Difference in Physician Responsiveness to New Technology and New Information by Patient Race: Evidence from Drug–Eluting Stents

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Abstract

We investigate how physicians' responsiveness to new technology and new information differ by patient race. Specifically, we leverage a unique clinical data set of physicians' stent choice for percutaneous coronary interventions (PCIs) across the US after the introduction of drug-eluting stents (DES) in 2003 and during a period of heightened DES safety concerns in 2006. Our unconditional analysis show that on average, black patients are no less likely to receive DES than White patients; however, analysis conditional on clinical risk factors shows that physicians are systematically less likely to provide DES to higher–risk Black patients and instead provide the older bare–metal stents. We find no evidence that physician experience explains these differences: while higher experience is associated with greater likelihood of DES recept, Black patients on average are treated by more experienced physicians. We also find no evidence supporting "statistical" discrimination regarding concerns about patient adherence to complementary medication: while provision of DES fell in 2006 following new information about the role of adherence in preventing mortality, the decrease was similar between White and Black patients. Finally, these results are not explained by patients being treated by different hospitals, or different physicians, or having different insurance coverage.

1 Introduction

We study differences by patient race in physicians' responses to two important events: the launch of a "blockbuster" new medical device, and a notable warning about the safety of that device, in which the safety concerns depended on the degree to which patients adhered to their medication regimen.

Economists have studied the diffusion of new medical technology and new information among physicians in the US, and how it differs by patient and physician characteristics. For example, recent research by (DeCicca, Isabelle, & Malak, 2024) found that younger physicians responded more quickly to new information about an old technology (C-sections), and that minority and less–educated patients were *more* likely to be treated in line with the new information. Similarly, (Howard, David, & Hockenberry, 2017) looked at MD responses to the 2002 publication of a study showing some knee surgeries are no better than placebo, finding that responses are smaller at MD owned surgery centers. However, they did not assess whether this had different impacts across patient characteristics. Other research has examined differences in access to new technology. For example, (Jung & Feldman, 2017) found that uptake of new drugs in 2014 to treat Hepatitis C was 11% lower for Black patients with cirrhosis compared to White and Hispanic patients. (Elhussein et al., 2022) studied the initiation of new diabetes medications such as GLP-1 receptor agonists, finding that initiation was lower among Black patients. (Ferris, Kuhlthau, Ausiello, Perrin, & Kahn, 2006) analyzed the diffusion of steroid metered dose inhalers (MDI) in children, finding that following the introduction of MDI in the early 1980s there was a large gap in MDI prescription among minority and non-minority children, with non-minority children being nearly half as likely to receive MDI following their introduction. This gap however decreased over time and was nonexistent in the late 1990s.

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Research has also studied the diffusion of drug–eluting stents (DES) for percutaneous coronary interventions (PCIs) following their introduction to the US in 2003. DES rapidly gained market share over the incumbent technology, bare-metal stents (BMS), due to clinical trials demonstrating their clinical superiority. This diffusion occurred despite the fact that physicians were not paid more to provide DES over BMS, hospital margins were lower from providing DES than BMS, and DES required patients to adhere to use of dual antiplatelet therapy known as clopidogrel. For example, (Epstein, Ketcham, Rathore, & Groeneveld, 2012) found within–hospital differences in provision of DES in the first five years after their introduction by payer type, with Medicaid–insured and uninsured patients consistently less likely to receive DES than those with private coverage. This research found little of the differences in DES use by payer type were explained by patients selection into different hospitals. A few papers also studied differences in diffusion by patient race using localized patient populations.

Current literature has examined at brief the racial disparities in DES receipt for smaller samples and time horizons. (Hannan et al., 2007) examines disparities in the use of DES versus BMS by race, payer type, and income level using data from New York State's Percutaneous Coronary Intervention Reporting System from 2003 to 2004. Findings indicate that Blacks were significantly less likely to receive DES compared to White patients, even after adjusting for patient and hospital characteristics. Patients with Medicaid or self–pay status were also less likely to receive DES, particularly in lower-income areas. Although hospital choice partially explained these disparities, racial and socioeconomic differences persisted even when controlling for hospital volume and other factors.

