, n (%)**	**VTE tool not applied, n (%)**
Provider type				
AP	73 (75.5%)	103	80 (78%)[a]	23 (22%)
MD	25 (25.5%)	39	16 (41%)[a]	23 (59%)
Total	98	142	96 (68%)	46 (32%)
VTE diagnosis				
DVT	49 (50%)	75	55 (73%)	20 (27%)
PE	39 (40%)	53	33 (62%)	20 (37%)
DVT and PE	1 (1%)	3	2 (67%)	1 (33%)
Other	9 (9%)	11	6 (55%)	5 (45%)
Total	98	142	96 (67.6%)	46 (32.4%)

Note. DVT = deep vein thrombosis; PE = pulmonary embolism. [a]When the VTE CDT was introduced, it was applied 78% of the time by APs, but only 41% by MDs ($p < .001$ by Fisher's exact test).

agulation medications in MSKCC formulary. All the APs and physicians were educated on the oncologic VTE tool. There were a total of six 1-hour education sessions attended by the 30 SCC front-line providers, consisting of 9 physicians, 19 NPs, and 2 PAs. The educational sessions focused on the background, goal of the project, the tool's algorithm, and how to use the tool. For all disciplines, 100% attendance was achieved.

The tool was launched in early September 2020. Using the tool was not mandatory, but was instituted as a new workflow and strongly recommended for all patients with a new diagnosis of VTE. Every time the tool was used, a follow-up survey was sent to the provider for their feedback and to assess if they found the tool to be helpful in initiating management for the specific patient with new VTE. Data were collected for 4 months.

Design

Thirty front-line SCC providers, including 9 physicians, 19 NPs, and 2 PAs were surveyed before and after the implementation of the CDT to assess their confidence in initiating management for oncology patients with new VTE. 70% (n = 21) completed the surveys. For this QI project, we compared groups pre- and post-intervention. Retrospective data were collected between June 1, 2020, and August 31, 2020, for patients who received anticoagulation in the SCC for new VTE. Prospective data were collected from September 8, 2020, to January 11, 2021, for patients for whom the oncologic VTE tool was applied and those whose providers prescribed anticoagulation but did not apply the oncologic tool for new VTE.

Setting

The intervention was implemented in multiple MSKCC ambulatory SCC sites located in New York and New Jersey on September 8, 2020. The SCCs are an extension of the hospital's Urgent Care Center and developed to provide care for adult patients (> 18 years old) who need evaluation and management for urgent or acute symptoms closer to home.

Sample

Adult patients (> 18 years old) were evaluated in the SCC for new VTE, which included deep vein thrombosis (DVT), pulmonary embolism (PE), or non-extremity–associated venous thrombosis, including portal vein thrombosis over a 4-month period. We excluded patients requiring anticoagulation for any non-VTE cause, including superficial vein thrombus and atrial fibrillation. Patients with recurrent VTE were also excluded.

DATA COLLECTION

Pre-Intervention Group

For control data, a chart review was conducted for all patients who received anticoagulation for

Table 3. Comparison of Actual Prescription, Tool Recommendations, and VTE Anticoagulation Tool Recommendations Followed

	Pre-intervention (n = 98)		Post-intervention tool applied (n = 72)		Post-intervention tool not applied (n = 46)			
Variable	**n**	**%**	**n**	**%**	**n**	**%**	χ^2	***p* value**
Anticoagulant prescribed							6.76	.149
Enoxaparin	71	72.4	50	69.4	36	78.3		
Rivaroxaban	27	27.6	18	25.0	8	17.4		
Apixaban	0	0.0	4	5.6	2	4.3		
VTE tool recommendation							4.98	.546
Enoxaparin	32	32.65	23	23.96	16	34.78		
Rivaroxaban	45	45.92	46	47.22	17	36.96		
Apixaban	0	0.0	1	1.04	0	0.0		
Contact Heme/ MOD	21	21.43	26	27.08	13	28.26		
VTE tool A/C recommendation followed							.921	.631
Followed	53	68.8	31	60.8	21	63.5		
Not followed	24	31.2	20	39.2	12	36.4		

Note. MOD = medical oncologist of the day; A/C = anticoagulant.

new VTE between June 1, 2020, and August 31, 2020. After chart review, the oncologic VTE tool was retrospectively applied to assess if the actual anticoagulation that was prescribed was the same or different than what the oncologic VTE tool recommended.

