Journal of the American Heart Association

ORIGINAL RESEARCH

Risk of Postdischarge Bleeding From Dual Antiplatelet Therapy After Percutaneous Coronary Intervention Among US Black and White Adults

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BACKGROUND: Dual antiplatelet therapy after percutaneous coronary intervention reduces myocardial infarctions but increases bleeding. The risk of bleeding may be higher among Black patients for unknown reasons. Bleeding risk scores have not been validated among Black patients. We assessed the difference in bleeding risk between Black and White patients along with the performance of the Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy, Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients, and Academic Research Consortium for High Bleeding Risk scores among both groups.

METHODS AND RESULTS: This was a single-center prospective study of patients who underwent percutaneous coronary intervention (2014–2019) and were followed for 1 year. The outcome was postdischarge Bleeding Academic Research Consortium 2 to 5 bleeding. Incidence rates were reported. Cox proportional hazards models measured the effect of self-reported Black race on bleeding and determined the predictors of bleeding among 19 a priori variables. The 3 risk scores were assessed among Black and White patients separately using the Harrell concordance index. Of 1529 included patients, 342 (22.4%) self-reported as being Black race. Unadjusted bleeding rates were 22.7 per 100 person-years among Black patients versus 16.3 among White patients (hazard ratio, 1.41 [95% CI, 1.00–2.00], P=0.052). Predictors of bleeding were age, glomerular filtration rate <30 mL/min per 1.73 m^2, prior bleeding, ticagrelor or prasugrel use, and anticoagulant use. Among Black and White patients, respectively, the C-indexes were the following: 0.644 versus 0.600 for Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy (P<0.001 for both), 0.620 versus 0.612 for Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients (P=0.003 and P<0.001, respectively), and 0.600 versus 0.598 for Academic Research Consortium for High Bleeding Risk (P=0.006 and P<0.001, respectively).

CONCLUSIONS: The risk of dual antiplatelet therapy–associated postdischarge Bleeding Academic Research Consortium 2 to 5 bleeding was not significantly different between self-reported Black and White patients. Bleeding risk scores performed similarly among both groups.

Key Words: incidence ■ percutaneous coronary intervention ■ platelet aggregation inhibitors ■ prasugrel hydrochloride ■ proportional hazards models ■ prospective studies ■ ticagrelor

Dual antiplatelet therapy (DAPT) is recommended after an acute myocardial infarction or percutaneous coronary intervention (PCI).[1] Although DAPT reduces the incidence of subsequent myocardial infarction, it causes increased bleeding and, through unclear mechanisms, is associated with excess noncardiac

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Supplemental Material is available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.121.024412

For Sources of Funding and Disclosures, see page 9.

JAHA is available at: www.ahajournals.org/journal/jaha

CLINICAL PERSPECTIVE

What Is New?

- The risk of dual antiplatelet therapy–associated postdischarge bleeding was not statistically higher for Black patients compared with White patients.
- A nonsignificant numerical difference was present, and this difference was primarily explained by a higher proportion of Black patients having severe kidney disease, defined by a glomerular filtration rate <30 mL/kg per 1.73 m^2 or end-stage renal disease.
- The Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy, Academic Research Consortium for High Bleeding Risk, and Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients scores had moderate predictive abilities among both Black and White patients.

What Are the Clinical Implications?

- Race should not be considered by clinicians when assessing bleeding risk while on dual antiplatelet therapy.
- Clinicians should consider the following 5 predominant factors when assessing bleeding risk: severe kidney disease, age, prasugrel or ticagrelor use, anticoagulant use, and prior bleeding.
- The Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy, Academic Research Consortium for High Bleeding Risk, and Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients scores can be confidently applied to both Black and White patients in clinical practice, with the Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy score better measuring gradations in age and kidney disease.

Nonstandard Abbreviations and Acronyms

ARC-HBR	Academic Research Consortium for High Bleeding Risk
BARC	Bleeding Academic Research Consortium
DAPT	dual antiplatelet therapy
PARIS	Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients
PRECISE-DAPT	Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy

mortality[2] and a lower quality of life.[3] Patients at high bleeding risk experience worse outcomes from DAPT,[4] and US guidelines recommend shorter durations of DAPT for patients at high bleeding risk.[1]

Risk factors associated with bleeding while on DAPT have been combined into risk scores to determine high bleeding risk. Three scores (Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy [PRECISE-DAPT],[5] Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients [PARIS],[6] and Academic Research Consortium for High Bleeding Risk [ARC-HBR[7]]) were designed to predict bleeding after hospital discharge and have been validated in external cohorts. They have been referenced in European antiplatelet guidelines,[8] but there is no consensus on which score should be used in clinical practice. Current US guidelines have not referenced these risk scores.

Prior studies have demonstrated increased bleeding from DAPT among Black adults compared with White adults.[9,10] Factors contributing to this difference are not known and may not be measured by the PRECISE-DAPT, PARIS, or ARC-HBR risk scores. In addition, the cohorts used to validate these 3 scores have been predominantly from European or Asian countries.[11,12] They have not been validated in self-reported Black adults—a subgroup underrepresented in PCI trials.[13] In the present study, we aim to (1) compare postdischarge bleeding between self-reported Black and White patients; (2) identify clinical factors that contribute to this difference; and (3) assess the ability of the PRECISE-DAPT, PARIS, and ARC-HBR risk scores to predict postdischarge bleeding among Black and White patients separately.

METHODS

The data that support the findings of this study are available from the authors on reasonable request. The PRiME-GGAT (Pharmacogenomic Resource to Improve Medication Effectiveness-Genotype-Guided Antiplatelet Therapy) prospective cohort study enrolled patients aged ≥18 years who underwent PCI at the University of Alabama at Birmingham Hospital. The study was approved by the University of Alabama at Birmingham Hospital institutional review board. Consent was obtained at enrollment, which

occurred during the index PCI hospitalization (June 2014–November 2019).

A structured form was used to record age, self-reported race, sex, and smoking status. Height, weight, and laboratory values were recorded from the medical record, measured on the day of PCI. Laboratory values included serum creatinine, white cell count, platelet count, and hemoglobin. The Chronic Kidney Disease Epidemiology Collaboration equation was used to derive an estimated glomerular filtration rate (GFR; mL/min per 1.73 m^2), which does not consider self-reported race as a variable.[14] The following variables were obtained from the medical record: history of diabetes (or the use of glucose-lowering medications), hypertension (or the use of antihypertensive medications), stroke (or transient ischemic attack), prior bleeding, and liver cirrhosis (with portal hypertension). Home and discharge medications (antiplatelets, anticoagulants, proton pump inhibitors, nonsteroidal anti-inflammatory drugs, and corticosteroids) were recorded from the medical record.

Patients were followed for 1 year. All University of Alabama at Birmingham medical records were reviewed, and records from facilities outside of the University of Alabama at Birmingham system were requested and reviewed. Postdischarge bleeding events were documented by study personnel and adjudicated by 2 physicians. Patients were right-censored from the analysis for the following 4 reasons: (1) they had any Bleeding Academic Research Consortium (BARC) 2 to 5 bleeding event, (2) they were no longer taking DAPT therapy, (3) they died, or (4) they were lost to follow-up. For patients lost to follow-up, the last known clinic visit or hospitalization was the point of censor.

Postdischarge bleeding events were categorized based on the BARC statement (Table S1).[15] The outcome for each of our analyses was postdischarge BARC 2 to 5 bleeding. The following summarizes the BARC schema: type 1 bleeding does not cause the patient to seek unscheduled care, type 2 bleeding prompts evaluation and care but does not meet types 3 to 5 criteria, type 3 bleeding is major (hemoglobin drop >3 g/dL, cardiac tamponade, intracranial, intraocular, required transfusion, surgical intervention, or vasoactive agents), type 4 bleeding is a coronary artery bypass graft related, and type 5 bleeding is fatal.