(Hannan et al., 2016) investigates whether racial and socioeconomic disparities in DES utilization persisted in 2011–2012 despite broader adoption of DES. Using New York State's Percutaneous Coronary Intervention Registry, the study finds that Black and Hispanic patients were still less likely to receive DES compared to White patients, with adjusted odds ratios of 0.70 and 0.80, respectively. Patients with private insurance were more likely to receive DES compared to those with Medicaid or Medicare. Additionally, there were substantial variations in DES usage across hospitals, with some hospitals using DES at rates as low as 52% compared to an average of 83%. These disparities were not fully explained by patient clinical characteristics, highlighting persistent inequities in access to newer medical technologies. (Gaglia Jr et al., 2014) examines DES utilization among 2,763 patients undergoing percutaneous coronary intervention (PCI) at Los Angeles County Hospital and Keck Hospital of USC from 2008 to 2012. The study finds that African Americans were significantly less likely to receive DES compared to non-African American, non–Hispanic patients (adjusted OR 0.57, p = 0.002). Surprisingly, uninsured and Medicaid patients were more likely to receive DES than those with private insurance, possibly due to treatment policies in safety-net hospitals. However, Medicare patients were less likely to receive DES. The study highlights ongoing racial disparities in PCI treatment decisions, suggesting that physician decision–making and institutional policies play a role in these patterns

Just before the start of 2006, the American College of Cardiology updated its guidelines recommending longer treatment with clopidogrel after DES receipt due to findings that without sustained adherence, DES patients faced elevated risk of complications relative to BMS. By the end of 2006, however, the FDA restated that DES (rather than BMS) should remain the standard of care for on–label usage for all patients. (Farb & Boam, 2007; Smith, Feldman, Hirshfeld, et al., 2006; Pfisterer, Brunner-La Rocca, Buser, et al., 2006; Tung, Kaul, Diamond, et al., 2006; Krone, Rao, Dai, et al., 2010)

The information shock in 2006 about potential safety concerns related to DES use may have led to different responses by patient race. For example, (Traylor, Schmittdiel, Uratsu, Mangione, & Subramanian, 2010) find that Black patients are less likely than White patients to adhere to cardiovascular medications as prescribed. For adherence following DES treatment specifically, (Goldman & Lakdawalla, 2005) suggest that new medical technologies can widen disparities, particularly when they are complex to use, as wealthier and more educated patients are often better equipped to manage demanding treatments. Since DES require a significantly longer regimen of clopidogrel compared to BMS, physicians may have selectively prescribed DES to patients they believed were more likely to adhere to the medication regimen, potentially using payer type as a proxy for adherence. This could explain why disparities in DES use by payer type peaked at the end of 2008, as physicians responded to safety concerns by increasingly reserving DES for patients they perceived as more likely to comply with clopidogrel therapy. However, there is limited evidence on how accurately clinicians predict long-term medication adherence or whether social factors reliably indicate adherence behavior. Data from one center suggests that clopidogrel adherence rates one year after stent placement showed little variation by stent type or payer type. Nevertheless, socioeconomic disparities in access to innovative medical technologies are likely to persist whenever physicians base treatment decisions on their assessments of patients' ability to manage complex therapeutic requirements. (Eisenstein, Anstrom, Kong, et al., 2007; Spertus, Kettelkamp, Vance, et al., 2006; Jackevicius, Tu, Demers, et al., 2008; Philipson, Mozaffari, & Maclean, 2010)

In this article we build on prior research and examine whether physician experience with DES plays a mediating role in how physicians responded to the 2006 information shock. We also contribute to the literature on technological diffusion across socioeconomic status. (Cutler, Deaton, & Lleras-Muney, 2006) argues that technology diffusion is a key driver in the explanation of mortality and longevity. (Glied & Lleras-Muney, 2008) and (Lleras-Muney & Lichtenberg, 2005) show that more educated individuals are more likely to take advantage of new drugs. (Jayachandran, Lleras-Muney, & Smith, 2010) finds that the introduction of new drugs had larger benefits for whites compared to blacks. (Moshfegh, 2023) examines a technological advance in breast cancer testing, finding that patients who say oncologists that adapt new technology were more likely to avoid unnecessary treatments, this coincides with large differences in technology diffusion by race even by patients seeing the same physicians. In non medical contexts (Jaravel, 2019) finds that high income households benefit from growing product variety compared to low income households.

