Ther Adv Gastroenterol
2017, Vol. 10(5) 387–396
DOI: 10.1177/1756283X17694807

Low adherence to national guidelines for proton-pump inhibitor prescription in patients receiving combination aspirin and anticoagulation

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Abstract

Background: Aspirin, when used with concurrent anticoagulation, increases the risk of gastrointestinal bleeding (GIB). Therefore, multisociety guidelines recommend prophylactic proton-pump inhibitors (PPIs) for patients receiving aspirin and anticoagulation. We aimed to determine rates and predictors of adherence to these recommendations.

Methods: All adult inpatients discharged from the hospital on aspirin and anticoagulation from July 2009 to June 2014 were retrospectively evaluated for PPI prescription on discharge instructions. We used univariate and multivariate logistic regression to test for predictors of PPI prescription.

Results: A total of 2422 patients were discharged on aspirin and anticoagulation; the mean age was 68 years and 53.2% were male; 42.2% were prescribed a PPI at discharge. On univariate analysis, factors associated with discharge PPI prescription included increased age (47.1% *versus* 37.9%), white race (47.3% *versus* 37.1–40.2%), higher aspirin dose (55.1% *versus* 39.4%), being married (46.2% *versus* 39.4%) and preadmission PPI use (96.6% *versus* 23.4%). On multivariate analysis, significant predictors of discharge PPI prescription were age 60–69 years [odds ratio (OR) 1.61] and 70–79 years (OR 1.48), and preadmission PPI use (OR 120.03). Lower odds of discharge PPI prescription included Medicaid (OR 0.55) or Medicare (OR 0.71) insurance, Spanish language (OR 0.63), and lower dose aspirin (81 mg) (OR 0.40).

Conclusions: A total of 42.2% of patients discharged on aspirin and anticoagulation were prescribed PPIs. Older age and preadmission PPI use were predictive of PPI prescription, while Medicaid/Medicare insurance, Spanish language, and lower dose aspirin decreased the likelihood of discharge PPI prescription. This creates an opportunity to improve primary GIB prevention through quality improvement interventions.

Keywords: acidity (esophageal), acidity (intragastric), compliance/adherence, guidelines, nonvariceal bleeding

Received: 13 November 2016; accepted in revised form: 11 January 2017

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Introduction and background

Evidence has long supported the use of low-dose aspirin, defined as 75–325 mg, in both primary and secondary treatment of cardiovascular disease.[1–3] At low doses, aspirin irreversibly acetylates cyclooxygenase 1 (COX-1), which blocks the formation of thromboxane A2 and inhibits platelet aggregation. This mechanism produces beneficial antithrombotic effects that help prevent acute cardiovascular events. Despite its clear role in cardiovascular disease prevention, aspirin has been shown to double the risk of major gastrointestinal bleeding (GIB), and the risk of GIB persists in people

who take aspirin for more than 1 year.[4–6] Aspirin is thought to promote gastrointestinal (GI) mucosal injury by blocking the COX-1 pathway depleting necessary prostaglandins that protect GI mucosa.

Patients who require aspirin for primary and secondary prevention of cardiovascular disease may also require anticoagulation such as warfarin, unfractionated heparin, or low molecular weight heparin for acute coronary syndrome, valvular, arrhythmic, or vascular indications. When anticoagulation therapy is used in combination with aspirin, the risk of clinically significant GIB increases further.[7–11] Therefore, a tradeoff must be made between the benefits of cardiovascular disease prevention and the increased risk of GIB. Collaborative guidelines between the American College of Cardiology Foundation (ACCF) Task Force, the American College of Gastroenterology (ACG), and the American Heart Association (AHA) have focused on combining goals of the cardiologist and gastroenterologist to create multidisciplinary recommendations that balance risks and benefits of antiplatelet therapies with interventions to reduce GIB risk. According to the 2008 ACCF/ACG/AHA recommendations, patients who take combination aspirin and anticoagulation therapy should receive a proton-pump inhibitor (PPI) to reduce the risk of GIB complications.[12]

