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Population-Based Analysis of Adherence to Postdischarge Extended Venous Thromboembolism Prophylaxis After Colorectal Resection

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Abstract

BACKGROUND: Prevention of venous thromboembolism after colorectal surgery remains challenging. National guidelines endorse thromboembolism prophylaxis for 4 weeks after colorectal cancer resection. Expert consensus favors extended prophylaxis after IBD surgery. The actual frequency of prescription after resection remains unknown.

OBJECTIVE: This study aimed to assess prescription of extended, postdischarge venous thromboembolism prophylaxis after resection in Michigan.

DESIGN: This is a retrospective review of elective colorectal resections within a statewide collaborative receiving postdischarge, extended-duration prophylaxis.

SETTING: This study was conducted between October 2015 and February 2018 at an academic center.

PATIENTS: A total of 5722 patients (2171 with colorectal cancer, 266 with IBD, and 3285 with other).

MAIN OUTCOME MEASURES: We compared the prescription of extended, postdischarge prophylaxis over time, between hospitals and by indication.

RESULTS: Of 5722 patients, 373 (6.5%) received extended-duration prophylaxis after discharge. Use was similar between patients undergoing surgery for cancer (282/2171, 13.0%) or IBD (31/266, 11.7%, $p = 0.54$), but was significantly more common for both patients undergoing surgery for cancer or IBD in comparison with patients with other indications (60/3285, 1.8%, $p < 0.001$). Use increased significantly among patients with cancer (6.8%–16.8%, $p < 0.001$) and patients with IBD (0%–15.1%, $p < 0.05$) over the study period. For patients with other diagnoses, use was rare and did not vary significantly (1.5%–2.3%, $p = 0.49$). Academic centers and large hospitals (>300 beds) were significantly more likely to prescribe extended-duration prophylaxis

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for all conditions (both $p < 0.001$), with the majority of prophylaxis concentrated at only a few hospitals.

LIMITATIONS: This study was limited by the lack of assessment of actual adherence, small number of observed venous thromboembolism events, small sample of patients with IBD, and restriction to the state of Michigan.

CONCLUSIONS: The use of extended-duration venous thromboembolism prophylaxis after discharge is increasing, but remains uncommon in most hospitals. Efforts to improve adherence may require quality implementation initiatives or targeted payment incentives. See **Video**

Abstract at <http://links.lww.com/DCR/B193>.

Abstract

La prevención del tromboembolismo venoso después de cirugía colorrectal sigue siendo un desafío. Las guías nacionales han aprobado la profilaxia del tromboembolismo durante cuatro semanas luego de una resección de cáncer colorrectal. El consenso de expertos favorece la profilaxia extendida solamente después de la cirugía por enfermedad inflamatoria intestinal. La frecuencia real de prescripción después de la resección colorrectal sigue siendo desconocida.

Evaluar la prescripción de profilaxia prolongada de tromboembolismo venoso después del alta luego de una resección colorrectal en Michigan.

Revisión retrospectiva de las resecciones colorrectales electivas seguidas de una profilaxia de larga duración con el apoyo de todo el estado (MI).

Este estudio se realizó entre octubre de 2015 y febrero de 2018 en un solo centro académico.

Un universo de 5722 pacientes operados (2171 por cáncer colorrectal, 266 por enfermedad inflamatoria intestinal, 3285 por otros diagnósticos).

Se comparó la prescripción de profilaxia prolongada después del alta según la duración, los hospitales y la indicación.