We compared baseline variables between Black and White patients using *t* tests for continuous variables and χ^2 tests for categorical variables. We chose these 19 variables because they were either included in the PRECISE-DAPT, PARIS, or ARC-HBR risk scores or they were determined a priori to be associated with bleeding.

We reported the number of bleeding events, person-years of follow-up, and the anatomical location of each bleeding event among all patients and then Black and White patients separately. Incidence rates of bleeding were calculated and reported as per 100 person-years.

We assessed the influence of each baseline variable on bleeding with a time-to-event analyses by using the fit proportional hazards function to develop Cox proportional hazards models. An unadjusted analysis was first performed and then a multivariable analysis using only those variables associated with bleeding with an unadjusted $P<0.20$. Hazard ratios with 95% CIs were reported. A sensitivity analysis was performed using the same methodology but accounting for the competing risk of death using the PHREG procedure (PROC PHREG, SAS software, version 9.4).

Cox proportional hazards models were then used to measure the mediating effect of each predictor variable (those with $P<0.05$ after multivariable adjustment) on the association between self-reported Black race and bleeding. Each model was adjusted for age and sex and then for each predictor variable independently. A sensitivity analysis was performed to determine the mediating effect of 3 forms of the GFR variable (GFR <30 mL/min per 1.73 m^2, GFR <45 mL/min per 1.73 m^2, and continuous) on the association between self-reported Black race and bleeding. The significance of each mediating effect was measured by the Sobel test.

We then assessed the performance of 3 commonly used risk scores among Black and White patients separately.

1. The PRECISE-DAPT score[5] is composed of 5 variables: age, GFR, hemoglobin, white cell count, and previous clinically significant bleeding. Each component is assigned point values as per Table S2. A score ≥25 denotes high bleeding risk, 18 to 24 denotes moderate risk, 11 to 17 denotes low bleeding risk, and ≤10 denotes very low bleeding risk. For this study, PRECISE-DAPT was condensed into high (≥25), moderate (18–24), and low (≤17) categories.
2. The PARIS score[6] is composed of 6 variables: age, current smoking, body mass index, GFR, hemoglobin, and oral anticoagulant use. Each is assigned a point value as per Table S3. A score ≥8 denotes high bleeding risk, 4 to 7 denotes moderate bleeding risk, and ≤3 denotes low bleeding risk.
3. The ARC-HBR score[7] is composed of 15 variables, classified as either major or minor criteria. For the present study, 7 variables were modified or excluded to fit our data set (Table S4). Having either 1 major or 2 minor criteria denote high bleeding risk.

We distributed patients into categories of risk for each score. For the PRECISE-DAPT and PARIS scores, we distributed patients into quartiles of risk because these scores were intended to be continuous. For the

ARC-HBR score, we distributed patients into 2 categories of risk (low or moderate versus high risk) as this score was intended to be binary. Incident rates of bleeding were reported for each risk category, stratified by race. Proportional hazard models were used to compare each category with the lowest category of risk, also stratified by race. Adjustment was made for sex and the predictor variables determined from the aforementioned analyses (those with $P<0.05$ after multivariable adjustment), unless the predictor variable was included in any 1 of the 3 risk scores.

We quantified the discriminative abilities of the 3 risk scores by measuring the Harrell concordance index (C-index).[16] To calculate this, we used the PHREG procedure (PROC PHREG, SAS software, version 9.4) to produce Cox proportional hazards models and selected the option to compute a Harrell C-index. The scores were included as single continuous variables for PRECISE-DAPT and PARIS and as a nominal variable for ARC-HBR. C-indexes were calculated for all patients and then Black and White patients separately.

All statistical tests were 2-sided, with main effects tested at an α level of 0.05 unless otherwise specified. Incidence rates were calculated by using the OpenEpi online software platform.[17] The other analyses were performed by using JMP software, version 16.2, and SAS software, version 9.4.

RESULTS

Of the 1558 patients enrolled in the study, 29 were excluded from the analysis because their self-reported race or ethnicity was other than Black race or White race, leaving 1529 patients included in the final analysis, of which 22.4% were Black patients. The analysis included 1027.1 person-years of follow-up. The mean follow-up was 0.62 years per person for Black patients and 0.69 years for White patients. Among all patients, 908 (59.3%) were censored for any reason (64.3% Black patients versus 57.9% White patients), and 39 patients (2.5%) were censored because of death (1.5% Black patients versus 2.8% White patients). Of the included patients, <1% had missing data elements.

Black patients were younger than White patients, and a smaller proportion of Black patients were aged ≥75 years (Table 1). A greater proportion of Black patients were women and were current smokers. body mass index was higher among Black patients, and a larger proportion of Black patients had a body mass index ≥35 kg/m^2. Mean GFR was lower among Black patients, and a greater proportion of Black patients had a GFR <30 mL/min per 1.73 m^2. Black patients had a lower mean white cell count and a higher mean platelet count. Black patients had a lower mean hemoglobin concentration, and a greater proportion of Black patients had a hemoglobin <12 g/dL. A greater proportion of Black patients had diabetes and hypertension. Other baseline variables, including antithrombotic medication use, were not different between groups.

Overall, 159 patients (10.2%) experienced a postdischarge BARC 2 to 5 bleeding event, of which 44 were Black patients (12.9%) and 115 were White patients (9.7%). The number of events per BARC category, and the anatomical location of each event, are reported in Table S5. The largest proportion of BARC 2 to 5 events were from gastrointestinal bleeding (37.1%), followed by nonprocedural hematomas (21.4%). The incidence of bleeding by each BARC category is presented in Table 2. Among all patients, the incidence of postdischarge BARC 2 to 5 bleeding was 15.5 per 100 person-years (Table 2).

For the time-to-event analysis, the unadjusted predictors of postdischarge BARC 2 to 5 bleeding were age, GFR <30 mL/min per 1.73 m^2, previous bleeding (requiring medical attention), ticagrelor or prasugrel use, anticoagulant use, hemoglobin, and prior ischemic stroke or transient ischemic attack (Table 3). Sex, liver cirrhosis, and proton pump inhibitor use each had a P value between 0.05 and 0.20 and were also included in the adjusted analyses. After adjustment for these 11 variables, only age, GFR <30 mL/min per 1.73 m^2, previous bleeding, ticagrelor or prasugrel use, and anticoagulant use remained predictors.

Self-reported Black race was not a significant predictor of bleeding (unadjusted hazard ratio, 1.41 [95% CI, 1.00–2.00]; $P=0.052$). Unadjusted and adjusted time-to-event curves for Black and White patients separately are displayed in Figures S1 and S2, respectively. The results of a sensitivity analysis incorporating the competing risk of death were similar and are presented in Table S6.

The mediating effects of each predictor variable individually on the relationship between self-reported Black race and BARC 2 to 5 bleeding are presented in Table S7. Only GFR<30 mL/min per 1.73 m^2 was a significant mediator (34.8% reduction in effect; $P<0.001$). Alternative forms of the GFR variable (<45 mL/min per 1.73 m^2 and continuous) did not have a mediating effect on the association between Black race and bleeding (Table S8).