Using a unique dataset spanning from 2003 to 2009, we examine the gap in treatment with DES and subsequent clinical outcomes by patient race. These data go well–beyond claims data in terms of tracking all of the individual–level risk factors used by the American College of Cardiology (ACC) for stent patients, as well as various complications that can occur. We first observe an initial gap in 2003 in the unconditional receipt of DES for Black patients relative to White patients, but this gap disappears by 2004. However, the unconditional comparison masks the fact that physicians appear to limit their provision of DES to higher–risk black patients relative to white patients, and these differences persist through the end of 2009. For example, the data show that Black patients who receive DES are 3 years younger, on average, and have a lower risk of heart failure. Our preferred models show that Black patients are around 2 percentage points less likely to receive DES, a 2.7% reduction relative to the mean. Notably, these differences cannot be explained by different races being treated by different providers, as they are estimated within physicians and controlling for physicians' experience with DES. In fact, while prior experience with DES is an important predictor of provision of DES receipt, Black patients on average are treated by physicians with more experience using DES. We also find no evidence supporting "statistical" discrimination regarding concerns about patient adherence to complementary medication, as we find no differences in post-surgical complications and mortality: while provision of DES fell in 2006 following the new information about the role of adherence in preventing mortality, the decrease was similar between White and Black patients. Finally, these results are not explained by patients being treated by different hospitals or different physicians or having different insurance coverage.

2 Data

We leverage patient–level data on PCI cases performed at an unbalanced panel of hospital–based coronary catheterization laboratories ("cath labs") from 2003-2009. These data come from hospitals who were clients of a consulting company, known at the time as Goodroe Healthcare Solutions, who installed proprietary software in the cath lab to capture real-time productivity and clinical measures. The data include anonymous, time-invariant identifiers for each hospital and physician. Although we cannot identify the hospitals, we do know they include for–profit and non–profit hospitals from across the US. We focus on physicians' decisions to provide patients with a DES as part fo their PCI procedures. PCIs can be performed without without DES, including with insertion of of BMS , or with angioplasty or several other techniques without insertion of any stent.

We have access to data on 446,550 PCI cases to which we apply a series of selection criteria. We restrict our sample to cases following the introduction of DES (2003) up to 2008. This leaves us with 340,641 PCI cases. To avoid potential issues with sample balance, we exclude patients at cath labs that join our sample after 2003, these joiners account for 120,312 cases. This additionally allows us to capture a true measure of DES case experience, as the introduction of DES is captured within our sample we are able to measure every PCI procedure a physician performs following the introduction of the new stent. Of the 220,329 cases remaining we denote any case in which a patient received at least 1 DES to be a DES case. DES cases account for 132,132 or 59.97% of our cases, while exclusively BMS cases account for 62,334 observations (28.3%). In our sample 44,809 patients (20.3%) received no stent.

The data provide patient characteristics, such as age and gender, as well as patients' PCI risk factors that are more detailed than those captured by insurance claims data. These risk factors allow us to implement the method for risk-adjusting PCI outcomes developed in the American College of Cardiology's National Cardiovascular Data Registry (ACC NCDR 2006). Finally, because DES were introduced to the US during our study period, we observe each physician's total volume of past DES cases at each point in time. To measure experience for each physician, we count the number of prior cases in which at least one DES was provided and assume no depreciation.

Table 1 provides summary statistics for all PCI cases and for DES cases only, separately by race.