Post-Intervention: VTE Tool Applied

Prospective data were collected between September 8, 2020, and January 11, 2021, for all patients in which the oncologic VTE tool was used. For those patients for whom the oncologic tool recommended anticoagulation, the patient's electronic health records were reviewed to see if the oncologic VTE anticoagulation recommendations were followed or not.

Post-Intervention: VTE Tool Not Applied

During the intervention period, there were also patients for whom the oncologic tool was not used for new VTE, but an anticoagulation medication was prescribed. Similar to the pre-intervention historical group, the oncologic VTE tool was applied retrospectively for this cohort to assess which anticoagulation medication the tool would have recommended if it was used and if the anticoagulation prescribed would have been similar or different than what the tool recommended.

Statistical Analysis

Provider characteristics including discipline, time working in the setting, practice experience, primary work location, and history of anticoagulation prescription were evaluated using descriptive statistics (n, %). Chi-square tests were conducted to compare three cohorts (pre-intervention, post-intervention VTE tool applied, and post-intervention VTE tool not applied) on the categorical outcomes of provider type, VTE diagnosis, anticoagulant prescription rates, VTE tool recommendations, and adherence to the VTE tool recommendations. Provider confidence in initiation management for a patient with a new DVT or PE was assessed using a Likert scale item, and pre- and post-intervention were examined using a Wilcoxon signed-rank test. Provider use of resources, perceived comfort (yes/no), and perceived discomfort (yes/no) in prescribing each medication was examined using McNemar tests. Provider perceptions of the VTE tool as helpful are presented using descriptive statistics (n, %). IBM SPSS version 27 was used to conduct statistical analysis with alpha set to .05.

Table 4. Comparison of Deviation Rates From Anticoagulation Recommendations

Recommendation		Anticoagulant prescribed					
Anticoagulant	**N**	**Enoxaparin**	**Rivaroxaban**	**Apixaban**	**No A/C**	**Deviation rate**	***p* value**
Pre-intervention							
Enoxaparin	32	31	1	0	0	3%	< .001
Rivaroxaban	45	22	23	0	0	49%	
Apixaban	0	0	0	0	0	N/A	
Post-intervention tool applied							
Enoxaparin	23	14	0	1	8	39%	< .094
Rivaroxaban	46	16	17	2	11	63%	
Apixaban	0	0	0	1	0	0	
Post-intervention tool not applied							
Enoxaparin	16	15	1	0	0	6%	< .001
Rivaroxaban	17	11	6	0	0	65%	
Apixaban	0	0	0	0	0	N/A	

Note. A/C = anticoagulant.

RESULTS

Provider demographics (N = 21) are displayed in Table 1. The majority of providers in the study were NPs (n = 16. 76.2%), and most of the providers had > 5 years of practice experience (n = 12, 57.1%). Only one provider (4.8%) reported no history of prescribing any anticoagulation for a patient with new DVT or PE. Table 2 displays provider type and VTE tool use. When the VTE CDT was introduced, it was applied 78% of the time by APs, but only 41% by MDs (p < .001 by Fisher's exact test).