There were differences in the proportions of patients classified as high risk, compared with low–moderate risk, between Black and White patients, for the PRECISE-DAPT and PARIS scores. The PRECISE-DAPT score classified 30.4% of all patients as high bleeding risk (35.4% of Black patients compared with 29.9% of White patients; $P=0.023$), the PARIS score classified 12.3% of all patients as high risk (15.8% of Black patients compared with 11.3% of White patients; $P=0.031$). There were no differences in the proportions classified as high risk, compared with low–moderate

Table 1. Baseline Characteristics of the Study Population

	All patients, N=1529	Black patients, n=342	White patients, n=1187	*P* value
Age, y	62.2±11.9	58.9±11.4	63.1±11.8	<0.001
Age ≥75 y	224 (14.7)	22 (6.4)	202 (17.0)	<0.001
Female sex	463 (30.3)	146 (42.7)	317 (26.7)	<0.001
Smoking status				
Current smoker	384 (25.8)	108 (32.6)	276 (23.9)	0.005
Former smoker	552 (37.1)	107 (32.3)	436 (37.7)	
Never smoker	552 (37.1)	116 (35.1)	445 (38.5)	
Body mass index, kg/m^2	30.3±6.1	31.1±7.1	30.0±5.8	0.010
<25 kg/m^2	282 (18.5)	66 (19.4)	216 (18.2)	0.007
25–34.9 kg/m^2	953 (62.5)	191 (56.0)	762 (64.4)	
≥35 kg/m^2	290 (19.0)	84 (24.6)	206 (17.4)	
GFR, mL/min per 1.73 m^2	74.8±25.7	67.8±30.4	76.8±23.8	<0.001
GFR ≥60 mL/min per 1.73 m^2	1130 (74.2)	227 (66.8)	903 (76.3)	<0.001
GFR 45–59 mL/min per 1.73 m^2	202 (13.2)	38 (11.2)	164 (13.9)	
GFR 30–44 mL/min per 1.73 m^2	90 (5.9)	23 (6.8)	67 (5.7)	
GFR <30 mL/min per 1.73 m^2 or requiring dialysis	101 (6.6)	52 (15.3)	49 (4.1)	
White cell count, ×10^3/μL	8.4 (6.5–10.8)	7.6 (3.7–10.3)	8.5 (6.7–10.8)	<0.001
Platelet count, ×10^9 per L	222.9±70.2	238.5±73.4	218.5±68.7	<0.001
Platelet count, <100×10^9 per L	27 (1.8)	3 (0.9)	24 (2.0)	0.240
Hemoglobin, g/dL	13.6±1.9	13.0±1.9	13.8±1.9	<0.001
Hemoglobin, <12 g/dL	291 (19.1)	98 (28.9)	193 (16.3)	<0.001
Diabetes	653 (42.7)	165 (48.3)	488 (41.1)	0.019
Hypertension	1308 (85.5)	308 (90.1)	1000 (84.2)	0.007
Prior ischemic stroke or TIA	210 (13.7)	54 (15.8)	156 (13.1)	0.217
Prior hemorrhage	21 (1.4)	2 (0.6)	19 (1.6)	0.194
Previous bleeding requiring medical attention*	105 (6.9)	27 (7.9)	78 (6.6)	0.397
ARC-HBR major bleeding history†	27 (1.8)	8 (2.3)	19 (1.6)	0.366
ARC-HBR minor bleeding history†	8 (0.5)	3 (0.9)	5 (0.4)	0.388
Liver cirrhosis with portal hypertension	24 (1.6)	5 (1.5)	19 (1.6)	1.000
$P2Y_{12}$ inhibitor use (in combination with aspirin)				
Clopidogrel	1001 (65.8)	228 (66.9)	773 (65.5)	0.182
Prasugrel	36 (2.4)	4 (1.2)	32 (2.7)	
Ticagrelor	475 (31.2)	104 (30.5)	371 (31.4)	
Anticoagulant use	218 (14.3)	44 (12.9)	174 (14.8)	0.430
Proton pump inhibitor use	538 (35.4)	115 (33.7)	423 (35.9)	0.480
Long-term NSAID use‡	63 (4.1)	14 (4.1)	49 (4.1)	1.000
Long-term corticosteroid use‡	68 (4.4)	13 (3.8)	55 (4.6)	0.655

Continuous variables are displayed as mean±SD or median (interquartile range) if the distribution was skewed, whereas categorical variables are displayed as number (percentage). ARC-HBR indicates Academic Research Consortium for High Bleeding Risk; GFR, glomerular filtration rate; PRECISE-DAPT, Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy; and TIA, transient ischemic attack.

*Definition used for the PRECISE-DAPT score.

†Defined in Table S4.

‡Both a home medication at the time of index percutaneous coronary intervention and continued at discharge.

risk, between Black and White patients, for the ARC-HBR criteria: 46.4% overall, with 48.3% of Black patients classified as high risk compared with 45.8% of White patients (*P*=0.46). The number of patients, events, and person-years of follow-up in each category of risk are provided in Table S9, along with unadjusted hazard ratios comparing risk categories. The incidence rates of BARC 2 to 5 bleeding among risk categories and adjusted hazard ratios comparing categories are presented in Figure.

For the PRECISE-DAPT score, the Harrell C-index was 0.614 for all patients (*P*<0.001), 0.644 for Black

Table 2. Incidence Rates for Postdischarge Bleeding Events by BARC Category

	All patients, N=1529	Black patients, n=342	White patients, n=1187
Person-years of follow-up	1027.1	213.2	813.9
Category of bleeding	Incidence rate per 100 person-years (95% CIs)		
BARC 2	11.1 (9.3–13.4)	12.7 (8.5–18.8)	10.8 (8.7–13.3)
BARC 3	4.0 (2.9–5.4)	7.5 (4.4–11.9)	3.1 (2.0–4.5)
BARC 4	0	0	0
BARC 5	0.3 (0.1–0.8)	0.5 (0.02–2.3)	0.2 (0.04–0.8)
Combined BARC 2 to 5	15.5 (13.2–18.0)	20.6 (15.2–27.5)	14.1 (11.7–16.9)

BARC indicates Bleeding Academic Research Consortium.

patients (*P*<0.001), and 0.600 for White patients (*P*<0.001). For the PARIS score, the C-index was 0.617 for all patients (*P*<0.001), 0.620 for Black patients (*P*=0.003), and 0.612 for White patients (*P*<0.001). For the ARC-HBR score, the C-index was 0.600 for all patients (*P*<0.001), 0.600 for Black patients (*P*=0.006), and 0.598 for White patients (*P*<0.001).

DISCUSSION

In the present study of 1529 patients who underwent PCI and were placed on DAPT, the risk of postdischarge bleeding was not significantly higher among Black patients compared with White patients. The only predictor of bleeding that contributed to a numerical difference was severe chronic kidney disease (CKD), defined as a GFR <30 mL/min per 1.73 m^2 or end-stage renal disease. The proportions deemed high bleeding risk by the PRECISE-DAPT and PARIS scores were higher among Black patients, with the PRECISE-DAPT score classifying more patients as high risk than the PARIS score (30.4% versus 12.3%, respectively). Each score had a moderate predictive ability among both groups. Overall, our study suggests that differences in severe renal failure are the primary contributor to any differences in bleeding risk among self-reported Black individuals and race should not be considered when

Table 3. Unadjusted and Adjusted Associations of Bleeding Risk Factors With Bleeding Academic Research Consortium 2 to 5 Bleeding