De 5722 pacientes, 373 (6.5%) recibieron profilaxia de duración prolongada después del alta. El uso fue similar entre pacientes sometidos a cirugía por cáncer (282/2171, 13.0%) o enfermedad inflamatoria intestinal (31/266, 11.7%, $p = 0.54$), pero fue significativamente más común para ambos en comparación con pacientes con otras indicaciones (60/3285, 1.8%, $p < 0.001$). El uso aumentó significativamente entre pacientes con cáncer (6.8% a 16.8% ($p < 0.001$)) y en pacientes con enfermedad inflamatoria intestinal (0% a 15.1%, $p < 0.05$) durante el período de estudio. Para pacientes con otros diagnósticos, su utilización fue rara y no varió significativamente (1.5% a 2.3%, $p = 0.49$). Los centros académicos y los grandes hospitales (>300 camas) tenían mayor probabilidad de prescribir la profilaxia de duración extendida en todas las afecciones (ambas $p < 0.001$), pero la mayoría de las profilaxis se concentraron en algunos pocos grandes hospitales.

Este estudio estuvo limitado por la falta de evaluación de actuales adherentes, por el pequeño número de eventos tromboembólicos venosos observados, por la pequeña muestra de pacientes con enfermedad inflamatoria intestinal y debido a ciertas restricciones en el estado de Michigan.

El uso de profilaxia para el tromboembolismo venoso de duración prolongada después del alta está en aumento, pero su uso sigue siendo poco frecuente en la mayoría de los hospitales. Los esfuerzos para mejorar la adherencia al tratamiento pueden requerir iniciativas de mejoría en la

calidad o incentivos específicos de reembolso. Consulte **Video Resumen** en <http://links.lww.com/DCR/B193>. (Traducción—Dr. Xavier Delgadillo)

Keywords

Colorectal cancer; Inflammatory bowel disease; Prophylaxis; Venous thromboembolism

Despite increasing attention to perioperative prophylaxis, postoperative venous thromboembolism (VTE) remains a problem after colorectal surgery. The incidence of postoperative VTE varies by surgical indication, ranging from 2.1% for Crohn's disease, 2.4% for diverticulitis, 2.9% for colorectal cancer, to 4.1% among those with ulcerative colitis.¹ Improved adherence to immediate postoperative prophylaxis may be insufficient, because over 40% of VTEs occur after hospital discharge.² Since 2012, guidelines from the American College of Chest Physicians (ACCP),³ the Enhanced Recovery After Surgery Society,⁴ and the American Society of Colon and Rectal Surgeons (ASCRS)⁵ have recommended extended-duration, postdischarge VTE prophylaxis after resection for colorectal cancer (CRC), defined as 4 weeks of low-molecular-weight heparin. National Institute for Health and Clinical Excellence guidelines in the United Kingdom have recommended extended-duration thromboprophylaxis for patients with CRC since 2010, but adherence remains low.⁶ While there are no formal VTE guidelines for IBD, there is published expert consensus recommending extended prophylaxis for these patients as well.^{4,5}

Whether surgeons in standard practice are providing recommended VTE prophylaxis is unknown. The existing studies of extended prophylaxis, some of which use national databases, all predate the ACCP guideline. For example, an analysis of Medicare beneficiaries undergoing CRC resection in 2008 to 2009 found that only 1.9% received extended prophylaxis.⁷ In addition, before 2013, extended prophylaxis was prescribed to <1% of patients undergoing surgery for IBD.⁸ To better understand the influence of new guidelines, it is important to know whether the rates of adherence have changed since their publication.

Thus, to understand current practice, we evaluated contemporary use of postdischarge, extended-duration VTE prophylaxis after colorectal resection within a population-based, comprehensive statewide surgical registry. We evaluated adherence according to the indication for surgery comparing CRC and IBD (for which there are published recommendations) versus other benign indications such as diverticulitis (for which extended prophylaxis is not recommended). In this study, we capitalize on the unique data infrastructure of the Michigan Surgical Quality Collaborative (MSQC), a validated, statewide clinical registry including both community and academic hospitals, to evaluate hospital trends in adherence by diagnosis. The findings will support targeted strategies for improvement at less adherent hospitals.