Anticoagulants prescribed did not differ significantly among groups (p = .149; see Table 3), although enoxaparin was prescribed most often for all three groups (pre-intervention, post-intervention tool applied, and post-intervention tool not applied). The VTE tool recommendation outcome showed rivaroxaban was the most often recommended anticoagulant for all three groups, although the anticoagulant recommendation did not differ significantly among groups (p = .546; Table 3). Figure 2 displays the adherence rates to the tool recommendations for each group. The tool recommendation was followed for 68.8% of cases in the pre-intervention group, 60.8% of cases in the post-intervention group when the tool was applied, and 63.5% in the post-intervention group when the tool was not applied (p = .631; Table 3). An assessment of deviation rates shows providers deviated from rivaroxaban recommendations significantly more often than enoxaparin recommendations in the pre-intervention (p < .001, Table 4) and post-intervention tool not applied groups (p < .001, Table 4). The same pattern continued for the post-intervention tool applied group, although the deviation rate between anticoagulants recommended vs. prescribed was not significantly different for this group (p = .094; Table 4).

Table 5. Confidence About Initiating Management for a Patient With New DVT or PE

	Pre			Post				
Variable	**Median**	**IQR**	**Mean**	**Median**	**IQR**	**Mean**	**Z**	***p* value**
Confidence	3	2, 3.5	2.81	3	3, 4	3.19	–2.14	.033

Note. N = 21. Confidence scale is 1 (Not Confident) to 4 (Very Confident). The median confidence score remained the same from pre (median = 3, IQR = 2, 3.5) to post (median = 3, IQR = 3, 4), although a Wilcoxon signed-rank test showed significantly higher scores at the post timepoint (Z = –2.14, p = .033).

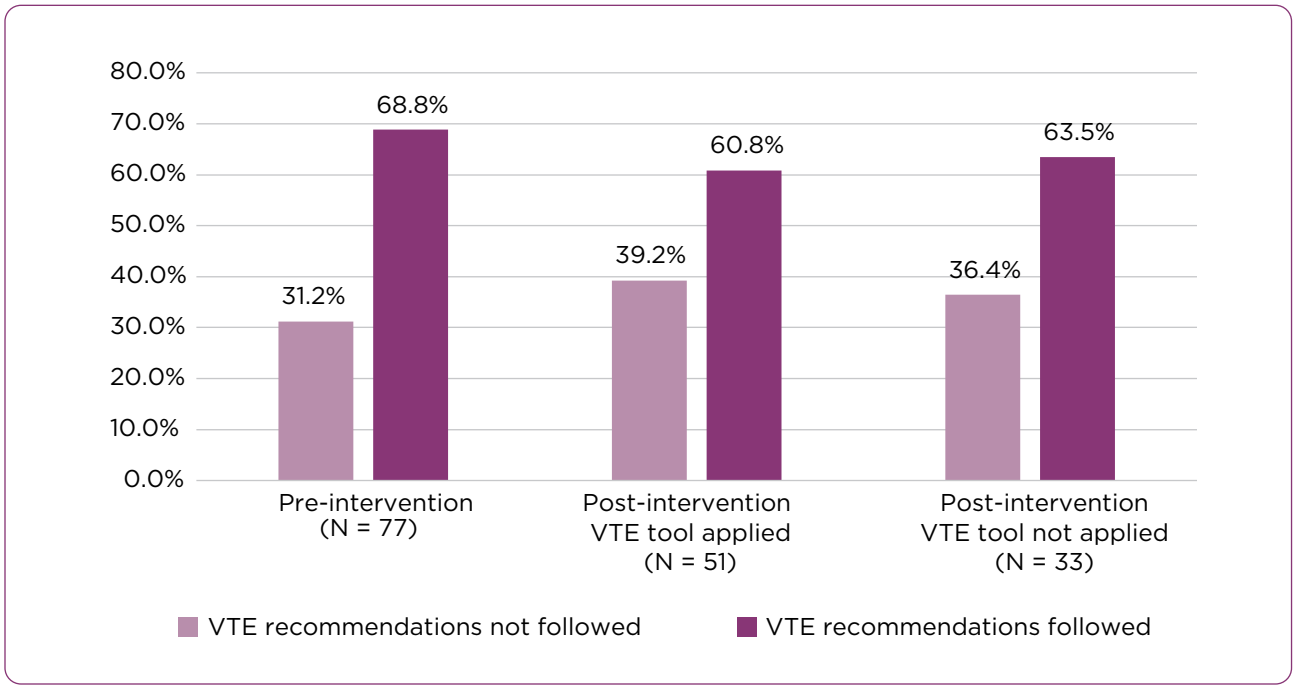

Figure 2. VTE tool anticoagulation recommendations followed vs. not followed.

