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Association Of Bleeding Avoidance Strategies with age-related bleeding and In-hospital mortality in patients undergoing percutaneous coronary Interventions☆

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ABSTRACT

Background: The association of bleeding avoidance strategy (BAS) (consisting of a combination of radial access, bivalirudin [rather than heparin +/− glycoprotein GPIIb/IIIa antagonists], and/or vascular closure devices after femoral access) with bleeding and in-hospital outcomes has not been evaluated among elderly patients undergoing percutaneous coronary interventions (PCI).
Methods: We studied BAS use, bleeding and in-hospital mortality among 121,635 patients categorized by age (<50, 50–59, 60–69, 70–79, and ≥80 years) undergoing PCI from the BMC2 registry (1/2010–12/2013).
Results: The use of BAS decreased marginally with age and despite improved utilization over time, remained lower among the elderly. BAS was used in a much lower risk cohort among all age groups. Nonetheless, compared with no BAS, the use of this strategy was associated with lower bleeding (adjusted OR 0.984, 95% CI 0.980–0.985) and in-hospital mortality (adjusted OR 0.996, 95% CI 0.994–0.997) among all age-groups. Similar relative reduction in the risk of bleeding was observed among all age groups with BAS use with lowest risk (thus greatest absolute risk reduction given their highest risk for bleeding) for the oldest cohort.
Conclusions: BAS use decreased with age among patients undergoing PCI despite its association with lower in-hospital mortality. Although overall utilization improved over time, it still remained lower in the elderly cohort, a group likely to benefit most from it. These data identified an opportunity to design strategies to improve BAS use particularly among high-risk elderly patients undergoing PCI so as to decrease bleeding and reduce related adverse events and costs.

1. Introduction

Peri-procedural bleeding is a common complication among patient undergoing percutaneous coronary intervention (PCI) and is associated with a higher morbidity and mortality post-procedure as well as longer hospitalization and increased costs [1–4]. Older age has been reported as a significant risk factor for bleeding after PCI [5–7]. Recently the use of bleeding avoidance strategies (BAS) has been shown to be associated with lower risk of peri-PCI bleeding. These strategies consist of a combination of the use of radial access (rather than femoral access), bivalirudin (rather than heparin +/− glycoprotein GPIIb/IIIa antagonists) and/or vascular closure devices after femoral access for PCI [2,8,9]. Prior reports suggested a risk-treatment paradox where BAS were utilized in low risk group compared to groups with high risk of bleedings [8,9]. However, the incidence of the use of BAS with age and its association with age-related bleeding and outcomes remain unknown. We hypothesized that given the higher risk of bleeding in the elderly, BAS use was likely to be higher with increasing age of the patients undergoing PCI. Furthermore, we theorized that given the higher risk of bleeding with older age, BAS were likely to be associated with greatest reduction in bleeding risk and better outcomes in the elderly. To test these hypotheses, we evaluated BAS use with age and its relationship with age-related bleeding and outcomes in patients undergoing PCI enrolled in the Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2), a collaborative statewide, multi-hospital PCI quality improvement [10–13].

Abbreviations: BAS, bleeding avoidance strategies; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting; BMC2, Blue Cross Blue Shield of Michigan Cardiovascular Consortium.

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2. Materials and methods

2.1. Patient population

We evaluated 124,606 patients undergoing PCI enrolled in the BMC2 registry between January 1, 2010 and December 31, 2013. The details of the design of BMC2 registry and the data collection process have been described previously [10–13]. Briefly, data on all patients undergoing PCI at 44 participating hospitals were collected using standardized data collection forms. All data elements including adverse events were prospectively defined. A dedicated staff member at participating sites collected the data and forwarded it to the coordinating center. Bleeding events were identified by participating sites and were not adjudicated. Sites were given a uniform standard definition of bleeding as described under the Methods section and were asked to categorized bleeding based on this definition. However, to ensure accuracy all participating sites were audited twice yearly. During the audit, 2% of cases were selected at random for review. Medical records of all patients undergoing coronary artery bypass grafting (CABG), and of those who died in the hospital were reviewed by auditors from the coordinating center to ensure accuracy. The choice of medications as well as equipment was at the discretion of the operating physician and encouraged to be consistent with national Guidelines for PCI [14]. Patients with cardiogenic shock ($n = 2971$) were excluded from this analysis.

