Assessment of a Best Practice Alert and Referral Process for Preprocedure Antithrombotic Medication Management for Patients Undergoing Gastrointestinal Endoscopic Procedures

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Abstract

IMPORTANCE Management of antithrombotic medications presents a challenge for many clinicians and patients before procedures. Anticoagulation clinic involvement may improve preprocedure coordination, satisfaction on the part of patients and clinicians, last-minute procedure cancellations, and patient safety.

OBJECTIVE To assess the implementation of an electronic medical record (EMR) best practice alert (BPA) and anticoagulation clinic referral process to assist with management of antithrombotic medication before gastrointestinal endoscopic procedures.

DESIGN, SETTING, AND PARTICIPANTS This multimodal evaluation of a quality improvement intervention using EMRs and survey data included patients using oral antithrombotic medications who were scheduled for elective gastrointestinal endoscopic procedures at an academic medical center along with the clinicians who ordered these procedures. Data were collected from November 1, 2017, through December 19, 2018. Data were analyzed in September 2019.

EXPOSURES Following a multidisciplinary intervention, a BPA and referral process for periprocedural antithrombotic medication management was implemented in November 2017.

MAIN OUTCOMES AND MEASURES The following implementation outcomes were assessed through EMR review and surveys through December 2018: use of BPAs, patient and clinician satisfaction with preprocedure anticoagulation management, procedure cancellation rates, reach, and spread by patient and clinician characteristics. Multilevel logistic regression was used to estimate variance in BPA use at the clinician level.

RESULTS A total of 2082 patients (mean [SD] age, 64.1 [11.9] years) and 144 clinicians were included in the analysis. The BPA was used broadly across the health system, resulting in anticoagulation clinic referral for 1389 patients (66.7%). Referral was more common for patients using anticoagulant vs antiplatelet medications (1041 of 1524 [68.3%] vs 346 of 556 [62.2%]; adjusted odds ratio [aOR], 1.51; 95% CI, 1.15-1.98) and for procedures ordered by gastroenterologists vs primary care clinicians (933 of 1241 [75.2%] vs 365 of 618 [59.1%]; aOR, 2.15; 95% CI, 1.46-3.17). Individual clinician behavior patterns explained 26.5% (95% CI, 18.7%-36.1%) of variation in anticoagulation clinic referrals. Implementation of the intervention was associated with high patient satisfaction and improvements in multidimensional measures of clinician satisfaction (clinician response rate, 44.2% [144 of 326]). In multivariable analysis, the odds of altered or canceled procedures because of medication mismanagement declined after implementation (8 of 50 [16.0%] vs 1 of 52 [1.9%]; aOR, 0.11; 95% CI, 0.01-0.96; P = .02).

(continued)
CONCLUSIONS AND RELEVANCE  A newly implemented BPA and anticoagulation clinic referral process was broadly adopted and used, had high satisfaction by patients and clinicians, and was associated with fewer disruptions to planned procedures caused by medication mismanagement.

Introduction

Managing chronic antithrombotic (anticoagulant and/or nonaspirin antiplatelet) medications before an elective procedure is a common clinical challenge for patients with atrial fibrillation, venous thromboembolism, and coronary artery disease. Frequently these antithrombotic medications are not managed in accordance with clinical trial evidence or guideline recommendations, placing patients at risk for bleeding or thrombotic complications. In the context of gastrointestinal endoscopy, a recent survey found that most primary care clinicians (including physicians, nurse practitioners, and physician assistants) and gastroenterologists did not believe that they should be responsible for preendoscopy antithrombotic medication management and often recommended management that was not congruent with the most recent randomized clinical trial evidence. In addition, more than 80% of primary care clinicians and gastroenterologists indicated that their institution could do more to help manage preendoscopy antithrombotic medications. For their part, patients also commonly express confusion and dissatisfaction with the coordination of their medications before elective procedures.

Before procedures, antithrombotic medications may be managed by 1 of 3 health care professionals: (1) the original prescriber of the drug (eg, cardiologist); (2) the proceduralist (eg, gastroenterologist); or (3) the referring clinician (eg, primary care clinician). Poorly coordinated preprocedure antithrombotic medication management can lead to inefficient and unsafe care, poor patient satisfaction, and potential delays in care delivery. Although particularly robust anticoagulation clinics may assist with preprocedural anticoagulant management, fewer assist with managing antiplatelet medication before procedures, despite frequent concurrent use of anticoagulant and antiplatelet medications. Anticoagulation clinics that provide preprocedure anticoagulant management often do so selectively and without an established referral process.