Table 1: Summary Statistics

	All Cases			DES Cases		
Characteristic	White	Black	Difference (W-B)	White	Black	Difference (W-B)
Female	0.340	0.457	-0.116***	0.347	0.466	-0.118***
Age	64.87	61.64	3.23***	64.69	61.64	3.05***
NYHA	0.177	0.116	0.061***	0.160	0.113	0.047***
STEMI	0.043	0.037	0.007***	0.044	0.036	0.007***
AMI	0.103	0.094	0.009***	0.106	0.097	0.009**
Cardshock	0.003	0.001	0.001**	0.003	0.001	0.001**
CVD	0.062	0.076	-0.013***	0.064	0.079	-0.016***
CHF Current	0.216	0.269	-0.054***	0.261	0.331	-0.071***
CLD	0.101	0.091	0.010***	0.105	0.099	0.006*
CHF Past	0.054	0.089	-0.034***	0.055	0.094	-0.039***
DH	0.229	0.357	-0.127***	0.235	0.373	-0.134***
EF3050	0.063	0.056	0.007***	0.067	0.060	0.007**
EFLE30	0.023	0.029	-0.006***	0.023	0.030	-0.007***
High Risk	0.000	0.002	-0.001***	0.000	0.002	-0.002***
IABP	0.019	0.014	0.005***	0.015	0.010	0.005***
LFT Main 50	0.088	0.074	0.015***	0.101	0.085	0.016***
LV Abnormal	0.124	0.123	0.001	0.145	0.144	0.001
PCI Elec	0.350	0.387	-0.037***	0.397	0.443	-0.045***
PCI Urge	0.160	0.173	-0.012***	0.185	0.197	-0.012***
PCI Emer	0.085	0.076	0.010***	0.082	0.071	0.011***
PCI Salv	0.001	0.001	0.000	0.001	0.001	0.000
Proxlad 50	0.010	0.006	0.004***	0.010	0.006	0.004***
Renal Failure	0.017	0.061	-0.044***	0.018	0.064	-0.046***
Thrombolysis	0.004	0.004	0.000	0.004	0.004	-0.001
TIMI	0.586	0.690	-0.104***	0.693	0.834	-0.141***
Valvsurg	0.006	0.004	0.002**	0.005	0.004	0.001
MD DES Experience	682.9	791.2	-108.4***	864.1	1001.3	-137.2***

*** p< 0.01 ** p< 0.05 * p< 0.10

3 Motivation

The unconditional comparison of DES receipt between Black and White patients, shown in Figure 1A, shows minimal differences between races in the likelihood of receiving DES in each year of our study period. As reported in 1, the difference fluctuates between black patients being 2.00 percentage points less likely to receive DES in 2003 to 1.32 percentage points more likely in 2005. However, these unadjusted differences among patients who receive PCI mask important differences between races in the types of patients being treated. When we condition on patient demographics and clinical risk factors, as shown in Figure 1B, racial differences in DES receipt are evident. The conditional difference growing as large as 3.37pp in 2005.

Other racial disparities in healthcare treatments are well documented, with explanations including differences in the characteristics of healthcare providers that treat different races, or differences in how given providers treat white versus black patients, e.g. due to communication barriers, implicit biases including "statistical" discrimination, and unobserved clinical differences. Given our unique context and data, we focus on the roles of differences in physician experience

Cardiovascular disease (CVD) remains one of the leading causes of morbidity and mortality globally, and racial disparities in healthcare outcomes, particularly in the context of cardiovascular interventions, have been well-documented (Lewey & Choudhry, 2014). Among these disparities, access to and outcomes from interventional procedures, such as percutaneous coronary interventions (PCI) involving drug-eluting stents (DES), have been a subject of growing concern (Olanisa et al., 2023). DES have revolutionized the management of coronary artery disease by improving patency rates and reducing the need for repeat revascularization (Stone et al., 2004, 2005; Morice et al., 2002). There persist disparities in the provision of DES (Gaglia Jr et al., 2014) which could contribute to persistent gaps in cardiovascular outcomes between racial groups (Gaglia Jr et al., 2009).