MATERIALS AND METHODS

Overview

We performed a multi-institutional, retrospective review of all patients who underwent elective colon and/or rectal resection between October 2015 and February 2018 and were entered into the MSQC registry. For the purpose of analysis, the 2 months of data from 2018 were combined with data from 2017, thereafter referred to as operative year 2017–18. The MSQC is a 73-hospital statewide collaborative quality initiative, including both community and academic institutions. It is funded by Blue Cross Blue Shield of Michigan (BCBSM), the dominant commercial insurance provider in the state,⁹ and focuses on 30-day outcomes after general, vascular, and gynecologic surgery. Membership includes 90% of eligible hospitals in Michigan and captures approximately 50,000 Michigan patients undergoing a wide variety of general, gynecologic, and vascular surgeries per year. Hospitals receive funding from BCBSM to support a trained nurse to abstract patient characteristics, perioperative processes of care, and 30-day outcomes. Patients are sampled according to an algorithm designed to minimize selection bias, and data are collected in a standardized fashion by trained nurse abstractors, with data regularly audited for validity. Eligibility is not limited to patients insured by BCBSM. As determined by the University of Michigan Institutional Review Board, the MSQC data collection does not meet the definition of human subjects research and is considered “not regulated.” No ethical approval was required.

Patients

We identified all patients aged 18 and over who underwent elective colon or rectal resections as identified by the following *Current Procedural Terminology* codes: 44140, 44141, 44143, 44144, 44145, 44146, 44147, 44150, 44151, 44155, 44156, 44157, 44158, 44160, 44204, 44205, 44206, 44207, 44208, 44210, 44211, 44212, 44238, 44799, and 45399. We excluded 354 (5.8%) patients who had contra-indications to prophylaxis, eg, history of prior documented deep vein thrombosis. We categorized the indications for surgery according to *International Classification of Diseases, 10th Revision*, as CRC (C18, C19, C20), IBD (K50, K51), or other indications (diverticulitis: K57; other: A419, C12, C15, C17, C21, C23, C25, C26, C48, C49, C54, C56, C61, C64, C67, C77, C78, C79, C7A, C7B, C80, C83, C85, C88, C92, D01, D09, D12, D13, D17, D18, D21, D36, D37, D3A, D49, E11, G89, I25, K28, K35, K36, K38, K40, K43, K45, K52, K55, K56, K57, K58, K59, K60, K62, K63, K64, K65, K66, K68, K91, K92, K94, L89, M72, N32, N36, N73, N80, N82, N83, Q43, R10, R13, R15, R19, S36, T18, T85, Z43, Z85, Z87, Z90, Z93, and Z98) captured in the MSQC database.

Outcomes and Measures

The primary outcome was hospital rate of prescription of postdischarge, extended-duration low-molecular-weight heparin prophylaxis. The primary predictors were operative year and clinical indication. We evaluated hospital characteristics including teaching status and hospital bed volume.

Statistical Analysis

We compared prescribing rates by hospital characteristics using Pearson χ^2 analyses and constructed caterpillar plots to display hospital rates for each diagnostic group (CRC, IBD, and other). Hospitals were ranked from highest to lowest with error bars to denote standard deviation of binomial confidence intervals. All analyses were performed using Stata version 15 (StataCorp, College Station, TX, 2017).

RESULTS

Use of Extended-Duration VTE Prophylaxis by Diagnosis and Operative Year

Among 5722 patients who met inclusion criteria, 2171 (38%) underwent surgery for CRC, 266 (4.6%) for IBD, and 3285 (57%) for other conditions (1515 (26%) with diverticulitis, 794 (14%) with benign neoplasms, and 10 (0.2%) with ischemic colitis). Across all diagnoses, 373 (6.5%) patients received extended VTE prophylaxis after discharge. As shown in Figure 1, the likelihood of use was similar among patients with CRC (13.0%) and IBD (11.7%, $p = 0.54$), but was significantly less common for patients with other indications (1.8%, $p < 0.001$). Specifically, proportional use during the study period increased significantly among patients with CRC from 6.8% in 2015 to 8.2% in 2016 to 16.8% in 2017–18 ($p < 0.001$). Use among patients with IBD also increased significantly from 0% to 6.4% to 15.1% ($p < 0.05$). Use among patients with other diagnoses was low and did not change over the study period (1.5%–2.3%, $p = 0.49$).