Because gastrointestinal endoscopy is one of the most commonly performed elective procedures for patients with long-term use of antithrombotic medications, we formed a multidisciplinary quality improvement team at our institution to redesign the process for managing preendoscopy antithrombotic medications for outpatients. This process resulted in the development of a best practice alert (BPA) within the electronic medical record (EMR) that recommended referral to the anticoagulation clinic for any outpatients currently using long-term antithrombotic medication therapy (other than aspirin) when an elective gastrointestinal endoscopy was ordered. Our objective was to evaluate acceptability, adoption, and effectiveness of preendoscopic antithrombotic management and patient and clinician satisfaction.

Methods

Preimplementation phase methods for this quality improvement study are described in eMethods 1, eMethods 2, eFigure 4, and eFigure 5 in the Supplement. The institutional review board of the University of Michigan, Ann Arbor, approved this study. A waiver of informed consent was approved by the institutional review board for use of the BPA and clinic cancellation data sets. This study followed the Standards for Quality Improvement Reporting Excellence (SQUIRE) reporting guideline.
Implementation Process
In November 2017, a new BPA was piloted within 2 clinics (1 gastroenterology and 1 primary care) and slowly expanded to additional clinics during the next 5 months. By April 2018, the BPA was active for the entire health system. The BPA is triggered when an outpatient, elective gastrointestinal endoscopic procedure is ordered for a patient who is found to be using an antithrombotic medication (anticoagulant or P2Y12 inhibitor antiplatelet). The BPA notifies the ordering clinician that the patient appears to be using an antithrombotic medication and recommends referral to the anticoagulation clinic for further management. The ordering clinician can accept the referral or decline and opt to manage the antithrombotic medication(s) on his or her own.

Before implementation, opinion leaders within each of the specialties (gastroenterology, family medicine, general medicine, and gynecology) most likely to order gastrointestinal endoscopic procedures were identified. They communicated with their colleagues about the BPA and referral process, acting in a physician champion role and as a liaison between their colleagues and the multidisciplinary team. Educational sessions led by one of us (J.E.K.) were held with the gastroenterology faculty during 2 faculty meetings. Communications via email were sent to all clinicians who frequently order gastrointestinal endoscopic procedures. There was also a notice about the BPA and referral process in the weekly information technology newsletter sent to all faculty and staff.

Data Collection and Implementation Outcomes Assessment
Four sets of data to measure the outcomes of implementing this BPA were collected. These outcomes cover the range of implementation, service, and client outcomes described by Proctor et al. Specifically, we assessed adoption of the BPA from EMR-based data and patient reports of which clinicians gave preprocedural instructions. We assessed acceptability and fidelity of the BPA and anticoagulation clinic referral process through clinician surveys. We assessed the effectiveness of the quality improvement intervention by measuring the frequency of a cancelled procedure. Finally, we assessed patient and clinician satisfaction as well as patient-centeredness through surveys.

Patient Surveys
We collected patient-reported data from a structured telephone survey. We identified consecutive patients who had recently completed an outpatient, elective gastrointestinal endoscopic procedure while prescribed an antithrombotic medication. Within 2 business days of their procedure, after obtaining verbal informed consent, patients answered questions that were entered into a web-based survey database (Qualtrics) by a research team member (E. Sippola). These surveys were conducted from May 25 through December 19, 2017, before implementation of the BPA and then from June 19 through November 30, 2018, after implementation. The survey assessed patients’ experience and satisfaction with preendoscopic management and coordination of their antithrombotic medication. The complete survey instrument can be seen in eAppendix 1 in the Supplement.