Seventy percent (n = 21) of the APs and physician providers completed a survey pre- and post-intervention. The results of the survey (Table 5) showed that the confidence of the providers was associated with a statistically significant improvement after implementing the oncologic VTE tool in initiating management for a patient with new VTE (pre median = 3, IQR = 2, 3.5; post median = 3, IQR 3, 4; p = .033). In addition, providers relied less on UpToDate or another online resource for initiating management post-intervention vs. pre-intervention (42.9% and 76.2%, respectively, p = .039; Table 6). There was also a clinically significant reduction in providers feeling uncomfortable with prescribing oral anticoagulants (rivaroxaban/apixaban) pre-intervention vs. post-intervention (29% and 5%, respectively, p = .125; Table 7). For the providers who used the oncologic VTE tool at the point of care during the intervention period, a follow-up survey on usefulness of the oncologic VTE CDT was completed for 86 patients and reported to be helpful 81.4% of the time in initiating management of oncologic VTE (Table 8).

DISCUSSION

Cancer patients often present to outpatient clinics with symptoms of VTE (Easaw et al., 2019). Various factors must be considered when initiating management. In addition, many providers are not familiar with the guidelines and lack knowl-

Table 6. Use of Various Resource Guides to Management for DVT/PE (N = 21)

Resource guide type	Pre	Post	McNemar *p* value
MSK Adult Anticoagulation Guidelines	12 (57.1%)	14 (66.7%)	.754
Primary team attending	12 (57.1%)	14 (66.7%)	.687
Pharmacy	3 (14.3%)	2 (9.5%)	.999
UptoDate/another online resource	16 (76.2%)	9 (42.9%)	.039
Oncologic VTE Tool	–	15 (71.4%)	–
Other	–	1 (4.8)	–

Table 7. Comfort and Discomfort in Prescribing Anticoagulant Medications at Pre and Post (N = 21)

	Comfortable			Uncomfortable		
Medication	**Pre**	**Post**	**McNemar *p* value**	**Pre**	**Post**	**McNemar *p* value**
Enoxaparin	21 (100%)	21 (100%)	nc	1 (4.8%)	1 (4.8%)	.999
Coumadin	3 (14.3%)	5 (23.8%)	.500	15 (71.4%)	16 (76.2%)	.999
Rivaroxaban/Apixaban	15 (71.4%)	18 (85.7%)	.375	6 (28.6%)	1 (4.8%)	.125
None	0 (0%)	0 (0%)	nc	3 (14.3%)	5 (23.8%)	.625
Other	2 (9.5%)	1 (4.8%)	.999	0 (0%)	1 (4.8%)[a]	nc

Note. nc = not calculated due to no variation in data for at least one timepoint.
[a]Apixaban was reported medication.

edge related to oral anticoagulants (Soff, 2018). Evidence-based guidelines can offer guidance but are not always utilized. A CDT can aid in decision-making utilizing protocols or guidelines at point of care (Bright et al., 2012; Jia et al., 2016; Patterson et al., 2019; Vinson et al., 2018). We hypothesized that implementing an oncologic VTE CDT will improve adherence to VTE guidelines, aid in clinical care, and improve the confidence of the SCC providers who are predominantly APs (70%) when initiating anticoagulation management for patients with new VTE. In this study, we analyzed the application of the tool by provider type, anticoagulation recommendations, and adherence with the evidence-based recommendations.