Use of Extended-Duration VTE Prophylaxis by Diagnosis and Hospital

Use of postdischarge VTE prophylaxis for CRC varied considerably by hospital. Only 24 (33%) hospitals prescribed any extended prophylaxis, with 2 (2.7%) prescribing for more than 40% of patients. Use of postdischarge VTE prophylaxis for IBD was even less common; only 5 (12%) hospitals prescribed any, with 2 (4.9%) prescribing for more than 20% of patients. For diagnoses without indicated postdischarge VTE prophylaxis, only 23 (32%) hospitals prescribed any, with one (1.4%) prescribing for more than 20% of patients. Overall, 6 hospitals (8%) accounted for 85% of extended-duration VTE prophylaxis for patients with CRC, whereas 49 (67%) hospitals prescribed none. On further evaluation, only two hospitals had prescription rates >40% for CRC or IBD diagnoses; of these two, only one prescribed extended VTE prophylaxis to >20% of patients with other diagnoses.

As shown in Table 1 and Figure 2, there was a higher rate of prescription in hospitals with 300 beds compared with hospitals with <300 beds (CRC: 19% vs 1%, $p < 0.001$; IBD: 15% vs 0%, $p < 0.01$; Other: 3% vs 0.5%, $p < 0.001$). Similarly, there was a higher rate of prescription (Table 1, Figure 3) in academic hospitals compared with community hospitals (CRC: 33% vs 6.6%, $p < 0.001$; IBD: 24% vs 1.4%, $p < 0.001$; Other: 5.8% vs 0.8%, $p < 0.001$). Notably, both of the most adherent hospitals (26 and 66) were academic hospitals with a bed volume of 300 beds.

DISCUSSION

Prescription of postdischarge, extended-duration VTE prophylaxis remains uncommon after resection for CRC and IBD despite guidelines and expert recommendations supporting its use. Notably, use has increased among Michigan hospitals over the past 3 years; however, the population-wide trends are heavily influenced by a few large academic institutions. It is important to highlight underuse by the vast majority of hospitals and surgeons. In our sample, nearly half of the hospitals in Michigan did not prescribe any extended-duration, postdischarge VTE prophylaxis after colorectal surgery for any patient in the registry. The few hospitals that did prescribe at high rates tended to be large, academic referral centers with specialty colorectal surgery practices.

These more recent data mirror and update the conclusions of previous studies of the use of extended-duration, postdischarge VTE prophylaxis. Evaluating Medicare beneficiaries undergoing colectomy for cancer in 2008 to 2009, Merkow et al⁷ found that less than 2% of patients were prescribed extended-duration VTE prophylaxis. Similarly, Brady et al⁸ found that use for patients with IBD in 2004 to 2013 was rare. On the other hand, a study of the Washington State Surgical Care and Outcomes Assessment Program (SCOAP) prospectively evaluated patients undergoing colectomy¹⁰ between 2006 and 2011, demonstrating increased VTE prophylaxis prescription rates from initially 20% to ultimately 80% to 90% with an unchanged VTE incidence rate of only 2.2%. Notably, this prophylaxis included perioperative and in-hospital prescription, with actual postdischarge extended VTE prophylaxis closer to 11%. The authors additionally acknowledge in their limitations that their VTE capture rate is likely an underestimate given possible documentation errors or misses in outpatient setting or admission to a non-SCOAP hospital after the index hospitalization. The sampling for all 3 studies preceded the guidelines and recommendations for use of postdischarge, extended-duration VTE prophylaxis for these diagnoses. The ACCP guideline for CRC was first published in 2012.³ The recommendation was grade 1B with a strong level of evidence, implying appropriate adherence should be high (>80%). In that context, very few hospitals in Michigan have achieved expected levels of adherence for patients with CRC.