Clinician Surveys
We assessed changes in the clinician-reported experience using online surveys (Qualtrics) before and after implementation. The first wave of surveys was sent to all attending cardiologists, gastroenterologists, and primary care clinicians at our center in the summer of 2015 (before implementation). This current analysis only includes primary care clinicians and gastroenterologists who responded to that survey, because cardiologists rarely order endoscopic procedures. The second wave of surveys was sent to all gastroenterologists and primary care clinicians who had managed 2 or more patients when the BPA was triggered from April 1 through July 31, 2018. This survey was administered from October 11 through December 19, 2018 (after implementation). Participant written informed consent was obtained before answering any survey questions. The preimplementation and postimplementation surveys assessed clinicians’ experience and expectations with managing antithrombotic medications before procedures, their perception of
institutional support, and their knowledge of available services within the anticoagulation clinic. Clinicians in the postimplementation wave of the survey were asked if they recalled seeing the alert along with their assessment of the alert’s usefulness, ease of use, their satisfaction, and how helpful the alert was in caring for their patients. The complete survey instrument can be seen in eAppendix 2 in the Supplement.

**Process Measures**

We used 2 complementary approaches to assess for canceled or altered procedures. First, we sampled patients presenting to the endoscopy unit for elective gastrointestinal endoscopic procedures in 3 waves. Endoscopy unit nurses completed a form if the patient was using an antithrombotic medication. The form assessed the specific antithrombotic medication and planned procedure, if the procedure had to be altered owing to mismanagement of the antithrombotic medication (eg, will perform colonoscopy but not perform a polypectomy), or if the procedure was canceled owing to mismanagement of the antithrombotic medication (herein referred to as *same-day cancelation*). These data were collected at all outpatient endoscopy units from June 1 through August 17, 2017, before implementation; from June 18 through July 2, 2018, shortly after full systemwide implementation; and from November 5 through 16, 2018, further after implementation. Analysis was performed by comparing the preimplementation phase with the combination of both postimplementation phases.

Second, we used the EMR to identify all endoscopic procedures scheduled from January 1, 2016, through April 30, 2019, that were canceled within 24 hours before their scheduled date (herein referred to as *cancellation within 24 hours*). We compared monthly cancelation rates before (January 2016 through October 2017) and after (May 2018 through April 2019) implementing the BPA (eFigure 6 in the Supplement).

To assess for use of the BPA implementation quality improvement intervention, we collected data for all instances of the BPA occurring from November 1, 2017, through December 19, 2018. Each BPA instance was categorized by the drug class (anticoagulant vs antiplatelet), ordering clinician specialty (primary care clinician, gastroenterologist, or other), and whether the BPA occurred during the pilot phase (November 2017 through March 2018) or after the systemwide implementation (April through December 2018).

**Quality Goals**

The team set goals before implementation. These included more than 80% patient and clinician satisfaction with preprocedural antithrombotic medication management, less than 5% of endoscopy cases requiring alteration or cancelation due to medication mismanagement, and broad use (>50%) of the anticoagulation clinic referral as recommended by the BPA.

**Statistical Analysis**

Data were analyzed in September 2019. We report descriptive statistics using $\chi^2$ tests or Fisher exact tests for categorical variables and Kruskal-Wallis tests for Likert scale survey responses, given their nonparametric assumptions. A multilevel logistic regression model was developed to assess the association between placement of an anticoagulation clinic referral (dependent variable) and drug class, clinician specialty, patient age (per decade), and pilot vs full implementation phases (independent fixed-effect variables). The final model included the clinician as random intercept variable, because there was very little variation at the clinic levels (intraclass correlation of 0.01). Using data collected from the endoscopy units (same-day cancelations data source), a multivariable logistic regression model was developed to assess the association between the combined outcome of either a same-day canceled or altered procedure (dependent variable) based on preimplementation vs postimplementation (independent variable) while adjusting for drug class and endoscopic procedure type. A canceled or altered procedure was defined as one in which a potential
or planned intervention (eg, polypectomy) could not be performed. All analyses were performed using Stata, version 14.2 (StataCorp LLC). Two-sided $P < .05$ indicated statistical significance.

Results

Preimplementation Phase

A total of 2082 patients (mean [SD] age, 64.1 [11.9] years) and 144 clinicians were included in the analysis. Several key findings emerged from the preimplementation process. First, gastrointestinal endoscopic procedures were ordered by multiple specialties (eg, gastroenterologist, primary care clinician) who were not all familiar with (1) the safety of stopping therapy with various antithrombetics (P2Y12 inhibitor and oral anticoagulant) in a specific clinical context or (2) the bleeding risk associated with specific endoscopic procedures (primarily among nongastroenterologists). Second, the pharmacists within the anticoagulation clinic provided only ad hoc assistance when specifically requested regarding preprocedure anticoagulant management (including warfarin sodium and the direct oral anticoagulants) but not antiplatelet medications. Third, endoscopy schedulers were a focal point in the coordination of care for patients using antithrombotic medications. Specifically, they were the group most likely to identify patients using an antithrombotic medication, because all patients (from internal and external referring clinicians) scheduling a procedure had to talk with a scheduler. In addition, schedulers had been trained to screen for antithrombotic medication use and, when needed, to direct patients to their referring clinicians for further instructions regarding preprocedure antithrombotic medication management.