Notably, APs were significantly more likely to apply the VTE CDT than MDs (78% vs. 41%). We hypothesize that this reflects the fact that MDs are more likely to be involved in cases with confounding parameters, precluding application of the VTE CDT tool. However, this will require confirmation. Our initial hypothesis was that application of the tool and adherence to the anticoagulation recommendations would favorably impact evidence-based practice. However, the actual anticoagulation prescribed remained relatively consistent from the pre-tool to post-tool periods. In addition, there was a greater deviation when the tool recommended rivaroxaban, and this could be consistent with the lack of knowledge of prescribers with oral anticoagulants as described in the literature (Paravattil & Elewa, 2018; Seroussi et al., 2019). As this was a new program, it is anticipated that ongoing education may improve the rate of deviation. The oncologic VTE tool was found to be overall helpful when used and improved providers' level of comfort with prescribing DOACs.

It is also possible that unaccounted for medical reasons, which were not accounted for in the decision tool, led to deviation from the recommendations. Deviation from the recommendations suggests some limitations of the tool as it did not factor in some other individual patient characteristics such as such as patient preference, insurance, anticipated decrease in the platelet count due to chemotherapy, and upcoming surgery that would have caused the providers to not follow the tool's anticoagulation recommendation and deviate when rivaroxaban was recommended. This will require further evaluation and upgrades to the decision tool.

Table 8. Perceptions of VTE Tool Being Helpful

	Completed surveys (N = 86)		
VTE tool use	**n**	**%**	**% reporting the VTE tool as helpful**
Very Helpful	17	19.8%	81.4%
Helpful	31	36.0%	
Somewhat Helpful	22	25.6%	
Not Helpful	16	18.6%	–

LIMITATIONS

There were several limitations to this study. First, the study may have missed patients during the study period with new VTE for which the providers did not use the oncologic VTE tool and did not prescribe an anticoagulant. Second, most of the providers did not provide specific reasons for why the tool's anticoagulation recommendation was not followed in the follow-up survey for the particular patient. In addition, this QI project served as a feasibility project to determine if providers would use a CDT. A double-blind, randomized control study would be the next logical step in studying whether CDSS can improve outcomes for patients with new VTE.

CONCLUSIONS

Using a CDSS to implement a CDT to improve initiation of management of new VTE is safe and effective. It can aid APs and physicians and improve their confidence in decision-making when initiating management for new VTE. It can also be utilized to help collect data, streamline decision-making, and identify opportunities for improvement in AP practice in oncology. Our goal is to take the lessons learned from this project and develop other evidence-based CDTs for oncologic-related disease complications to guide and improve AP practice for patients with cancer.

Disclosure

Dr. Soff has served on boards for Amgen, Anthos Therapeutics, Bayer Pharmaceuticals, Bristol Myers Squibb, Dova Pharmaceuticals, HengRui (USA) Ltd, Janssen Scientific Affairs, Novartis, and Pfizer. The other authors have no conflicts of interest to disclose.

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Appendix A. Absolute Contraindications to Anticoagulations

- Major active bleeding (requiring > 2u transfusion, 2gm Hgb drop, intracranial or intraspinal bleeding)
- Indwelling neuraxial catheters
- Neuraxial anesthesia/lumbar puncture
- Interventional spine and pain procedures
- Surgery in prior 72 hours
- Platelets < 25k

Appendix B. Relative Contraindication for Any Anticoagulation

- Clinically significant bleeding
- Thrombocytopenia (platelets < 30,000–50,000/µL)
- Underlying hemorrhagic coagulopathy (elevated PT/aPTT or known bleeding disorder)
- Severe platelet dysfunction
- Recent major surgery at risk for bleeding
- High risk for falls
- CNS metastases
- Any antiplatelet therapy
- Any NSAID
- Dose adjustment may be required for renal dysfunction
- Dose adjustment may be required for hepatic dysfunction

Note. PT = partial thromboplastin time; aPTT = activated partial thromboplastim time; CNS = central nervous system; NSAID = nonsteroidal anti-inflammatory drug.