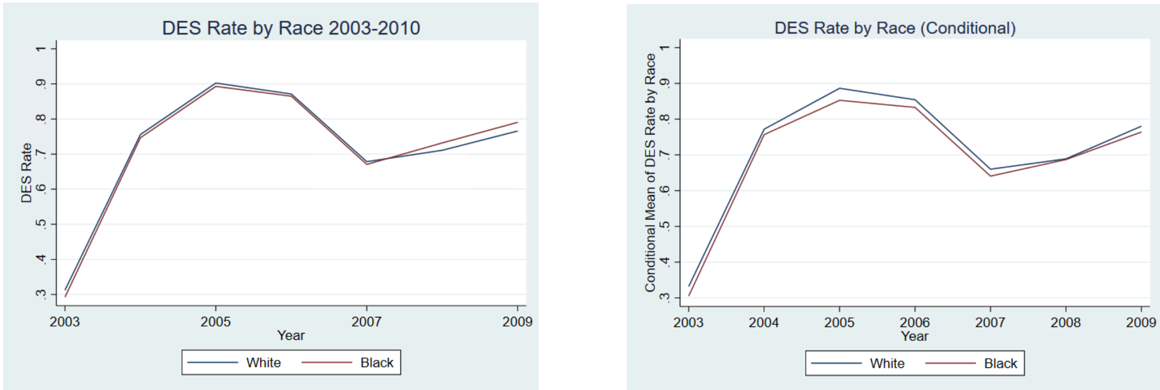
A central aspect of these disparities lies in the role of healthcare providers, whose decisions regarding the utilization of DES may be influenced by a range of factors, including implicit biases and prior clinical experience (Yong, Abnousi, Asch, & Heidenreich, 2014). Prior research indicates that physicians' levels of experience with new technology may influence their decision-making, as more experienced clinicians may be more likely to recommend these devices in complex cases (Putzer & Park, 2012). However, it remains unclear whether racial disparities in DES provision persist or are moderated by the amount of prior experience the physician has with these stents. To the best of our knowledge we are the first study to utilize a comprehensive measure of physician experience with this technology. Given the potentially significant impact of both physician experience and racial factors on the decision to use DES, this study aims to investigate whether physician experience serves as a moderating factor in the racial differences in DES use. By exploring these issues, this study seeks to shed light on the intersection of physician experience, racial disparities, and the use of DES. Understanding whether and how physician experience impacts the equitable provision of cutting-edge treatments like drug-eluting stents is crucial for developing targeted interventions aimed at reducing healthcare disparities. This research is not only timely but essential for promoting more equitable healthcare delivery and ensuring that all patients, regardless of racial background, receive optimal and equal care.

By investigating the interaction between physician experience and racial disparities in DES provision, our study aims to contribute to the broader literature on healthcare equity. Specifically, we explore whether physicians with greater experience using DES exhibit different patterns of treatment across racial groups and whether the observed disparities can be explained by differences in patient adherence concerns, hospital characteristics, or physician-level variation.

Table 2: Mean DES Rate by Race - Percentage

	Unconditional				Conditional			
Year	White	Black	Difference	Percent Difference	White	Black	Difference	Percent Difference
2003	31.25	29.25	2.00**	6.40	33.17	30.50	2.67***	8.05
2004	75.44	74.66	0.78	1.03	77.19	75.67	1.52*	1.97
2005	87.99	89.31	-1.32	-1.50	88.64	85.27	3.37***	3.80
2006	87.68	86.50	1.18	1.35	85.43	83.28	2.15**	2.52
2007	68.22	67.07	1.15	1.69	66.00	64.06	1.94	2.94
2008	72.90	73.19	-0.29	-0.00	68.90	68.70	0.20	0.29
2009	79.48	79.06	0.42	0.53	78.03	76.41	1.62	2.08

*: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$. Significance reported for t-tests in unconditional case, and F-tests in conditional case.



(a) Unconditional DES Rate by Race

(b) Conditional DES Rate by Race

Figure 1: DES Rate by Race

4 Empirical Approach

Given the descriptive statistics above, we evaluate whether selection into DES treatment on clinical risk factors differs by race. Due to the richness of our data, we have many potential risk factors, as listed in Table 1. To limit spurious results due to multiple comparisons, we rely on a single index measure, defined as the likelihood of complication predicted by all of these risk factors. Specifically, we first estimate an additively separable linear probability model of patient complications on patient demographics and all of the clinical risk factors that were used by the ACC for risk adjustment of PCI patients during our study period. Equation (1) outlines the model, where $\mathbb{1}[Complication_i]$ represents an indicator for whether or not patient i experiences a complication, and $\boldsymbol{X}_i'$ are the vector of clinical risk factors.

$$\mathbb{1}[Complication_i] = \alpha_0 + \boldsymbol{X}_i'\boldsymbol{\alpha} + +\varepsilon_i \tag{1}$$

These models include all the characteristics listed in Table 1 except for physician DES experience, and we do not include race and time indicators. Alternatively, we estimate a random forest model using the Stata `rforest` command, employing the same set of features as in Equation (1). This procedure constructs an ensemble of decision trees based on bootstrap samples from the original dataset, randomly selecting subsets of predictors at each split. The predictions from the random forest model are averaged across all trees to generate a composite prediction, allowing us to capture potential nonlinearities and complex interactions among the clinical risk factors. We use out-of-bag (OOB) error rates provided by the `rforest` command to assess the predictive performance and guard against overfitting.