No formal process was in place to ensure that a plan for antithrombotic medication management was reached or that it was communicated to the patient and/or their family. The team thus concluded that the central challenges to safe, effective, and efficient preprocedure medication management were consistently identifying the clinician responsible for preprocedure medication management and standardizing that management decision in accordance with the best evidence.

Postimplementation Phase

Adoption and BPA Use

During the study period, the BPA resulted in a referral to the anticoagulation clinic in 1389 of 2082 cases (66.7%) with endoscopy orders among patients using antithrombotic medications (study flowchart in eFigure 1 in the Supplement). Overall use of the BPA increased during the pilot phase as it was sequentially rolled out to new clinics until it reached a plateau by May 2018, when it was being used across the entire health system (Figure 1). As shown in Table 1, referral was less common during the pilot phase compared with the implementation phase (308 of 495 [62.2%] vs 1081 of 1587 cases).

![Figure 1. Number of Best Practice Alerts and Referrals to the Anticoagulation Clinic by Month](https://jamanetwork.com/)

The pilot phase included November 2017 through March 2018. Full systemwide use of the best practice alerts started in April 2018 and was assessed through December 2018.
adjusted odds ratio (aOR), 0.61; 95% CI, 0.45-0.81) but more common for patients using anticoagulants compared to antiplatelet medications (1041 of 1524 [68.3%] vs 346 of 556 [62.2%]; aOR, 1.51; 95% CI, 1.15-1.98), for older patients (aOR per decade of age, 1.12; 95% CI, 1.01-1.24), and for gastroenterologists compared with primary care clinicians (933 of 1241 [75.2%] vs 365 of 618 [59.1%]; aOR, 2.15; 95% CI, 1.46-3.17). Clinician-level variation explained 26.5% (95% CI, 18.7%-36.1%) of variation in referral after the BPA.

Effectiveness: Endoscopy Unit Experience

Data from 102 patients presenting to endoscopy were collected and analyzed in the same-day cancelation sample. This sample included data from 50 patients in the preimplementation phase (no BPA) and 52 patients in the combined 2 postimplementation phases (all of whom received the BPA). Differences in the types of endoscopy and antithrombotic medications being used by the patients in the preimplementation and postimplementation phases were noted (eTable in the Supplement). Patients in the postimplementation phase were less likely to require a same-day alteration or cancelation of their endoscopic procedure as a result of antithrombotic medication mismanagement (8 of 50 [16.0%] vs 1 of 52 [1.9%]; aOR, 0.11; 95% CI, 0.01-0.96; P = .02). There were few same-day canceled procedures in both phases (3 of 50 [6.0%] and 1 of 52 [1.9%]; P = .29), and no patients required an altered procedure in the postimplementation sample. Using EMR-based data, cancelations within 24 hours of a scheduled endoscopic procedure declined from 9.4% to 7.5% after implementation of the BPA (P = .02) (eFigure 2 in the Supplement).

Patient Experience Survey

A total of 122 of 130 patients (93.8%) completed the structured survey (74 before implementation and 48 after implementation) to measure adoption, patient centeredness, and satisfaction (Table 2). Most respondents were male (49 of 74 [66.2%] before implementation and 29 of 48 [60.4%] after implementation). Mean (SD) age was 67.8 (11.5) years before implementation and 69.7 (8.6) years after implementation.

After implementation, preendoscopy antithrombotic management instructions were more likely given by the anticoagulation clinic (19 of 36 [52.8%]) and less likely given by primary care clinicians (2 of 36 [5.6%]) and cardiologists (3 of 36 [8.3%]; P = .02) (Figure 2A). There was also a shift in preprocedure instructions being given by telephone (24 of 36 [66.7%]) compared with in person (4 of 36 [11.1%]) or by mailed letter (7 of 36 [19.4%]), but this difference was not statistically significant (P = .27) (Figure 2B).