	Unadjusted HR (95% CI)	*P* value	Adjusted HR (95% CI)	*P* value
Self-reported Black race	1.41 (1.00–2.00)	0.052	1.37 (0.94–1.99)	0.098
Age, per y	1.01 (1.00–1.03)	0.039	1.01 (1.00–1.03)	0.044
GFR <30 mL/min per 1.73 m^2 or end-stage renal disease	2.65 (1.72–4.09)	<0.001	1.90 (1.15–3.11)	0.011
Previous bleeding requiring medical attention	2.45 (1.57–3.81)	<0.001	1.80 (1.13–2.89)	0.014
Ticagrelor or prasugrel use vs clopidogrel use	1.80 (1.32–2.46)	<0.001	2.15 (1.56–2.97)	<0.001
Anticoagulant use	2.41 (1.67–3.46)	<0.001	2.38 (1.64–3.46)	<0.001
Hemoglobin, g/dL	0.86 (0.80–0.93)	<0.001	0.94 (0.86–1.03)	0.189
Female sex	1.26 (0.91–1.75)	0.170	1.07 (0.77–1.52)	0.693
Prior ischemic stroke or TIA	1.53 (1.03–2.28)	0.034	1.24 (0.81–1.88)	0.319
Liver cirrhosis with portal hypertension	2.10 (0.86–5.11)	0.144	1.70 (0.67–4.35)	0.265
Proton pump inhibitor use	1.25 (0.91–1.71)	0.168	1.02 (0.74–1.42)	0.905
Current smoking, yes	0.81 (0.55–1.19)	0.269	…	…
Body mass index ≥35 kg/m^2	1.05 (0.71–1.55)	0.783	…	…
White cell count per $10^3/\mu L$	1.02 (0.97–1.05)	0.974	…	…
Platelet count per $10^9/L$	1.39 (0.39–4.68)	0.597	…	…
Diabetes	1.11 (0.81–1.51)	0.525	…	…
Hypertension	1.03 (0.40–2.65)	0.95	…	…
Long-term NSAID use	0.54 (0.20–1.45)	0.219	…	…
Long-term corticosteroid use	1.52 (0.80–2.88)	0.200	…	…

GFR indicates glomerular filtration rate; HR, hazard ratio; and TIA, transient ischemic attack.
The variables included in the adjusted model were those with an unadjusted *P* value <0.20.

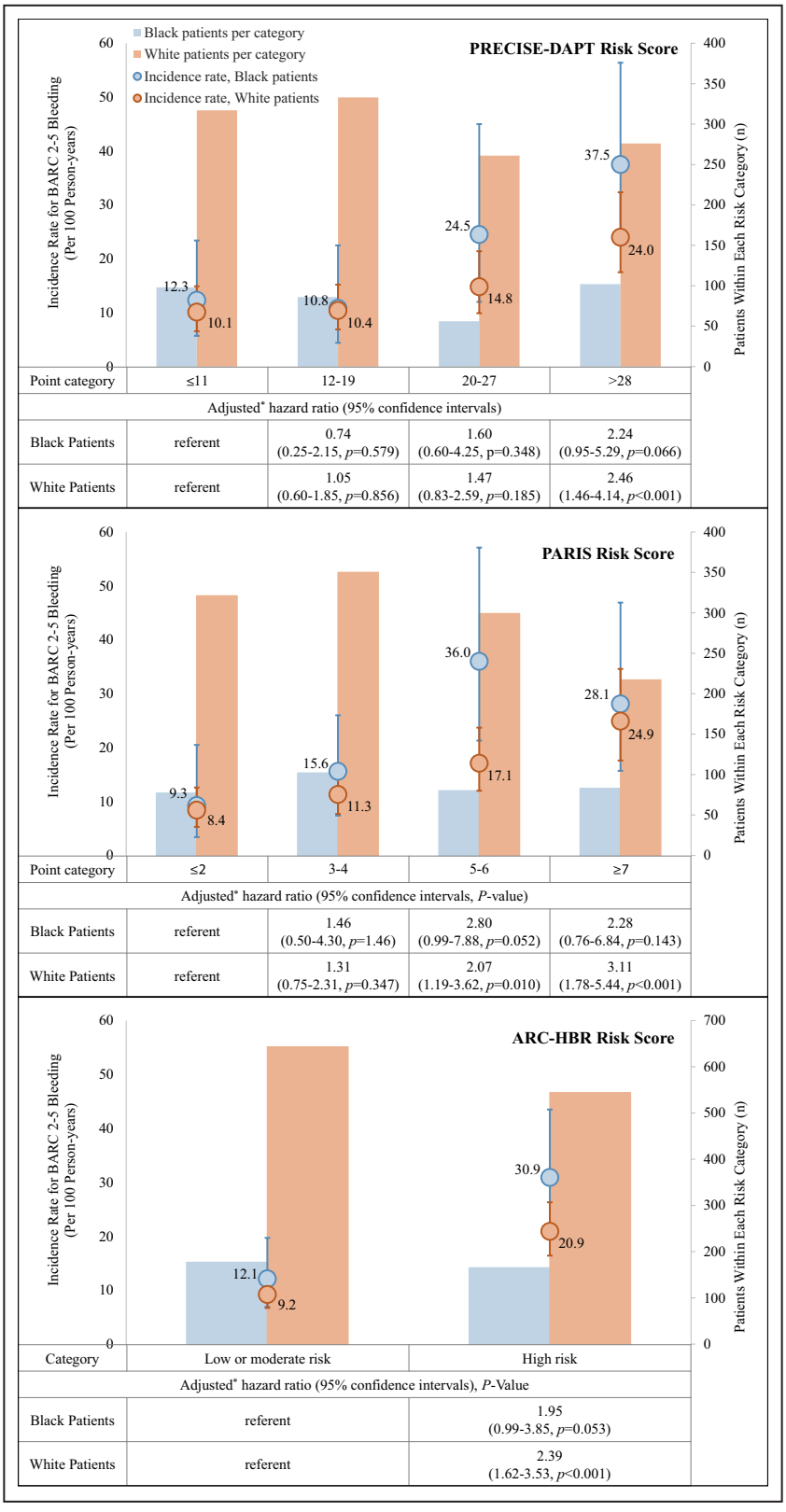

Figure. Incidence of BARC 2 to 5 bleeding among categories of risk, stratified by race. Models were adjusted for sex, ticagrelor or prasugrel use, and proton pump inhibitor use. ARC-HBR indicates Academic Research Consortium Criteria for High Bleeding Risk; BARC, Bleeding Academic Research Consortium; PARIS, Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients; and PRECISE-DAPT, Predicting Bleeding Complications in Patients Undergoing Stent Implantation and Subsequent Dual Anti Platelet Therapy.

deciding DAPT duration. The PRECISE-DAPT score categorized GFR with greater granularity and better stratified patients at higher risk.

The unadjusted risk of bleeding was 41% higher among Black patients, but this difference did not meet statistical significance (P=0.052). A larger proportion of Black patients were censored from the analysis, for reasons other than death, and some events that occurred may not have been observed. Other studies have reported a higher unadjusted risk of DAPT-associated bleeding among self-reported Black adults compared with other racial or ethnic groups.[9,10,18–20] However, these studies were different than ours in multiple ways. The most prominent difference was that prior studies used definitions of bleeding other than the BARC criteria, such as transfusion requirements, *International Classification of Diseases* (*ICD*) codes, and non-BARC definitions of major bleeding. To our knowledge, our study is the only to apply the BARC criteria to examine bleeding among self-reported Black patients.

The only variable that reduced the effect of self-reported Black race on postdischarge bleeding was the presence of severe CKD (GFR <30 mL/min per 1.73 m^2, including end-stage renal disease). It has been well demonstrated that CKD increases the risk of bleeding while taking antiplatelet medications.[21] Multiple mechanisms have been reported by which uremic toxins and increased fibrinogen levels reduce platelet adhesion and aggregation.[22] Also well documented is that self-reported US Black adults have a higher prevalence of severe CKD,[23] compared with White adults, partially because of a higher prevalence of diabetes,[24] lower blood pressure control,[25] and more frequent homozygosity for variants of the *Apolipoprotein L1* gene.[26] We also observed a higher prevalence of diabetes and hypertension among Black patients in our cohort.