To date, several studies have shown low rates of PPI use in patients taking nonsteroidal anti-inflammatory drugs (NSAIDs) who are at increased risk for GIB.[13–15] However, to our knowledge no such study has examined the rates of PPI use in patients prescribed combination aspirin and anticoagulation therapy. Given that many anticoagulants are started in the inpatient setting for acute indications, the composition of the list of medications prescribed at hospital discharge is an opportunity for patients on anticoagulation treatment who are taking concomitant aspirin to be instructed to take a PPI for GIB prevention. In this study, we aimed to examine adherence to the recommended practice of PPI prescription at hospital discharge in patients receiving combination aspirin and anticoagulation as per the guidelines. We also aimed to identify predictors of adherence to this recommendation so as to guide future interventions aimed at improving primary GIB prevention.

Methods

Study design and inclusion criteria

In this retrospective cohort study, we identified all adult patients (⩾18 years age) who were discharged from New York Presbyterian Hospital – Columbia University Medical Center with a prescription for combination aspirin and anticoagulation therapy during the 5-year period spanning 1 July 2009 and 30 June 2014. The first hospital discharge for each patient between the dates of this study was included and subsequent hospital discharges for each patient were excluded. Marital status, language spoken, and length of stay are routinely and systematically collected for all admitted patients in addition to patient age, sex, race, and type of insurance. All patients are required to have an updated discharge medication requisition prior to discharge. This generates the outpatient medication prescription list prior to discharge. Home medications are obtained from the outpatient electronic medical record that is then verified and updated by providers upon admission. Aspirin doses included 81 mg and 325 mg. Anticoagulation therapy included warfarin, enoxaparin, dabigatran, fondaparinux, rivaroxaban, apixaban, and low molecular weight heparin not specified. A concurrent parenteral and oral anticoagulation bridge to oral therapy was also included in the anticoagulation definition. This study was approved by the Institutional Review Board of Columbia University Medical Center (IRB-AAAO4163).

Outcome measures

The primary outcome of this study was compliance with ACCF/ACG/AHA recommendations as determined by the presence of PPI prescription at the time of hospital discharge for patients on combination aspirin and anticoagulation therapy. The discharge medication reconciliation list in the electronic health record system was used to determine the presence of PPI prescription. PPI medications included at least once-daily dosage of any of the following list of medications: omeprazole, esomeprazole, pantoprazole, lansoprazole, dexlansoprazole, and rabeprazole. Given that guidelines solely recommend PPIs for dual aspirin and anticoagulation therapy, the use of H2 receptor antagonists was not assessed in this study. Limited data are available regarding the effect of H2 receptor antagonists on preventing gastric injury from low-dose aspirin, and acid

suppression by H2 receptor antagonists does not prevent most NSAID-related gastric ulcers. [12]

Statistical analysis

Baseline patient characteristics of the cohort were presented as percentages. Univariate analysis using χ^2 and Fisher's exact tests, as appropriate, was used to compare rates of PPI use by patient characteristic. The following patient variables were tested as potential factors associated with adherence to guidelines regarding PPI prescription: patient age, sex, race, insurance, primary language, marital status, aspirin dose at discharge, anticoagulation type, concurrent corticosteroid or antiplatelet drug prescription, and regular PPI use prior to admission. Multivariate logistic regression was used to identify which among these variables were independently associated with PPI prescription. As a *post hoc* analysis, we then repeated the multivariate analysis, now restricted to those patients who were not already taking a PPI prior to admission. All analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC).