In the preimplementation and postimplementation phases, patient satisfaction with communication about and coordination of preendoscopy antithrombotic medications was high (61 of 72 [84.7%] for preimplementation vs 41 of 43 [95.3%] for postimplementation; P = .08). Similarly,

Table 1. Clinicians’ Response to Best Practice Alert by Patient and Clinician Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Referral Status</th>
<th>Odds Ratio (95% CI)</th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Placed (n = 1389)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient age, mean (SD), y</td>
<td>64.4 (12.0)</td>
<td>63.7 (11.9)</td>
<td>1.05 (0.96-1.14) per decade</td>
<td>1.12 (1.01-1.25) per decade</td>
</tr>
<tr>
<td>Drug class, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticoagulant</td>
<td>1041 (68.3)</td>
<td>483 (31.7)</td>
<td>1.35 (1.08-1.69) per decade</td>
<td>1.51 (1.15-1.98)</td>
</tr>
<tr>
<td>Antiplatelet</td>
<td>346 (62.2)</td>
<td>210 (37.8)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Pilot phase, No. (%)</td>
<td>308 (62.2)</td>
<td>187 (37.8)</td>
<td>0.85 (0.67-1.07)</td>
<td>0.61 (0.45-0.81)</td>
</tr>
<tr>
<td>Full implementation phase, No. (%)</td>
<td>1081 (68.1)</td>
<td>506 (31.9)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Clinician specialty, No. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary care</td>
<td>365 (59.1)</td>
<td>253 (40.9)</td>
<td>1 [Reference]</td>
<td>1 [Reference]</td>
</tr>
<tr>
<td>Gastroenterology</td>
<td>933 (75.2)</td>
<td>308 (24.8)</td>
<td>1.85 (1.48-2.32)</td>
<td>2.15 (1.46-3.17)</td>
</tr>
<tr>
<td>Other</td>
<td>91 (40.8)</td>
<td>132 (59.2)</td>
<td>0.45 (0.31-0.65)</td>
<td>0.39 (0.23-0.66)</td>
</tr>
</tbody>
</table>

* Use of the best practice alert and anticoagulation clinic referral are for patients using antithrombotic medications with an order for an elective endoscopic procedure from November 2017 through December 2018. Data collected were based on clinician response to the best practice alert. Intraclass correlation at the clinician level was 0.26 (95% CI, 0.19-0.36).

b Calculated from a multilevel logistic regression model including all variables in the table and adjusted for clustering at the clinician level.
satisfaction with finding information about preendoscopy medication management was high in the preimplementation (65 of 72 [90.3%]) and postimplementation (40 of 42 [95.2%]; \(P = .34\)) phases.

Clinician Experience Survey
A total of 144 primary care clinicians and gastroenterologists completed the clinician survey (68 primary care clinicians before and 23 after implementation; 26 gastroenterologists before and 27 after implementation) to measure acceptability, fidelity, and satisfaction. Overall survey response rates were 48.5% for the preimplementation survey and 37.9% for the postimplementation survey (44.2% overall response rate [144 of 326]). Responding clinicians varied widely in time elapsed since training (median, 22 years [interquartile range, 11-31 years]) and saw a mean of 40 patients per week (interquartile range, 20-60 patients per week). The gastroenterologists performed a mean of 35 (interquartile range, 22-50) endoscopic procedures each month.

After implementation of the BPA, clinicians were more likely to identify the anticoagulation clinic (12 of 94 [12.8%] vs 28 of 50 [56.0%]) and less likely to identify the primary care clinician (52 of 94 [55.3%] vs 13 of 50 [26.0%]) or cardiologist (21 of 94 [22.3%] vs 5 of 50 [10.0%]) as making preprocedure antithrombotic medication decisions (preimplementation vs postimplementation for each, \(P < .001\)). Similarly, they were more likely to believe that the anticoagulation clinic (22 of 94 [23.4%] vs 24 of 50 [48.0%]) should make preprocedure antithrombotic medication decisions and