We next estimate models of DES receipt and how it differs by patient race, conditional on patient characteristics, physician experience, and other factors. Specifically, we feature results from estimates of this regression:

$$\begin{aligned}\mathbb{1}[DES_i] = \beta_0 + \beta_1[Experience_{j,t}] + \beta_2[\mathbb{1}[Black_i] \times Experience_{j,t}] \\ + \beta_3\mathbb{1}[Black_i] + \boldsymbol{X}_i'\boldsymbol{\beta} + [\gamma_t + \theta_j + \omega_h] + \varepsilon_i\end{aligned} \tag{2}$$

Where $\mathbb{1}[DES_i]$ is an indicator for whether or not patient i receives a DES, $Experience_{j,k}$ is the cumulative measure of DES case experience that physician j has at time t when operating on patient i, $\mathbb{1}[Black_i]$ is an indicator for patient i's race, and $\boldsymbol{X}_i'$ are the vector of clinical risk factors. In our featured models, several vectors of fixed effects are included: γ_t, θ_j, and ω_h represent quarter–by–year–level, physician–level, and hospital–level unobserved heterogeneity, respectively.

With this model we evaluate the conditional differences between races in DES receipt, including the role of physician experience in moderating or mediating any differences. We estimate this model using Ordinary Least Squares (OLS) with robust standard errors to account for heteroskedasticity. Robust standard errors are appropriate in this setting because individual observations represent distinct patient-level outcomes, and residuals may exhibit heteroskedasticity due to differing patient-level risk factors and clinical conditions.

Although we include physician-level, hospital-level, and quarter-by-year fixed effects to capture correlated errors within these groups, explicit clustering of standard errors is not strictly necessary unless there is a strong reason to believe errors remain correlated within clusters after controlling extensively for these fixed effects. Given that our model comprehensively controls for multiple levels of fixed effects and we observe minimal remaining within-group error correlation, robust standard errors are sufficient for obtaining valid inference.

Finally, we assess how patients' clinical outcomes differ by race:

$$\mathbb{1}[Outcome_i] = \delta_0 + \delta_1[DES_i] + \delta_2[\mathbb{1}[Black_i] + \delta_3[\mathbb{1}[Black_i] \times DES_i] + \boldsymbol{X}_i'\boldsymbol{\delta} + [\gamma_t + \theta_j + \omega_h] + \varepsilon_i \quad (3)$$

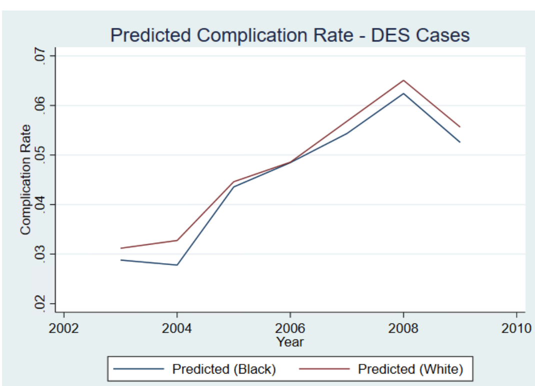
Where in separate models, $Outcome_i$ represents readmission, non–fatal complication, and mortality for an individual patient.

We extend these models to assess how new information about DES' risks in early 2006 influenced treatment decisions and clinical outcomes, and whether the effects differed by race. Specifically, we include an indicator for a case being in the year following the American College of Cardiology ACC's announcement and re–estimate Equations 2 and 3. Additionally we estimate this model for patient outcomes (1-yr readmission, complications, and mortality) as the dependent variable to provide additional insights in potential differences in negative post-surgical events due to the information shock.

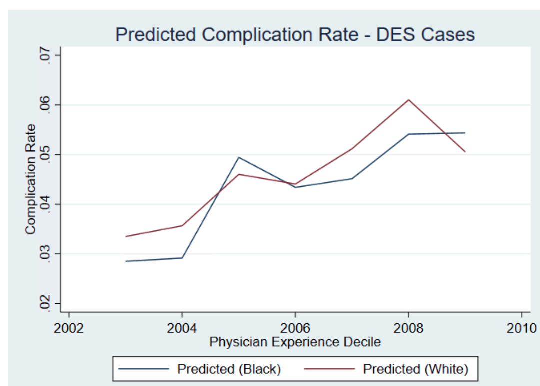
5 Results

5.1 Risk Factors

Figure 2 presents the results of Equation 1 from the linear probability model (Panel A) and the random forest model (Panel B). The results show that on average, Black patients who receive DES have complication rates predicted by their presenting clinical risk factors that are lower than White patients. This suggests that physicians were selectively avoiding providing DES to higher–risk black patients. As the figure shows, the changes over time in the risk–level of DES patients are substantially larger than the differences between races at any given point in time. Specifically, as physicians gained more experience with DES from 2003–2009, patients who received DES became systematically higher risk.