In the present study, severe CKD alone did not entirely explain the numerical difference in postdischarge bleeding between Black and White adults, and other unmeasured variables must have contributed. We only included clinical variables that have been consistently and repeatedly associated with an increased risk of bleeding. Socioeconomic and structural differences between these groups almost certainly contribute to higher rates of bleeding as well as the development of diabetes, hypertension, and subsequently CKD among Black patients. An analysis of the National Cardiovascular Data Acute Coronary Treatment and Intervention Outcomes Network Registry found zip code, as a surrogate for socioeconomic status, to be associated with major bleeding events after multivariable adjustment (odds ratio, 1.10 [95% CI, 1.05–1.16]).[27] We did not report differences in variables that demonstrate this structural bias because no single socioeconomic variable has been repeatedly associated with DAPT-associated bleeding, and socioeconomic variables were not included in widely cited risk scores. Because we felt that we could not adequately measure such differences, we chose to focus on clinical variables.

Among all patients, our analysis demonstrated a C-index of 0.614 for the PRECISE-DAPT score, 0.617 for the PARIS score, and 0.600 for the ARC-HBR score. C-indexes were higher among Black patients for all 3 scores compared with White patients. However, the C-index values we reported for these scores are lower than those described in other studies. For example, the PRECISE-DAPT derivation study reported a C-index in the derivation cohort of 0.73 and 0.70 and 0.66 in the 2 validation cohorts.[5] Studies of the PRECISE-DAPT score by Choi et al reported C-statistics between 0.75 and 0.81.[28–30] The reasons for the different statistics reported by these studies, compared with our own, are likely methodological. Costa et al[5] used the end point of TIMI (Thrombolysis in Myocardial Infarction) major and minor bleeding as the outcome rather than BARC 2 to 5 bleeding. Choi et al stratified the PRECISE-DAPT score into 2 to 3 categories of risk rather than evaluating it as a continuous score. In each referenced study, patients requiring oral anticoagulation were excluded, whereas in our study we included these patients. Systematic reviews of commonly used risk scores have reported similar wide variation in risk score performances because of methodological and study population differences.[31]

Although the C-indexes were similar between the PRECISE-DAPT, PARIS, and ARC-HBR scores, there are differences between these scores that should be considered. Apart from ticagrelor, prasugrel, and anticoagulant use, age and GFR <30 mL/min per 1.73 m^2 were the strongest contributors to bleeding risk, and the PRECISE-DAPT score contains 25 categories for GFR and 19 for age, compared with between 2 and 5, respectively, for PARIS and 3 and 2, respectively, for ARC-HBR. This contributed to large differences in the proportions of patients classified as high risk between scores: 35.4% for the PRECISE-DAPT score, 15.8% for the PARIS score, and 46.7% for the ARC-HBR score. Because so few patients were deemed high risk by the PARIS score, the incidence of bleeding among patients in the quartile below the high-risk quartile was 20.6 per 100 person-years compared with 10.4 per 100 person-years for the PRECISE-DAPT score. The ARC-HBR score simply classified so many patients as being high risk that it is not clinically useful. Finally, the PARIS and ARC-HBR scores both include oral anticoagulation, whereas the PRECISE-DAPT score does not. Oral anticoagulation is already included in guideline-recommended algorithms for choosing the duration of DAPT, and therefore its inclusion in a risk score is not beneficial. For these reasons, we believe that the PRECISE-DAPT score should be used for risk-stratifying patients taking DAPT.

Limitations were present in our study. First, self-reported race is a social construct, and we did not report the social determinants of health that contribute to disparate outcomes. The definitions for socioeconomic variables remain heterogenous and without clear standards, and we felt that including these variables would not produce clinical value. Second, past medical history items were obtained by screening the patient's medical record, yet some data elements may have not been recorded in the medical record. Third, 4 of the ARC-HBR criteria were excluded because the data required for these variables were incomplete. However, the prevalence of these variables in the general population is low, and their inclusion would likely not have affected the performance of the score. Finally, this was primarily a descriptive and exploratory analysis with substantial probability of type I error greater than nominal (α=0.05 for some of the hypothesis tests) because of multiple comparisons.

In conclusion, self-reported Black patients did not have a statistically higher risk of postdischarge bleeding while on DAPT compared with White patients. The PRECISE-DAPT, PARIS, and ARC-HBR risk scores performed similarly among both Black and White patients, although more Black patients were classified as high risk by the PRECISE-DAPT and PARIS scores. Clinicians should not consider self-reported Black race in their assessment of bleeding risk, although they should consider age, GFR <30 mL/min per 1.73 m^2, anticoagulant use, ticagrelor or prasugrel use, and prior bleeding, as these were the strongest predictors. The PRECISE-DAPT score better characterized differences in GFR and thus may be the most appropriate score for this indication among the US population.

ARTICLE INFORMATION

Received November 25, 2021; accepted July 7, 2022.

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Sources of Funding

This work was supported by the National Institutes of Health (T32HL129948, RO1HL092173, and K24HL133373), Clinical and Translational Science Award UL1TR000165, University of Alabama Birmingham's Health Service Foundations' General Endowment Fund, and the Hugh Kaul Personalized Medicine Institute. Hillegass is supported by Institutional Development Award (IDeA) Networks for Clinical and Translational Research (IDeA-CTR) (U54GM115428).

Disclosures

None.

Supplemental Material

Tables S1–S9
Figures S1–S2

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SUPPLEMENTAL MATERIAL

Table S1. Bleeding Academic Research Consortium (BARC) definition for bleeding events.

Type 0	No bleeding.
Type 1	Bleeding that is not actionable and does not cause the patient to seek unscheduled performance of studies, hospitalization, or treatment by a healthcare professional; may include episodes leading to self-discontinuation of medical therapy by the patient without consulting a healthcare professional.
Type 2	Any clinically overt sign of hemorrhage (more bleeding than would be expected for a clinical circumstance) that is actionable but does not meet criteria for type 3, 4, or 5 BARC bleeding. The bleeding must require diagnostic studies, hospitalization, or treatment by a healthcare professional. Examples include: Hematocrit testing, hemoccult testing, endoscopy, colonoscopy, computed tomography scanning, or Urinalysis
Type 3a	Overt bleeding plus hemoglobin drop of 3 to <5 g/dL(provided hemoglobin drop is related to bleed) Any transfusion with overt bleeding.
Type 3b	Overt bleeding plus hemoglobin drop ≥5 g/dL (provided hemoglobin drop is related to bleed) Cardiac tamponade Bleeding requiring surgical intervention for control (excluding dental/nasal/skin/hemorrhoid) Bleeding requiring intravenous vasoactive agents.
Type 3c	Intracranial hemorrhage (does not include microbleeds or hemorrhagic transformation, does include intraspinal) Subcategories confirmed by autopsy or imaging or lumbar puncture Intraocular bleed compromising vision
Type 4	CABG-related bleeding Perioperative intracranial bleeding within 48 hours Reoperation after closure of sternotomy for the purpose of controlling bleeding Transfusion of ≥5 units whole blood or packed red blood cells within a 48 hour period Chest tube output ≥2 L within a 24 hour period
Type 5a	Probable fatal bleeding; no autopsy or imaging confirmation but clinically suspicious
Type 5b	Definite fatal bleeding; overt bleeding or autopsy or imaging confirmation

Table S2. Variables included in the Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients (PRECISE-DAPT) score, with associated point assignments.