Results

Patient characteristics

A total of 2422 patients were discharged on combination aspirin and anticoagulation during this 5-year period. Sociodemographic characteristics are listed in Table 1. The median age was 69 years, 53.2% were male, 42.7% were white, 21.3% were Spanish speaking, and 42% were married. A proportion of 9.3% of patients enrolled had Medicaid as their primary insurance, while 22.5% had Medicare insurance. The median length of hospital admission was 6 days. A total of 1958 (80.8%) patients were discharged on an aspirin dose of 81 mg, and 414 (17.1%) were prescribed 325 mg. [In the remaining 50 (2.06%) patients, the aspirin dose was not specified in the discharge medication list.] A total of 1179 (48.7%) patients were discharged on oral anticoagulation therapy, 705 (29.1%) were prescribed parenteral anticoagulation, and 538 (22.2%) were prescribed both oral and parenteral anticoagulation at discharge as a bridge to oral anticoagulation. The most common anticoagulants prescribed at discharge were warfarin (56.5%), enoxaparin (49.9%), and rivaroxaban (12.9%) (Table 2). In addition, 435 (18.0%) of these patients were discharged on concurrent antiplatelet therapy, 472 (19.5%) on corticosteroid therapy, and 76 (3.14%) on both antiplatelet and corticosteroid therapy.

Predictors of PPI prescription at discharge

Among patients on combination aspirin and anticoagulation therapy, 1023 (42.2%) were prescribed a PPI at discharge as per ACCF/ACG/AHA guidelines. On univariate analysis (Table 3), increased age (age 60–69: 47.1% *versus* age < 60: 37.9%; $p = 0.0003$), race/ethnicity (white: 47.3% *versus* other all other races: 37.1–40.2%; $p = 0.0002$), marital status (married: 46.2% *versus* not married: 39.4%; $p = 0.0009$) were associated with PPI prescription at discharge. Higher aspirin dose at discharge (325 mg: 55.1% *versus* 81 mg: 39.4%; $p < 0.0001$) and oral anticoagulation therapy compared with parenteral or combination oral and parenteral (oral anticoagulation: 46.7% *versus* other parenteral combinations 34.2–40.9%; $p < 0.0001$) were also associated with PPI prescription at discharge. Being discharged on concurrent corticosteroid therapy (54.5% *versus* 39.3%; $p < 0.0001$) in addition to aspirin and anticoagulation also increased the likelihood of PPI prescription at discharge, while concurrent antiplatelet therapy (38.9% *versus* 43.0%; $p = 0.11$) and combination corticosteroid plus antiplatelet therapy (52.6% *versus* 41.9%; $p = 0.62$) did not affect likelihood. PPI prescription prior to admission was strongly associated with PPI prescription at discharge (96.6% *versus* 23.4%; $p < 0.0001$).

On multivariate analysis (Table 4), age 60–69 years [odd ratio (OR) 1.61; 95% confidence interval (CI) 1.17–2.23; $p = 0.0037$) and 70–79 (OR 1.48; 95% CI 1.06–2.06; $p = 0.020$) years, and regular PPI use prior to admission (OR 120.03; 95% CI 75.06–191.92; $p < 0.0001$) remained significant predictors of PPI prescription at discharge. Lower odds of PPI prescription at discharge were found for patients who were enrolled in Medicaid (OR 0.55; 95% CI 0.35–0.88; $p = 0.012$) or Medicare (OR 0.71; 95% CI 0.51–0.97; $p = 0.034$) compared with commercial insurance. Additional factors associated with lower odds of PPI prescription included Spanish as the patient's primary language (OR 0.63; 95% CI 0.45–0.87; $p = 0.0049$), lower dose aspirin on discharge (81 mg) (OR 0.40; 95% CI 0.31–0.53; $p < 0.0001$), and being prescribed an oral plus

Table 1. Characteristics of patients discharged on combination aspirin and anticoagulation.

Characteristic	Number of patients (%) (n = 2422)
Patient age (years)	
Mean/median/SD	68.1/69.0/14.6
<60	586 (24.2)
60–69	643 (26.6)
70–79	633 (26.1)
⩾80	560 (23.1)
Sex	
Male	1288 (53.2)
Female	1134 (46.8)
Race	
White	1035 (42.7)
African American	237 (9.79)
Other	677 (28.0)
Unknown	473 (19.5)
Insurance	
Medicaid	223 (9.32)
Medicare	538 (22.5)
Commercial insurance	844 (35.3)
Self pay	788 (32.9)
Primary language	
English	1630 (67.3)
Spanish	516 (21.3)
Other	178 (7.35)
Unknown	98 (4.05)
Marital status	
Not married	1406 (58.1)
Married	1016 (42.0)
Length of admission (mean/median/SD) (days)	9.0/6.0/11.0
Aspirin dose at discharge	
81 mg	1958 (80.8)
325 mg	414 (17.1)
Type of anticoagulation	
Oral	1179 (48.7)
Parenteral	705 (29.1)
Oral + parenteral	538 (22.2)
Discharged on antiplatelet* therapy	435 (18.0)
Discharged on steroid	472 (19.5)
Discharged on antiplatelet + steroid therapy	76 (3.14)
Discharged on a PPI	1023 (42.2)
Discharged on an H2RA	201 (8.30)