On the other hand, recommendations for IBD are more varied and controversial. In 2018, ASCRS published a grade 2C recommendation for extended-duration VTE prophylaxis for patients with IBD undergoing colectomy.¹ Because of the low quality of the evidence, ASCRS recommended shared decision making to address concerns of the high risk of GI bleeding.¹¹ Similarly, guidelines from the Association of Coloproctology of Great Britain and Ireland in 2018 suggested extended-duration VTE prophylaxis for the same patients with a grade 2B recommendation.¹² Level 2 recommendations are assigned based on evidence obtained from at least one well-designed, nonrandomized controlled study; grade B and C recommendations are given based on evidence from level 2 or 3 studies and generally consistent findings (B) or based on evidence from level 2 or 3 studies but inconsistent findings (C). Although there was majority expert consensus, the level of evidence was low; therefore, the expected level of adherence to extended-duration VTE prophylaxis may be lower in the IBD patient population. Still, the level of use observed in this study suggests

that most surgeons do not prescribe extended-duration VTE prophylaxis, even as part of standard practice considerations.

Among the third category of patients (noncancer, non-IBD), no major society recommends prescribing extended-duration VTE prophylaxis after colectomy. Indeed, the observed prescription of extended-duration VTE prophylaxis for these patients may actually represent overuse due to the spillover of diagnoses for which there are no recommendations presently. Overuse, in this context, refers to unnecessary prescription of extended-duration VTE prophylaxis in non-CRC, non-IBD patients despite a lack of evidence-based guidelines to support its use. Further investigation of factors leading to this overuse may be warranted. At this time, however, our study found that the majority of hospitals across Michigan do not prescribe extended-duration VTE prophylaxis in large proportions to patients with other indications for colectomy.

The observed underuse of postdischarge, extended-duration VTE prophylaxis is clinically important in CRC and IBD surgery. The 30-day incidence of postoperative VTE of between 2% and 4% for patients with CRC and IBD indicates a critical need for improvement.¹ The associated 1.9% mortality of after colorectal surgery VTE is not insignificant.¹³ Clearly, improved use of extended-duration thromboprophylaxis is necessary to reduce disease burden and avoid mortality from one of the most preventable causes of death after surgery.

From an economic perspective, a recent analysis estimated incremental health care costs among patients with VTE exceed \$30,000.¹⁴ Thus, extended-duration thromboprophylaxis is considered cost-effective, particularly in patients with an expected VTE incidence >2.4% such as ulcerative colitis and colorectal cancer. Within our clinical statewide registry, VTE rates after colectomy by hospital ranged from 0% to 5.56%. Each hospital, therefore, will need to identify and target for extended prophylaxis those patients whose risk factors make prophylaxis likely to be cost-effective. There has been concern over payors' willingness to provide coverage and the risk of high out-of-pocket costs to patients.¹⁵ Yet, we found no association between insurance status and use, and the high rates of adherence achieved in large academic hospitals suggest that cost alone is not the obstacle to prescribing.

There are a number of potential limitations to this study. First, the data assess prescribing patterns rather than actual adherence. However, because prescribing is the step most within surgeons' locus of control and is the necessary first step to actual use, it will need to be the first focus of performance improvement efforts. Second, despite a relatively large cohort, the small number of observed VTE events limits our power to evaluate the clinical efficacy of extended VTE prophylaxis. Thus, we rely on larger epidemiologic studies and expert consensus to support the indications for extended prophylaxis in these patients. Third, the sample of patients with IBD in the study cohort was small with 32 hospitals not having any patients with IBD who underwent colectomy in the MSQC registry. However, the data are representative of the hospitals that are involved in surgical care for patients with IBD in the State and should reflect their contemporary practice patterns accurately. Fourth, this study was not powered to detect differences in VTE rates between hospitals or the association between prescribing patterns and the incidence of VTE. Recognizing that the VTE incidence varies significantly between institutions in MSQC, it is not clear that broad prophylaxis

practices are indicated in all settings. Rather, a more nuanced recommendation might tailor prescription to clinical sites in which a critical threshold of baseline VTE rate is exceeded. Finally, these data come from Michigan hospitals and may not be directly generalizable to hospitals in other states. However, the population of the state of Michigan is representative of the U.S. demographic with the MSQC providing both community and academic hospital data generalizable to other states with respect to racial, ethnic and geographic diversity. Thus, the findings are expected to be relevant to surgical practices outside of Michigan.