Age (years)	Estimated glomerular filtration rate ($mL/min/1.73m^2$)	Hemoglobin (g/dL)	White Blood Cell Count (10^3 cells per uL)	Previous bleed requiring medical attention
≤51.49 (0)	>98 (0)	≥ 12.0 (0)	≤ 5.485 (0)	No (0)
51.50-53.49 (1)	94.1-98.0 (1)	11.9 (1)	5.486-6.455 (1)	Yes (25)
53.50-55.49 (2)	90.2-94.0 (2)	11.8 (2)	6.456-7.425 (2)	
55.50-57.49 (3)	86.3-90.1 (3)	11.7 (2)	7.426-8.395 (3)	
57.50-59.49 (4)	82.3-86.2 (4)	11.6 (3)	8.396-9.366 (4)	
59.50-61.49 (5)	78.4-82.1 (5)	11.5 (4)	9.367-10.355 (5)	
61.50-63.49 (6)	74.5-78.3 (6)	11.4 (5)	10.356-11.305 (6)	
63.50-65.49 (7)	70.5-74.4 (7)	11.3(5)	11.306-12.275 (7)	
65.50-68.49 (8)	66.6-70.4 (8)	11.2 (6)	12.276-13.245 (8)	
68.50-70.49 (9)	62.7-66.5 (9)	11.1 (7)	13.246-14.215 (9)	
70.50-72.49 (10)	58.7-62.6 (10)	11.0 (8)	13.216-15.285 (10)	
72.50-74.49 (11)	54.8-58.6 (11)	10.9 (8)	15.186-16.155 (11)	
74.50-75.49 (12)	50.8-54.7 (12)	10.8 (9)	16.156-17.125 (12)	
76.50-78.49 (13)	46.9-50.7 (13)	10.7 (10)	17.126-18.095 (13)	
78.50-80.49 (14)	43.0-46.8 (14)	10.6 (11)	18.096-19.065 (14)	
80.50-83.49 (15)	39.0-42.9 (15)	10.5 (11)	≥19.065 (15)	
83.50-86.49 (16)	35.1-38.9 (16)	10.4 (12)		
86.50-87.49 (17)	31.2-35.0 (17)	10.3 (13)		
87.50-89.49 (18)	27.2-31.1 (18)	10.2 (13)		
≥89.50 (19)	23.3-27.1 (19)	10.1 (14)		
	19.4-23.2 (20)	≤10.0 (15)		
	15.4-19.3 (21)			
	11.5-15.3 (22)			
	7.6-11.4 (23)			
	3.6-7.5 (24)			
	<3.6 (25)			

Table S3. Variables included in the Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients (PARIS) risk score, with associated point assignments.

Variable	Variable Increment (Assigned Points)				
Age (years)	<50 (0)	50-59 (1)	60-69 (2)	70-79 (3)	≥ 80 (4)
Current smoking	No (0)	Yes (2)			
Body mass index (kg/m^2)	<25 (2)	25-34.9 (0)	≥35 (2)		
Estimated glomerular filtration rate <60 $mL/min/1.73m^2$	Absent (0)	Present (2)			
Hemoglobin <12 g/dL	No (0)	Yes (3)			
Triple therapy (aspirin, $P2Y_{12}$ inhibitor, and anticoagulant) on discharge	No (0)	Yes (2)			

Table S4. Academic Research Consortium Criteria for High Bleeding Risk, with modifications made for the present study.

Major Criteria	Minor Criteria	Modifications for the Present Study*
	Age ≥ 75 years	~
Anticipated use of long-term oral anticoagulation		~
Severe or end-stage chronic kidney disease (eGFR <30 ml/min)	Moderate chronic kidney disease (eGFR 30-59 mL/min)	~
Hemoglobin <11 g/dL	Hemoglobin 11-12.9 g/dL for men and 11-11.9 g/dL for women	~
Spontaneous bleeding requiring hospitalization or transfusion in the past 6 months or at any time, if recurrent	Spontaneous bleeding requiring hospitalization or transfusion within the past 12 months not meeting the major criteria	~
Moderate or severe baseline thrombocytopenia (platelet count <100x10^9/L)†		~
Chronic bleeding diathesis		Data unavailable‡
Liver cirrhosis with portal hypertension		~
	Long-term use of oral NSAIDs or steroids	Defined as having one of these medications prescribed on admission and at discharge.
Active malignancy (excluding nonmelanoma skin cancer) within the past 12 months§		Data unavailable‡
Previous spontaneous ICH (at any time) Previous traumatic ICH within the past 12 months		Both traumatic ICH and spontaneous ICH were included as one major criteria.
Presence of a brain arteriovenous malformation		~
Moderate or severe ischemic stroke within the past 6 months	Any ischemic stroke at any time not meeting the major criterion	Stroke was not distinguished, and any past ischemic stroke was labeled as a minor criteria.
Nodeferrable major surgery on dual antiplatelet therapy		Data unavailable‡
Recent major surgery or major trauma within 30 days before percutaneous coronary intervention		Data unavailable‡

Definitions: eGFR, estimated glomerular filtration rate; ICH, intracranial hemorrhage; NSAID, nonsteroidal anti-inflammatory drug; *Fields with ~ represents variables for which no modification was necessary. †Baseline thrombocytopenia was defined by ARC-HBR as thrombocytopenia before PCI. ‡Not included as an ARC-HBR variable for the present study. §Active malignancy was defined by ARC-HBR as diagnosis within 12 months and/or ongoing requirement for treatment (including surgery, chemotherapy, or radiotherapy).

Table S5. Number and anatomic location of events by Bleeding Academic Research Consortium (BARC) category.

Location of bleeding event	All patients	Black patients	White patients
	Number of events (proportion within category)		
Total BARC 2 events	**115**	**27**	**88**
Hematoma	31 (27.0%)	8 (29.6%)	23 (26.1%)
Gastrointestinal	28 (24.3%)	8 (29.6%)	20 (22.7%)
Genitourinary	13 (11.3%)	1 (3.7%)	12 (13.6%)
Epistaxis	13 (11.3%)	2 (7.4%)	11 (12.5%)
Bruise	10 (8.7%)	2 (7.4%)	8 (9.1%)
Hemoptysis	3 (2.6%)	0	3 (3.4%)
Gingival	1 (0.9%)	0	1 (1.1%)
Not recorded	16 (13.9%)	6 (22.2%)	10 (11.4%)
Total BARC 3 events	**41**	**16**	**25**
Gastrointestinal	28 (24.3%)	10 (37.0%)	18 (20.5%)
Genitourinary	3 (2.6%)	0	3 (12.0%)
Hematoma	1 (0.9%)	0	1 (4.0%)
Epistaxis	1 (0.9%)	1 (6.3%)	0
Gingival	1 (0.9%)	1 (6.3%)	0
Intracranial hemorrhage	1 (0.9%)	0	1 (4.0%)
Retroperitoneal Hemorrhage	1 (0.9%)	0	1 (4.0%)
Not recorded	5 (4.3%)	4 (25%)	1 (4.0%)
Total BARC 4 events	**0**	**0**	**0**
Total BARC 5 events	**3**	**1**	**2**
Intracranial hemorrhage	1 (33%)	0	1 (50.0%)
Retroperitoneal hematoma	2 (66.6%)	1 (100.0%)	1 (50.0%)

Table S6. Unadjusted and adjusted association of bleeding risk factors on Bleeding Academic Research Consortium 2-5 bleeding, accounting for the competing risk of death.