2.2. Definition of complications

These definitions are available on the registry Website (https://bmc2.org) as well as published previously [10–13]. Access site hematoma (regardless of access) was defined as any hematoma requiring transfusion, or prolonged hospital stay or caused a drop in hemoglobin ≥3 g/dl. Vascular complications included pseudoaneurysm, arteriovenous fistula, femoral nerve injury, retroperitoneal hematoma, access site hematoma, or any access site complication requiring surgical repair. Gastrointestinal bleeding was considered when the patient had hematemesis or melena associated with a decrease in hematocrit and hemoglobin. Mortality was defined as all-cause death from either cardiac or non-cardiac etiology. Bleeding avoidance strategies were defined as the use of vascular closure devices during femoral access, radial approach, bivalirudin, or a combination of these [9]. The current analysis was funded by a grant from the Blue Cross Blue Shield of Michigan Foundation. The BMC2 registry is funded by Blue Cross Blue Shield of Michigan. The sponsors had no role in the study design, analysis, drafting and editing of the manuscript or decision to publish these results.

2.3. Statistical analysis

Patients were categorized into five age-based groups: <50 years, 50 to 59 years, 60 to 69 years, 70 to 79 years, ≥80 years. Continuous

Table 1
Baseline characteristics of study population.

	Age					
Variable	<50 years	50–59 years	60–69 years	70–79 years	>80 years	*p*-Value
n	12,557	27,822	37,028	28,583	15,645	
(%)	10.32%	22.87%	30.44%	23.50%	12.86%	
Demographics						
Age (years) (mean)	44.0	54.9	64.5	74.2	84.0	NA
Race—white	81.27%	83.50%	85.87%	88.25%	90.64%	<0.001
Body mass index (kg/m^2) (mean)	32.1	31.7	31.3	29.9	27.4	<0.001
Medical history						
Hypertension	72.59%	81.10%	86.99%	90.79%	91.94%	<0.001
Diabetes mellitus	30.50%	35.47%	42.12%	41.68%	32.99%	<0.001
Current smoker	59.58%	47.41%	27.37%	12.95%	4.83%	<0.001
CHF	8.27%	10.99%	14.69%	19.88%	26.73%	<0.001
Atrial fibrillation	2.67%	4.91%	9.60%	16.86%	24.26%	<0.001
Previous MI	33.08%	34.43%	35.44%	36.55%	35.97%	<0.001
Previous PCI	38.19%	43.02%	47.06%	49.23%	46.05%	<0.001
Previous CABG	7.12%	11.85%	19.91%	26.54%	24.95%	<0.001
COPD	10.19%	16.66%	20.02%	22.20%	20.15%	<0.001
PVD	6.81%	11.68%	16.78%	21.71%	23.15%	<0.001
Gastrointestinal bleeding	0.49%	0.70%	0.86%	1.39%	1.57%	<0.001
Indication for PCI						
Primary PCI-STEMI	21.86%	15.14%	10.42%	7.61%	9.81%	<0.001
NSTE-ACS	53.58%	53.14%	52.48%	53.79%	57.16%	<0.001
Staged	5.80%	6.08%	6.10%	6.17%	6.02%	<0.001
Other	15.66%	23.40%	29.35%	31.16%	25.62%	<0.001
Baseline laboratory						
Hemoglobin (gm/dl)	14.2	14.0	13.5	13.0	12.4	<0.001
GFR	138.9	117.0	94.7	72.7	51.7	<0.001
Baseline medications						
Aspirin	95.59%	95.66%	95.56%	95.54%	94.90%	0.009
Clopidogrel	64.46%	66.95%	70.85%	79.65%	85.43%	<0.001
Prasugrel	26.45%	24.12%	19.95%	9.88%	2.40%	<0.001
Predicted bleeding risk based on the NCDR model (mean)	1.72%	1.84%	2.08%	2.52%	43.65%	<0.001
Predicted bleeding risk based on the NCDR model with BAS use	1.59%	1.71%	1.95%	2.39%	3.46%	<0.001
Predicted bleeding risk based on the NCDR model without BAS use	2.06%	2.22%	2.47%	2.87%	4.11%	<0.001

CHF = congestive heart failure; MI = myocardial infarction; PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting; COPD = chronic obstructive pulmonary disease; PVD = peripheral vascular disease; STEMI = ST-elevation myocardial infarction; NSTE-ACS = non-ST elevation acute coronary syndrome; GFR = glomerular filtration rate