(a) Predicted Complications DES: LPM



(b) Predicted Complications DES: Random Forest

Figure 2: Predicted Complications

5.2 Receipt of DES

The empirical estimates from our featured version of Equation 2 and nested versions of it are reported in Table 3.

Table 3: Impact of Physician DES Experience on DES Receipt by Race - Quartiles

Independent Variable	(1)	(2)	(3)	(4)
Black	0.003	-0.004	-0.021***	-0.018**
	(0.008)	(0.008)	(0.007)	(0.007)
Black × DES Exp. Quartile				
1		Reference Case		
2	-0.024*	-0.024*	-0.015	-0.020*
	(0.012)	(0.012)	(0.011)	(0.011)
3	-0.039***	-0.040***	-0.028***	-0.032***
	(0.012)	(0.012)	(0.011)	(0.010)
4	-0.007	-0.011	-0.006	-0.010
	(0.011)	(0.011)	(0.010)	(0.010)
DES Exp. Quartile				
1		Reference Case		
2	0.386***	0.384***	0.115***	0.121***
	(0.003)	(0.003)	(0.003)	(0.004)
3	0.457***	0.452***	0.134***	0.142***
	(0.003)	(0.003)	(0.004)	(0.004)
4	0.769***	0.456***	0.161***	0.166***
	(0.003)	(0.003)	(0.004)	(0.005)
Demographic Controls		X	X	X
Risk Factor Controls		X	X	X
Hospital FE			X	X
Quarter-Year FE			X	X
Physician FE				X
r^2	0.1872	0.1990	0.3398	0.3538

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

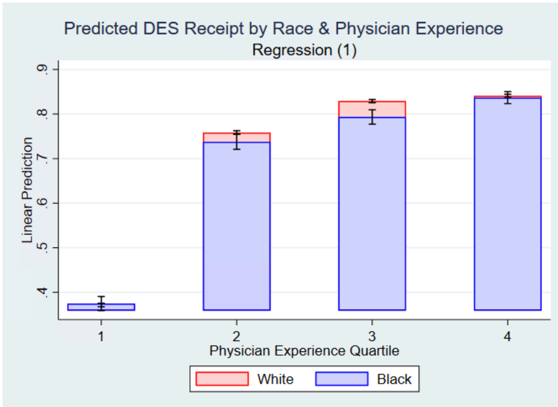
Moving left to right across columns adds controls to the models, as indicated below the reported estimates. Once time and healthcare provider (whether hospital or hospital and physician) are accounted for, racial differences are evident, with black PCI patients who are treated by the least experienced physicians being 1.8–2.1 percentage points (2.7–3.1% of the mean) less likely to receive DES than observably identical white patients treated by the same provider.

Because our models include physician experience level indicators and their interactions with race, we present the key results graphically in Figure 3, with the panels corresponding to the columns in Table 3 and the featured model reported in panel (d). Evident from each model is that the likelihood of a patient receiving DES grows with the physician's prior volume of experience using DES, even conditional on the quarter–year of treatment (panels b–d), and these differences exceed those that exist between Black and White patients.

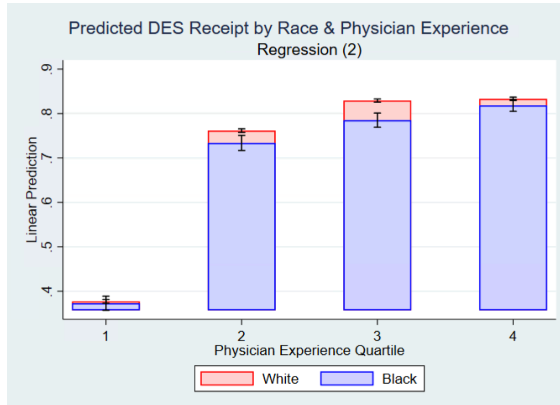
The results give clear evidence that racial differences persist, and even tend to increase, at all levels of physician experience.[1] That is, the results provide no evidence that as physicians gain experience with DES, they tend to provide DES at the same rates to otherwise observably identical Black and White patients. If anything, the racial gap tends to be larger among more experienced physicians, e.g. in our featured model, Black patients treated by the most experienced quartile of physicians are 3.1 percentage points less likely to receive DES than their White counterparts. Furthermore, at any given moment in time, Black patients are treated by physicians with greater experience with DES than White patients, as shown in Figure 4b.[2]