	Unadjusted HR (95% CI)	*P*-value	Adjusted HR (95% CI)	*P*-value
Self-reported Black race	1.42 (1.01-2.01)	0.047	1.37 (0.94-2.01)	0.106
Age (per year)	1.01 (1.00-1.03)	0.061	1.02 (1.00-1.03)	0.047
GFR <30 mL/min/1.73m^2 or end-stage renal disease	0.39 (0.26-0.59)	<0.001	0.52 (0.31-0.87)	0.013
Previous bleeding requiring medical attention	2.42 (1.55-3.76)	<0.001	1.92 (1.16-3.17)	0.011
Ticagrelor or prasugrel use	1.81 (1.33-2.48)	<0.001	2.07 (1.49-2.87)	<.0.001
Anticoagulant use	2.37 (1.65-3.40)	<0.001	2.28 (1.54-3.37)	<.0.001
Hemoglobin (g/dL)	0.87 (0.79-0.95)	0.001	0.95 (0.86-1.06)	0.388
Female sex	1.25 (0.90-1.74)	0.175	1.07 (0.74-1.54)	0.725
Prior ischemic stroke or TIA	1.52 (1.03-2.25)	0.036	1.19 (0.78-1.82)	0.409
Liver cirrhosis with portal hypertension	1.96 (0.81-4.75)	0.137	1.66 (0.58-4.72)	0.345
Proton pump inhibitor use	1.24 (0.91-1.70)	0.181	1.02 (0.73-1.44)	0.908
Current smoking (yes)	0.81 (0.55-1.20)	0.290	0.96 (0.62-1.50)	0.866
Body Mass Index ≥35 kg/m^2	1.06 (0.72-1.56)	0.761	1.06 (0.71-1.60)	0.771
White cell count (per 10^3/uL)	1.01 (0.98-1.05)	0.417	1.01 (0.98-1.05)	0.448
Platelet count (per 10^9/L)	1.00 (1.00-1.00)	0.640	1.00 (1.00-1.00)	0.507
Diabetes history	1.09	0.580	0.93	0.681

	(0.80-1.49)		(0.67-1.30)	
Hypertension	1.03 (0.66-1.62)	0.898	0.86 (0.52-1.42)	0.561
Long-term NSAID use	0.55 (0.20-1.46)	0.228	0.47 (0.15-1.44)	0.184

Abbreviations: CI, confidence intervals; GFR, glomerular filtration rate. HR, hazard ratio. *The variables included in the adjusted model were those with an unadjusted *p*-value <0.2.

Table S7. The effect of self-reported Black race on Bleeding Academic Research Consortium 2-5 bleeding, with individual adjustment for predictors of bleeding.[*]

Variables in the model, other than self-reported Black race	Hazard ratio for self-reported Black race (95% CI)	*p*-value	Adjusted % change in effect size from the baseline model[‡]	*p*-value for the presence of mediation[§]
Age and sex (baseline model)[†]	1.46 (1.02-2.09)	0.037	referent	referent
GFR <30, age, and sex	1.30 (0.90-1.88)	0.158	-34.8%	<0.001
Ticagrelor or prasugrel use, age, and sex	1.53 (1.07-2.18)	0.020	15.2%	0.186
Anticoagulant use, age, and sex	1.52 (1.06-2.18)	0.022	13.0%	0.817
Previous bleed requiring medical attention, age, and sex	1.44 (1.00-2.05)	0.047	-4.3%	0.210

Abbreviations: CI, confidence intervals; GFR, glomerular filtration rate; HR, hazard ratio. [*]Variables found to be significant after multivariable adjustment ($p<0.05$) [†]Age and sex were chosen as variables for the baseline model as they are commonly associated with exposure and outcome differences. [‡]The equation used for this column was: $(1 - \text{Adjusted HR}_{\text{Black race}}) - (1 - \text{Baseline HR}_{\text{Black race}}) / (1 - \text{Baseline HR}_{\text{Black race}}) \times 100$. [§]Derived from Sobel's test.

Table S8. Unadjusted and adjusted effects of three forms of the glomerular filtration rate (GFR) variable on Bleeding Academic Research Consortium 2-5 bleeding, and the mediating effect of each form on the association between self-reported Black Race and bleeding.

	Adjusted* effect of GFR on BARC 2-5 Bleeding		Mediation effect of GFR on the association between self-reported Black race and bleeding			
GFR variable form	Hazard ratio for GFR (95% CI)	P-value	Adjusted† hazard ratio for self-reported Black race (95% CI)	*P*-value	Change (%) in effect size compared with the baseline model ‡	*p*-value for the presence of mediation§
~	~	~	1.46 (1.02-2.09)	0.037	referent	referent
GFR <30 mL/min/1.73m^2	2.41 (1.54-3.76)	<0.001	1.30 (0.90-1.88)	0.158	-33.8%	0.003
GFR <45 mL/min/1.73m^2	1.65 (1.12-2.45)	0.012	1.36 (0.95-1.96)	0.096	-20.0%	0.043
GFR (per mL/min/1.73m^2)	0.99 (0.99-1.00)	0.057	1.36 (0.94-1.97)	0.098	-20.0%	0.159

*Adjusted for age, sex, prior bleeding, ticagrelor or prasugrel use, and anticoagulant use. †Adjusted for age, sex, and the GFR form described in the first column. The equation used for this column was: (1 – Adjusted $HR_{Black\ race}$) - (1 – Baseline $HR_{Black\ race}$) / (1 – Baseline $HR_{Black\ race}$) x 100.
§Derived from Sobel's test.

Table S9. Number of patients, person-years, and events within categories of PRECISE-DAPT, PARIS, and ARC-HBR risk, as well as unadjusted comparisons between categories, among Black and White patients separately.

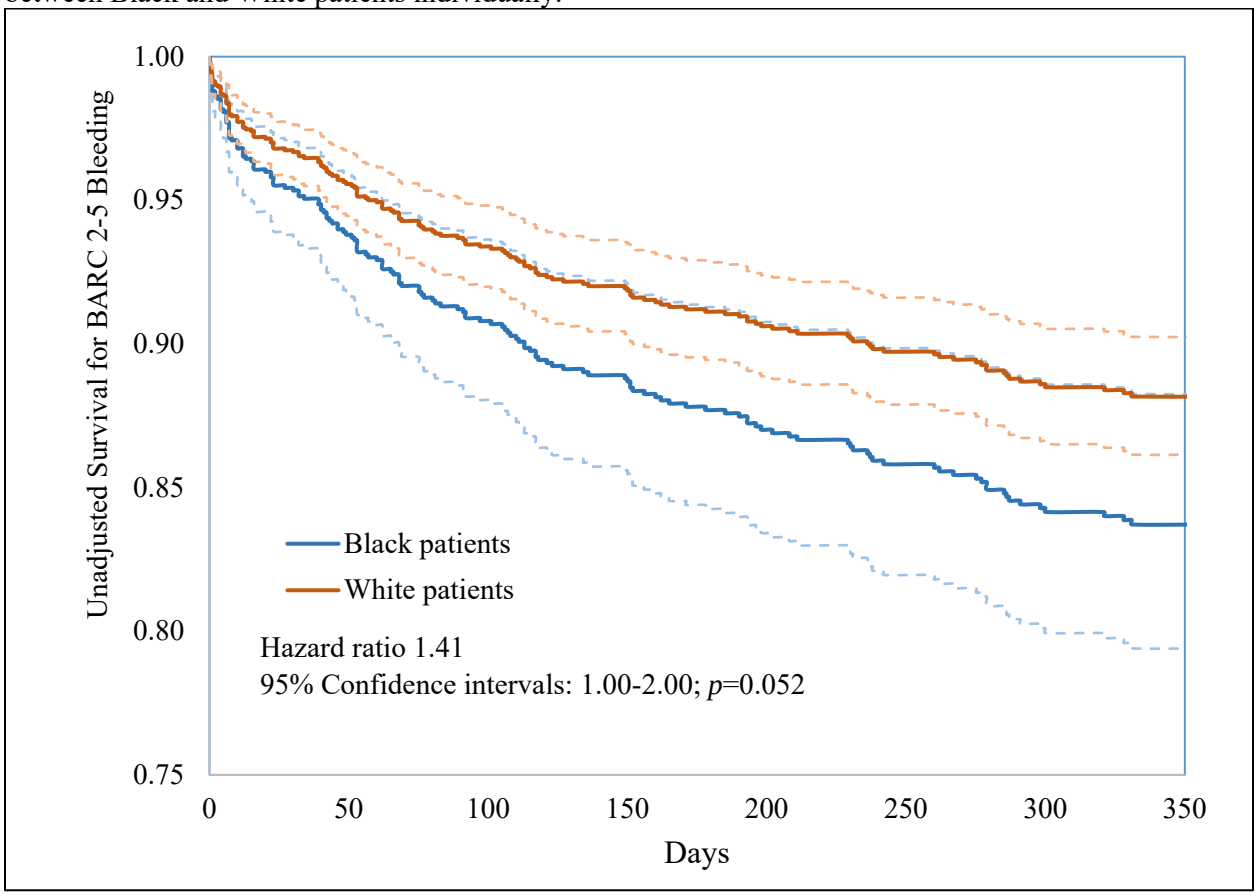
PRECISE-DAPT Risk Score				
Points composing risk category	≤11	12-19	20-27	>28
Number of patients per risk group				
Black Patients	98	86	56	102
White Patients	317	333	261	276
Person-years of follow-up per risk group				
Black Patients	65.0	55.6	36.7	56.0
White Patients	228.0	240.0	175.3	170.7
Number of events per risk group				
Black Patients	8	6	9	21
White Patients	23	25	26	41
Unadjusted hazard ratio (95% confidence intervals), *p*-value				
Black patients	referent	0.85 (0.30-2.46, *p*=0.769)	1.96 (0.76-5.08, *p*=0.166)	2.87 (1.27-6.47, *p*=0.011)
White patients	referent	1.03 (0.59-1.82, *p*=0.907)	1.45 (0.83-2.55, *p*=0.192)	2.28 (1.37-3.80, *p*=0.002)