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Implementation Time</th>
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<tbody>
<tr>
<td></td>
<td>Before</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>67.8</td>
</tr>
<tr>
<td>Male, No./total No. (%)</td>
<td>49/74</td>
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<tr>
<td>Procedure performed, No./total No. (%)</td>
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<tr>
<td>Upper endoscopy</td>
<td>31/73</td>
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<tr>
<td>Lower endoscopy</td>
<td>42/73</td>
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<tr>
<td>Antithrombotic indication, No./total No. (%)</td>
<td></td>
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<tr>
<td>Atrial fibrillation</td>
<td>29/74</td>
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<tr>
<td>Venous thromboembolism</td>
<td>24/74</td>
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<tr>
<td>Coronary or peripheral artery disease</td>
<td>17/74</td>
</tr>
<tr>
<td>Mechanical valve</td>
<td>4/74</td>
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<tr>
<td>Antithrombotic medication stopped for procedure, No./total No. (%)</td>
<td></td>
</tr>
<tr>
<td>67/74</td>
<td>42/48</td>
</tr>
<tr>
<td>Previous surgery or procedure with antithrombotic therapy stopped, No./total No. (%)</td>
<td></td>
</tr>
<tr>
<td>47/73</td>
<td>34/47</td>
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</table>

Table 2. Characteristics of Patient Survey Respondents

Figure 2. Patient-Reported Venue and Methods for Preprocedural Medication Instructions
less likely to recommend this be done by cardiologists (37 of 94 [39.4%] vs 9 of 50 [18.0%]; preimplementation vs postimplementation for each, $P = .01$). As shown in **Figure 3**, opinions about institutional care processes for preprocedure antithrombotic management improved after implementation.

Among the survey respondents who had been exposed to the BPA (n = 48), their recollection of the BPA and satisfaction were high (eFigure 3 in the Supplement). After implementation of the BPA, responding clinicians were more likely to agree that the anticoagulation clinic provided assistance with determining the need for periprocedural bridging anticoagulation (18 of 94 [19.1%] vs 36 of 45 [80.0%]), recommended an agent for periprocedural bridging (28 of 94 [29.8%] vs 36 of 45 [80.0%]), and prescribed any bridging anticoagulant medication (18 of 94 [19.1%] vs 24 of 45 [53.3%]; preimplementation vs postimplementation for each, $P < .001$).

**Discussion**

In response to patient- and clinician-reported difficulty managing preprocedure antithrombotic medications leading to frequent same-day endoscopy cancelation, we implemented a BPA that recommended referral to the anticoagulation clinic for medication management assistance. That effort was successful across a broad range of implementation outcomes, including acceptability, adoption, fidelity, effectiveness, patient centeredness, and satisfaction.8

Most clinicians acted on this BPA to refer patients to the anticoagulation clinic for preprocedure medication management. After implementation of this BPA, clinician satisfaction improved. In addition, the overall number of canceled or altered procedures was reduced in the same-day endoscopy unit sample with a significant reduction found in the EMR-based analysis of cancelations within 24 hours. While achieving these improvements, patient satisfaction remained very high, and there was growing support for and awareness of the anticoagulation clinic’s role in managing preprocedure antithrombotic medications among primary care clinicians and gastroenterologists.

Antithrombotics remain one of the highest-risk medications for adverse drug events.9 The periprocedural period is particularly high risk, given the number of short-term medication changes and the risk of thromboembolic and bleeding events around the time of a procedure.10 At the same time, the evidence guiding periprocedural management decisions has been changing rapidly during the past 5 years. This evidence includes new recommendations to be less aggressive with heparin

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**Figure 3. Change in Clinician-Reported Attitudes About Preprocedural Antithrombotic Management**

<table>
<thead>
<tr>
<th>Institution has structures in place</th>
<th>Strongly disagree or oppose</th>
<th>Disagree or oppose</th>
<th>Slightly disagree or oppose</th>
<th>Slightly agree or support</th>
<th>Agree or support</th>
<th>Strongly agree or support</th>
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<tbody>
<tr>
<td>Pre-BPA</td>
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<tr>
<td>Post-BPA</td>
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<tr>
<td>I know who to contact with questions</td>
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<td>Pre-BPA</td>
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<td>Post-BPA</td>
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<td>Institution could do more to help</td>
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<td>Pre-BPA</td>
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<tr>
<td>Post-BPA</td>
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<tr>
<td>Supportive of or opposed to anticoagulation clinic role</td>
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<tr>
<td>Pre-BPA</td>
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<tr>
<td>Post-BPA</td>
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Each survey question included a 6-point Likert-type scale with responses ranging from strongly disagree or oppose to strongly agree or support. Full survey questions are included in eAppendix 2 in the Supplement. Bars compare the responses obtained before and after implementing the best practice alert (BPA) and anticoagulation clinic referral process.