*Antiplatelet drug category does not include aspirin.
H2RA, H2 blocker; PPI, proton-pump inhibitor; SD, standard deviation.

Table 2. Frequencies of patients on aspirin therapy taking anticoagulation or antiplatelet medications.

Drug name	Number of patients (%)
Anticoagulation drug	
Warfarin	1368 (56.5)
Enoxaparin	1209 (49.9)
Dabigatran	52 (2.15)
Fondaparinux	25 (1.03)
Rivaroxaban	313 (12.9)
Apixaban	19 (0.78)
LMWH not specified	87 (3.59)
Antiplatelet drug*	
Clopidogrel	404 (16.7)
Prasugrel	6 (0.25)
Ticagrelor	5 (0.21)

*Antiplatelet drug category does not include aspirin.
LMWH, low molecular weight heparin.

parenteral anticoagulation bridge (OR 0.50; 95% CI 0.36–0.68; $p < 0.0001$).

We then repeated the multivariate analysis, now limited to patients who were not taking a PPI prior to admission so as to determine factors associated with new PPI prescription at discharge. A total of 1798 patients discharged on aspirin and anticoagulation were not taking a PPI prior to admission, and 420 (23.4%) of these patients were started on a PPI at discharge. On multivariate analysis (Supplementary Table 1), age 60–69 (OR 1.58; 95% CI 1.13–2.20; $p = 0.0078$) and 70–79 (OR 1.46; 95% CI 1.04–2.06; $p = 0.030$) were significant predictors of PPI prescription at discharge. Patients not taking a PPI prior to admission who were Medicaid insured (OR 0.58; 95% CI 0.36–0.94; $p = 0.27$), Spanish speaking (OR 0.55; 95% CI 0.39–0.78; $p = 0.0009$), prescribed lower dose aspirin (81 mg) at discharge (OR 0.39; 95% CI 0.30–0.52; $p < 0.0001$), and prescribed an oral plus parenteral anticoagulation bridge (OR 0.48; 95% CI 0.34–0.68; $p < 0.0001$) had a decreased likelihood of being prescribed a PPI at discharge. Medicare insurance no longer reached significance as a factor associated with lower odds of PPI prescription at discharge in patients not taking a PPI at admission.

Discussion

In this retrospective cohort study, we found that PPIs are underprescribed in patients on

Table 3. Univariate analysis: factors associated with PPI prescription at discharge among patients on combination aspirin and anticoagulation therapy.