PARIS Risk Score				
Points composing risk category	≤2	3-4	5-6	≥7
Number of patients per risk group				
Black patients	77	102	80	83
White patients	321	350	299	217
Person-years of follow-up per risk group				
Black patients	54.0	68.5	44.5	46.2
White patients	241.2	247.4	193.0	132.3
Number of events per risk group				
Black patients	5	10	16	13
White patients	21	28	33	33
Unadjusted hazard ratio (95% confidence intervals), *p*-value				

Black patients	Referent	1.56 (0.53-4.57, p=0.416)	3.51 (1.28-9.58, p=0.014)	2.89 (1.28-9.58, p=0.044)
White patients	Referent	1.28 (0.73-2.25, p=0.397)	1.89 (1.09-3.24, p=0.024)	2.68 (1.55-4.64, p<0.001)
ARC-HBR Risk Score				
Risk Categories	Not high risk		High risk	
Number of patients per risk group				
Black patients	177		165	
White patients	643		544	
Person-years of follow-up per risk group				
Black patients	116.2		97.0	
White patients	468.7		345.2	
Number of events per risk group				
Black patients	14		30	
White patients	43		72	
Unadjusted hazard ratio (95% confidence intervals), *p*-value				
Black patients	referent		2.45 (1.30-4.62, *p*=0.006)	
White patients	referent		2.18 (1.50-3.19, *p*<0.001)	

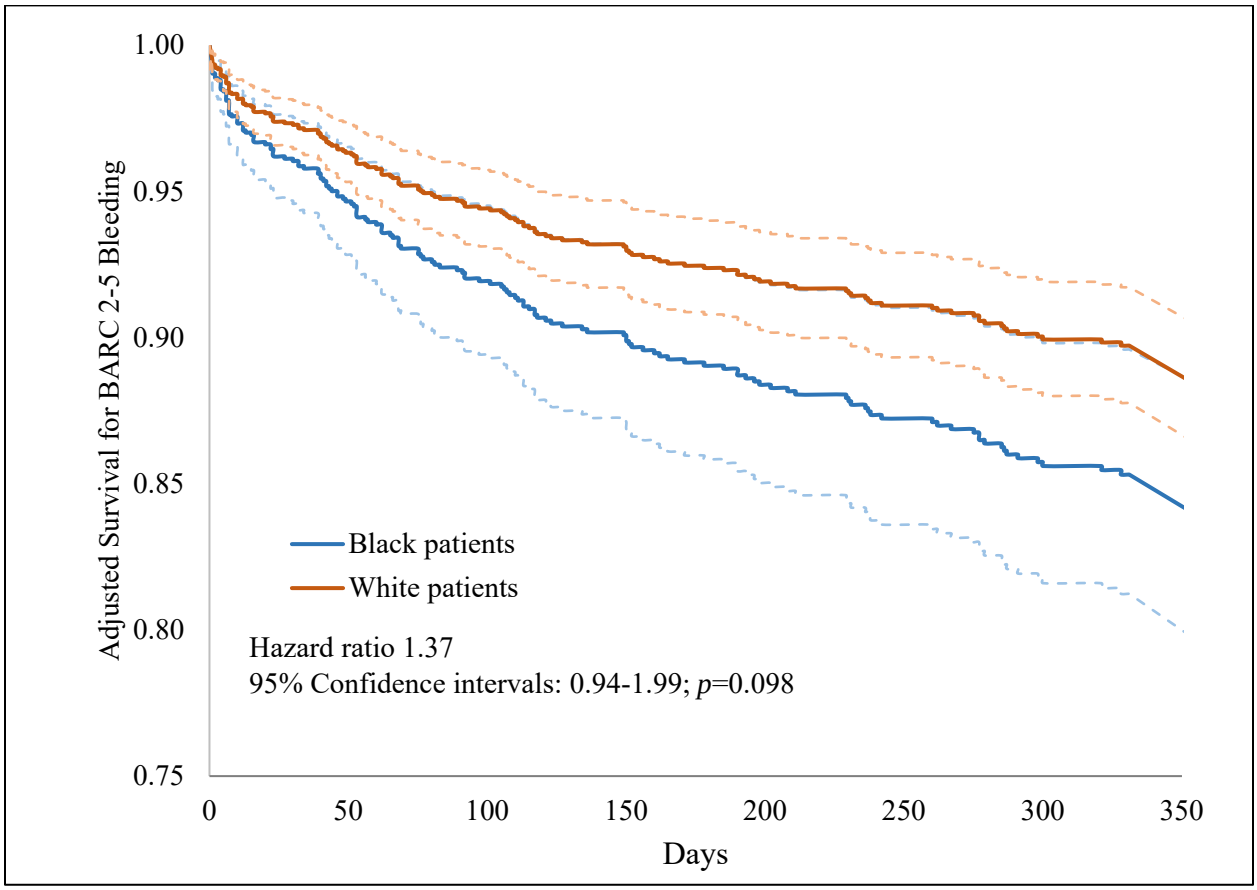
Abbreviations: BARC, Bleeding Academic Research Consortium; PARIS, Patterns of Nonadherence to Antiplatelet Regimens in Stented Patients; PRECISE-DAPT, PREdicting bleeding Complications In patients undergoing Stent implantation and subsEquent Dual Anti Platelet Therapy. The PRECISE-DAPT and PARIS risk scores have three categories of risk based on a point system, but the ARC-HBR schema has a binary design, with only high and not-high risk categories.

Figure S1. Unadjusted time-to-event curves for the endpoint of BARC 2-5 bleeding for all patients, and between Black and White patients individually.



Abbreviations: BARC, Bleeding Academic Research Consortium. Survival estimates were generated by applying the PHREG procedure to produce an unadjusted cox proportional hazard model (PROC PHREG, SAS software, version 9.4).

Figure S2. Adjusted[a] time-to-event curves for BARC 2-5 bleeding for all patients, and between Black and White patients individually.



Abbreviations: BARC, Bleeding Academic Research Consortium. Survival estimates were generated by applying the PHREG procedure to produce a cox proportional hazard model. [a]Adustment was made for age (per year), GFR <30 mL/min/1.73m^2, previous bleeding requiring medical attention, ticagrelor or prasugrel use, and anticoagulant use.