$^a P < .001$, pre-BPA vs post-BPA.

$^b P = .20$, pre-BPA vs post-BPA.

$^c P = .003$, pre-BPA vs post-BPA.
bridging for warfarin-treated patients, 4 new direct oral anticoagulants with unique pharmacological properties that differ greatly from those of warfarin, and no clear source of national recommendations for P2Y12 antiplatelet management for noncardiac surgery.1,11

The revised preendoscopy workflow in this project leverages the expertise of an existing anticoagulation clinic, helping to expand its scope of work and reach. With the increasing diversity of antithrombotic medications being used clinically, anticoagulation clinics have an opportunity to serve many roles to promote safe medication use, including in the periprocedural period.6 However, justifying the use of these important staff members requires careful implementation evaluation. Consistent with the framework first presented by Proctor and colleagues,8 we believe we have demonstrated successful implementation across the domains of implementation outcomes (acceptability, adoption, and fidelity), service outcomes (effectiveness and patient centeredness), and client outcomes (satisfaction).8 Important to health care administrators, avoiding canceled procedures can greatly improve revenue capture for these procedures. With the use of ongoing analyses, we hope to assess the association of the BPA and anticoagulation referral process with guideline-recommended management.

Although this project was specific to gastrointestinal endoscopy, it has the potential to be generalizable to many other elective surgical procedures. As a central repository of anticoagulation expertise, the anticoagulation clinic can support preprocedure management care coordination, decision-making, and communication for any number of different procedures (eg, cardiac procedures or elective orthopedic or general surgical procedures). In addition, the BPA leverages information routinely collected in the EMR (eg, current medications) to identify which patients would be appropriate for a referral to the anticoagulation clinic. We believe that by designing this BPA as part of the current clinician workflow (alert occurs at the time the endoscopy order is placed, not hours or days later) and using an opt-out design that allows single-click ordering, overall clinician satisfaction is optimized and use of BPA is encouraged. This outcome is particularly important given that more than one-quarter of variation in referral to the anticoagulation clinic is explained by individual clinician differences. Creating standard workflows that ensure high-quality care for all patients is a laudable goal, and further work is needed to explore how to better operationalize BPAs and other clinical prompts.

Although overall rates of inappropriate medication management or same-day procedure cancelation were quite low, these rates improved after implementing the BPA and anticoagulation clinic referral process. When combined with the increases in patient and clinician satisfaction, the implementation was deemed to be a success and may serve as a model for other procedures or health systems looking to similarly improve their periprocedural antithrombotic medication management.

Strengths and Limitations
This study has a number of important strengths, including complementary data collection from multiple stakeholder groups and the use of validated survey instruments for patient- and clinician-reported outcomes. However, a few important limitations must be acknowledged. First, this implementation effort was conducted at a single academic health center, and the outcomes reported may not be realized at different health centers with a different patient, clinician, and/or resource mix. Second, although data collection was completed concurrently with implementation, causation cannot be inferred from these findings. Third, some data collected were sampled (eg, endoscopic procedure alteration or cancelation) using on-site endoscopy unit staff. Therefore, those estimates may include measurement error and/or bias in the estimates. Other data were captured from the EMR. As with most quality improvement studies, limited data collection may introduce possible unmeasured confounding. Fourth, the clinician survey response rate was low and may not represent the attitudes of all clinicians. Fifth, although we have demonstrated changes in attitudes and procedural outcomes, we were unable to assess for any change in clinical outcomes (eg, bleeding or
stroke rates). In addition, data collection occurred in the 6 months after implementation, and therefore we are not yet able to report on the sustainability of this implementation intervention.

Conclusions

We redesigned the management of preprocedure antithrombotic medications before elective gastrointestinal endoscopic procedures by using an EMR BPA to encourage referral to the anticoagulation clinic. Successful implementation of this new process was associated with improved patient and clinician satisfaction, a low rate of medication mismanagement, and a substantial reduction in canceled elective endoscopic procedures.

ARTICLE INFORMATION

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