Characteristic	Discharged on a PPI ($n = 1023$)	Not discharged on a PPI ($n = 1399$)	*p* value
Patient age (years)			0.0003
<60	222 (37.9)	364 (62.1)	
60–69	303 (47.1)	340 (52.9)	
70–79	288 (45.5)	345 (54.5)	
⩾80	210 (37.5)	350 (62.5)	
Sex			0.07
Male	522 (40.5)	766 (59.5)	
Female	501 (44.2)	633 (55.8)	
Race			0.0002
White	489 (47.3)	546 (52.75)	
African American	88 (37.1)	149 (62.9)	
Other	256 (37.8)	421 (62.2)	
Unknown	190 (40.2)	283 (59.8)	
Insurance			0.027
Medicaid	78 (35.0)	145 (65.0)	
Medicare	234 (43.5)	304 (56.5)	
Commercial insurance	380 (45.0)	464 (55.0)	
Self pay	317 (40.2)	471 (59.8)	
Primary language			0.0053
English	727 (44.6)	903 (55.4)	
Spanish	199 (38.6)	317 (61.4)	
Other	60 (33.7)	118 (66.3)	
Unknown	37 (37.8)	61 (62.2)	
Marital status			0.0009
Not married	554 (39.4)	852 (60.6)	
Married	469 (46.2)	547 (53.8)	
Aspirin dose at discharge			<0.0001
81 mg	771 (39.4)	1187 (60.6)	
325 mg	228 (55.1)	186 (44.9)	
Anticoagulation type			<0.0001
Oral	551 (46.7)	628 (53.3)	
Parenteral	288 (40.9)	417 (59.2)	
Oral + parenteral	184 (34.2)	354 (65.8)	
Concurrent antiplatelet* therapy			0.11
Discharged on antiplatelet therapy	169 (38.9)	266 (61.2)	
Not discharged on antiplatelet therapy	854 (43.0)	1133 (57.0)	
Concurrent steroid therapy			<0.0001
Discharged on steroid therapy	257 (54.5)	215 (45.6)	
Not discharged on steroid therapy	766 (39.3)	1184 (60.7)	
Concurrent antiplatelet + steroid therapy			0.062
Discharged on antiplatelet + steroid therapy	40 (52.6)	36 (47.4)	
Not discharged on antiplatelet + steroid therapy	983 (41.9)	1363 (58.1)	
PPI at admission			<0.0001
Taking a PPI at admission	603 (96.6)	21 (3.37)	
Not taking a PPI at admission	420 (23.4)	1378 (76.6)	

*Antiplatelet drug category does not include aspirin.
PPI, proton-pump inhibitor.

Table 4. Multivariate analysis: predictors of PPI prescription at discharge among patients on combination aspirin and anticoagulation therapy.

Characteristic	OR	95% CI	*p* value
Patient age (years)			
<60	1.0	[ref]	[ref]
60–69	1.61	1.17–2.23	0.0037
70–79	1.48	1.06–2.06	0.020
⩾80	1.12	0.81–1.60	0.45
Sex			
Male	0.80	0.63–1.01	0.062
Female	1.0	[ref]	[ref]
Race			
White	1.0	[ref]	[ref]
African American	0.73	0.48–1.10	0.13
Other	1.02	0.75–1.37	0.92
Unknown	0.74	0.52–1.04	0.084
Insurance			
Medicaid	0.55	0.35–0.88	0.012
Medicare	0.71	0.51–0.97	0.034
Commercial insurance	1.0	[ref]	[ref]
Self pay	0.85	0.66–1.13	0.27
Primary language			
English	1.0	[ref]	[ref]
Spanish	0.63	0.45–0.87	0.0049
Other	0.70	0.45–1.10	0.13
Unknown	1.21	0.71–2.04	0.48
Marital status			
Not married	1.0	[ref]	[ref]
Married	1.21	0.95–1.55	0.12
Aspirin dose at discharge			
81 mg	0.40	0.31–0.53	<0.0001
325 mg	1.0	[ref]	[ref]
Anticoagulation type			
Oral	1.0	[ref]	[ref]
Parenteral	0.84	0.63–1.10	0.20
Oral + parenteral	0.50	0.36–0.68	<0.0001
Discharged on antiplatelet* therapy	0.77	0.55–1.08	0.13
Discharged on steroid therapy	1.16	0.84–1.61	0.37
Discharged on antiplatelet + steroid therapy	1.15	0.52–2.52	0.73
PPI at admission	120.03	75.06–191.92	<0.0001

*Antiplatelet drug category does not include aspirin.
CI, confidence interval; HR, hazard ratio; PPI, proton-pump inhibitor.