CONCLUSIONS

Adherence to recommendations for extended thromboprophylaxis after colorectal surgery has increased for both CRC and IBD in recent years, but use is highly concentrated among a select few providers. They tend to congregate in large, academic referral centers with specialty colorectal surgery practices. Even now, more than 6 years after publication of high-level guidelines recommending extended prophylaxis in CRC surgery, 67% of Michigan hospitals continue to not prescribe extended-duration VTE prophylaxis after discharge for any of their patients with CRC. These findings indicate a need for multifaceted, interdisciplinary implementation strategies^{15–17} to increase awareness of and adherence to recommended prevention. Previous successful examples of effective quality improvement through regional collaboratives^{18–20} will provide the blueprints for such efforts.

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REFERENCES

1. Ali F, Al-Kindi SG, Blank JJ, Peterson CY, Ludwig KA, Ridolfi TJ. Elevated venous thromboembolism risk following colectomy for IBD is equal to those for colorectal cancer for ninety days after surgery. *Dis Colon Rectum*. 2018;61:375–381. [PubMed: 29420429]
2. Wilson MZ, Connelly TM, Tinsley A, Hollenbeak CS, Koltun WA, Messaris E. Ulcerative colitis is associated with an increased risk of venous thromboembolism in the postoperative period: the results of a matched cohort analysis. *Ann Surg*. 2015;261:1160–1166. [PubMed: 24983992]
3. Gould MK, Garcia DA, Wren SM, et al. Prevention of VTE in nonorthopedic surgical patients: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. *Chest*. 2012;141(2 suppl):e227S–e277S. [PubMed: 22315263]
4. Gustafsson UO, Scott MJ, Hubner M, et al. Guidelines for perioperative care in elective colorectal surgery: Enhanced Recovery After Surgery (ERAS[®]) Society Recommendations: 2018. *World J Surg*. 2019;43:659–695. [PubMed: 30426190]