combination aspirin and anticoagulation therapy, as only 42.2% were prescribed this class of medications in accordance with 2008 ACCF/ACG/AHA guidelines for primary GIB prevention. In addition, 23.4% of patients on aspirin and anticoagulation previously not taking a PPI before admission were appropriately placed on a PPI at discharge. Our findings suggest that there is a need to improve guideline adherence to prevent adverse events in patients at risk for GIB. Our

results also identify several demographic and medication-related factors that affect adherence to guidelines, creating opportunities of focus for future interventions to improve primary GIB prevention. Older age and PPI prescription at admission were predictors of PPI prescription at discharge in accordance with guidelines. Socioeconomic factors including Medicaid or Medicare insurance and Spanish as the primary language decreased the likelihood of being appropriately prescribed a PPI at discharge, while medication characteristics including lower dose aspirin and being bridged on parenteral anticoagulation also decreased the odds of PPI prescription. When restricting the analysis to subjects who were not using a PPI prior to admission to determine factors associated with initiation of a PPI at discharge, the results were comparable to our main analysis. In that *post hoc* analysis, only Medicare was no longer a significant factor associated with decreased odds of new PPI prescription, which is likely explained by a lack of power in this subset.

To our knowledge, this is the first study that assesses compliance with established guidelines on GIB prevention and identifies predictors of guideline adherence for patients discharged from the hospital on combination aspirin and anticoagulation therapy. Previous studies have focused on assessing rates of GIB prophylaxis in patients taking NSAIDs, but not on concurrent aspirin and anticoagulation. Thus far, underprescription of prophylactic therapies in patients on NSAIDs who are at risk for GIB has been documented by several studies and rates range between 20% and 38%.[16–20]

In studies from the United States, higher socioeconomic status has been associated with increased rates of PPI use in patients taking NSAIDs who are at risk for bleeding,[19] while in one study from the Netherlands, where insurance is almost universally provided, lower income is associated with increased long-term PPI prescription in patients on NSAIDs.[21,22] The decreased likelihood of PPI prescription at discharge in Medicaid and Medicare insured patients on combination aspirin and anticoagulation supports previous studies from the United States in which higher income correlates with increased rates of PPI prescription. Possible explanations include increased patient awareness of PPIs, decreased need for prior authorization, and ability to pay higher copayments among higher income, privately insured patients. Spanish as the primary language also decreased the odds of PPI prescription at discharge, which further supports previous studies in which racial/ethnic differences affected awareness of NSAID-associated ulcer risks and appropriate use of GI prophylaxis.[22,23]

Additional factors such as momentum and perceptions of medication therapy may have influenced adherence to guidelines in this study. Patients on combination aspirin and anticoagulation therapy who were already taking a PPI at admission were highly likely to be discharged on a PPI. One prior study has shown that approximately 75% of all hospitalized patients prescribed a PPI at admission were also prescribed a PPI at discharge.[24] A majority of these prescriptions were without acceptable indications, suggesting that hospitalization was not utilized as an opportunity to re-evaluate PPI prescription. Our results suggest that the need for a new PPI prescription is not routinely evaluated among patients discharged from the hospital with a new indication for this medication class.

There are several limitations to this study. As this was a retrospective analysis, indications for combination aspirin and anticoagulation and indications for initiating, continuing, or withholding PPI prescription at discharge were not available and so were not examined. Lack of indication for initiation or continuation of PPIs may overestimate guideline compliance as providers could have prescribed a PPI for another indication. Clinical information regarding whether patients successfully complied with their PPI prescription was not available, which could overestimate the number of patients actually taking PPIs. Alternatively, the number of patients taking PPIs could have been underestimated given that some PPIs are available without a prescription; nevertheless, it is unlikely that patients would be verbally advised to take this class of medication without it appearing on the written discharge medication list. Despite these limitations, less than half of patients on aspirin and anticoagulation were prescribed a PPI at discharge, indicating that efforts are still necessary to improve guideline compliance. A main driving factor for PPI prescription at discharge was PPI prescription at admission; though this could be due to inertia, it is also possible that PPI at admission may serve as a proxy for increased GI risk. The

presence of other GIB risk factors and incidence of GIB events subsequent to discharge in our cohort was not available. Future efforts will be needed to track GIB consequences of underprescription of PPIs in patients taking combined aspirin and anticoagulation.

We did not examine the long-term effects of continued PPI use in this patient population. Given a lack of consensus on adverse effects of long-term PPI use, growing evidence suggests that PPIs should be used for evidence-based indications to minimize inappropriate PPI use.[25,26] In recommendations for patients taking aspirin and anticoagulation, there is currently no consensus on which dosages of PPIs are the most effective in preventing GIB, and thus, we did not examine PPI dosages. Future studies are needed to determine which PPI doses are most effective in preventing GIB in this population. In addition, the 2008 ACCF/ACG/AHA recommendations defined anticoagulants as unfractionated heparin, low molecular weight heparin, and warfarin. Direct oral anticoagulants (DOACs) were not included. The effect of PPIs on preventing GIB in patients on DOACs is still not established. PPIs have been shown to prevent upper GIB but not lower GIB in patients on dabigatran, and the magnitude of effect was similar to H2 blockers, while in another study, PPIs were associated with increased GIB in patients taking rivaroxaban.[27,28] Given there are few data on PPI use in preventing GIB in patients on DOACs, we cannot assume that lack of PPI use in patients on DOACs is nonadherence of guidelines and further studies must be performed. Data on ethnicity were incomplete and therefore Spanish as the primary language was used as a surrogate for Hispanic ethnicity. This likely underestimates the numbers of patients who self identify as Hispanic. Since our study cohort was derived from a large, academic, tertiary care referral center, these results may not be generalizable to all medical centers in the United States. To minimize data limitations, future studies should focus on prospectively studying each risk factor for underprescription of patients on aspirin and anticoagulation. Despite these limitations, this is the first study to date looking at center adherence to guidelines on primary GIB prevention for patients on combination aspirin and anticoagulation therapy and provides important information to help identify opportunities for improvement and intervention.

In summary, overall less than half of patients discharged on combination aspirin and anticoagulation therapy were prescribed PPIs at discharge in accordance with guidelines for primary GIB prevention, and only 23.4% of patients not previously on a PPI were newly started on appropriate PPI therapy at discharge. Integrating best evidence into routine practice requires timely and effective interventions that iterate required knowledge for practice change at every relevant patient encounter.[29] The discharge medication reconciliation process includes a review of all medications a patient will be taking at home and patient education on medications prior to hospital discharge. This is a key opportunity in hospital-based care to ensure appropriate and safe use of medications according to established guidelines for each patient. In inpatient practice, nuanced guidelines can be overlooked given patient volume and focus on inpatient issues. Physician practice has been shown to improve in response to both oral and written education targeted to specific performance measures or clinical guideline recommendations.[30,31] Concise verbal education or written statements that focus on guiding inpatient clinicians on PPI prescription for patients on aspirin and anticoagulation could help improve awareness of clinical guidelines. Verbal education or written literature provides an opportunity to remind physicians to consider PPIs for patients who have demographic or medication-related factors that were associated with decreased PPI prescription at discharge, including Spanish language, younger age, Medicaid/Medicare insurance, or an anticoagulation bridge. Previous studies have also shown that computerized order entry using clinical decision support systems improves performance in medication prescribing and reduces medication errors.[32–34] Clinical decision support systems are computer-generated recommendations, including advice on drug prescribing, delivered to a clinician through the electronic health record. Given our results, a clinical decision support system that reminds physicians at the time of the discharge medication reconciliation to evaluate the patient for PPI prescription if the patient is on aspirin and anticoagulation may help increase guideline adherence. This intervention could be applied to all inpatients on aspirin and anticoagulation, and thus, may remove the effects of demographic and medication-related factors on PPI prescription. Future efforts should focus on prospectively evaluating risk factors for underprescription of PPIs, creating educational

programs, and creating an intervention at the time of the discharge medication reconciliation to improve rates of PPI prescription at discharge for patients on combination aspirin and anticoagulation according to guidelines.

Acknowledgements

All authors approve the final manuscript submitted and they approve the authorship list. Conception and design: RS, AR, CR, BL; analysis and interpretation of the data: RS, AR, CR, BL; drafting of the article: RS; critical revision of the article for important intellectual content: RS, AR, CR, BL, RR, RG; final approval of the article: BL, RR, RG. This project (IRB-AAAO4163) was approved by the Institutional Review Board of Columbia University Medical Center on 11/1/2015.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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