5. Stahl TJ, Gregorcyk SG, Hyman NH, Buie WD; Standards Practice Task Force of The American Society of Colon and Rectal Surgeons. Practice parameters for the prevention of venous thrombosis. *Dis Colon Rectum*. 2006;49:1477–1483. [PubMed: 17041751]
6. Srinivasaiah N, Arsalani-Zadeh R, Monson JR. Thrombo-prophylaxis in colorectal surgery: a National Questionnaire Survey of the members of the Association of Coloproctology of Great Britain and Ireland. *Colorectal Dis*. 2012;14:e390–e393. [PubMed: 22321914]
7. Merkow RP, Bilimoria KY, Sohn MW, et al. Adherence with postdischarge venous thromboembolism chemoprophylaxis recommendations after colorectal cancer surgery among elderly Medicare beneficiaries. *Ann Surg*. 2014;260:103–108. [PubMed: 24169191]
8. Brady MT, Patts GJ, Rosen A, et al. Postoperative venous thromboembolism in patients undergoing abdominal surgery for IBD: a common but rarely addressed problem. *Dis Colon Rectum*. 2017;60:61–67. [PubMed: 27926558]
9. Kaiser Family Foundation. Market Share and Enrollment of Largest Three Insurers – Large Group Market. www.kff.org/other/state-indicator/market-share-and-enrollment-of-largest-three-insurers-large-group-market/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22michigan%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D. Accessed July 3, 2019.
10. Nelson DW, Simianu VV, Bastawrous AL, et al.; Colorectal Writing Group for Surgical Care and Outcomes Assessment Program-Comparative Effectiveness Research Translation Network (SCOAP-CERTAIN) Collaborative. Thromboembolic complications and prophylaxis patterns in colorectal surgery. *JAMA Surg*. 2015;150:712–720. [PubMed: 26060977]
11. Fleming FJ, Aquina CT. Extended-duration venous thromboembolism prophylaxis following colorectal surgery: ready for prime time? *Dis Colon Rectum*. 2018;61:273–274. [PubMed: 29420420]
12. Brown SR, Fearnhead NS, Faiz OD, et al.; ACPGBI IBD Surgery Consensus Collaboration. The Association of Coloproctology of Great Britain and Ireland consensus guidelines in surgery for inflammatory bowel disease. *Colorectal Dis*. 2018;20(suppl 8):3–117.
13. Sanderson B, Hitos K, Fletcher JP. Venous thromboembolism following colorectal surgery for suspected or confirmed malignancy. *Thrombosis*. 2011;2011:828030. [PubMed: 22084669]
14. Iannuzzi JC, Rickles AS, Kelly KN, et al. Defining high risk: cost-effectiveness of extended-duration thromboprophylaxis following major oncologic abdominal surgery. *J Gastrointest Surg*. 2014;18:60–68. [PubMed: 24101450]
15. Scaglione L, Piobbici M, Pagano E, Ballini L, Tamponi G, Ciccone G. Implementing guidelines for venous thromboembolism prophylaxis in a large Italian teaching hospital: lights and shadows. *Haematologica*. 2005;90:678–684. [PubMed: 15921383]
16. Caprini JA, Hyers TM. Compliance with antithrombotic guidelines. *Manag Care*. 2006;15:49–50, 53.
17. Vázquez FJ, Bilbao MS, Saimovici J, Vaccaro C. Improving adherence rate of extended prophylaxis for venous thromboembolic disease after abdominal and pelvic oncologic surgery: a pilot educational study. *Clin Appl Thromb Hemost*. 2015;21:750–754. [PubMed: 25908111]
18. Vu JV, Collins SD, Seese E, et al. Evidence that a regional surgical collaborative can transform care: surgical site infection prevention practices for colectomy in Michigan. *J Am Coll Surg*. 2018;226:91–99. [PubMed: 29111416]
19. Nikolian VC, Regenbogen SE. Statewide clinic registries: the Michigan Surgical Quality Collaborative. *Clin Colon Rectal Surg*. 2019;32:16–24. [PubMed: 30647542]
20. Share DA, Campbell DA, Birkmeyer N, et al. How a regional collaborative of hospitals and physicians in Michigan cut costs and improved the quality of care. *Health Aff (Millwood)*. 2011;30:636–645. [PubMed: 21471484]

FIGURE 1.

Extended, postdischarge VTE prophylaxis use by operative year by indication: colorectal cancer (Cancer), IBD, and Other. VTE = venous thromboembolism.

FIGURE 2.

Extended VTE prophylaxis use by hospital bed volume (number of beds). VTE = venous thromboembolism.

FIGURE 3. Extended VTE prophylaxis use by hospital teaching status. VTE = venous thromboembolism.

TABLE 1.

Hospital characteristics on receipt of extended, postdischarge VTE prophylaxis

Hospital characteristics	Cancer VTE prophylaxis		IBD VTE prophylaxis		Other VTE prophylaxis	
	Yes n = 282	No n = 1889	Yes n = 31	No n = 235	Yes n = 60	No n = 3225
Bed volume						
<300	7 (2)	731 (39)	0 (0)	60 (26)	6 (10)	1213 (38)
>300	275 (98)	1158 (61)	31 (100)	175 (74)	54 (90)	2012 (62)
Teaching status						
Community	108 (38)	1535 (81)	2 (6)	144 (61)	22 (37)	2605 (81)
Academic	174 (62)	354 (19)	29 (94)	91 (39)	38 (63)	620 (19)

Data presented as n (%).

VTE = venous thromboembolism.