[1]Our models account for patient age linearly. Given prior evidence about differences in DES provision by insurance type, we re–estimate the models using only patients age 65+ to ensure that the sample all has Medicare coverage. The are reported in Table 12 and are highly similar to those from the full sample. Thus differences in insurance coverage do not explain the observed differences in DES provision.

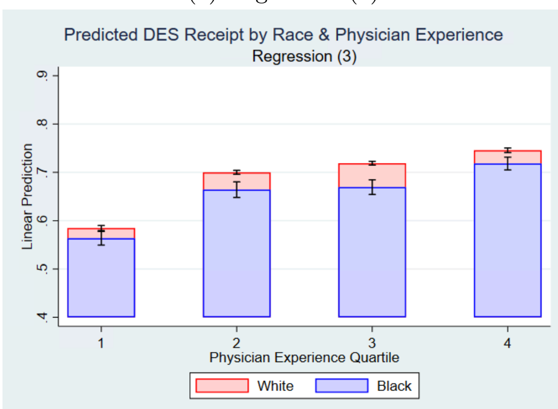
[2]The table of values underlying the unconditional figure is reported in Table 10.



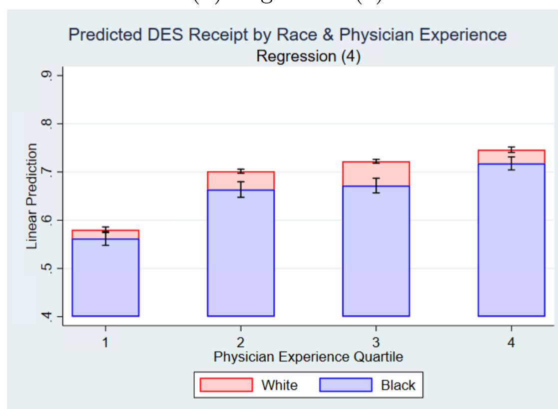
(a) Regression (1)



(b) Regression (2)

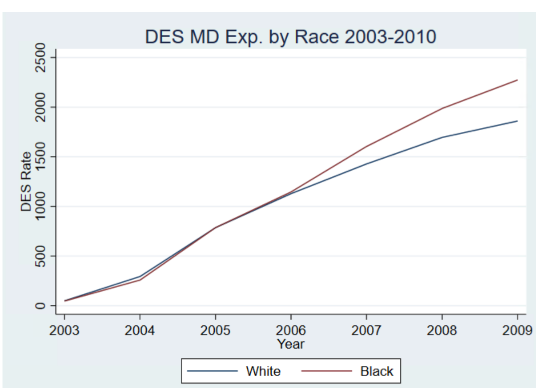


(c) Regression (3)

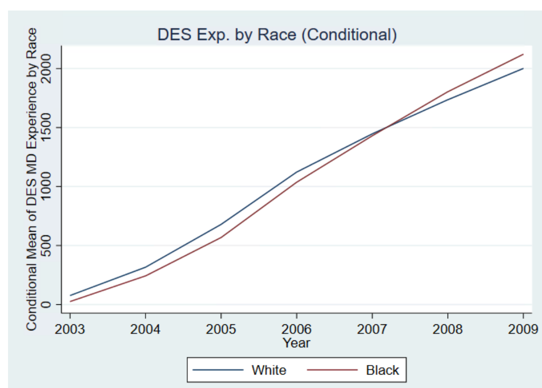


(d) Regression (4)

Figure 3: Main Analysis Results



(a) Unconditional DES Exp by Race



(b) Conditional DES Exp by Race

Figure 4: Physician DES Experience by Race

These results raise the question of how the Black patients who do not receive DES are being treated, whether with BMS or via PCI without stents. We evaluate this directly by re–estimating the same four models but with the outcome defined as the receipt of any stent. The results are presented in Table 9.

5.3 Clinical Outcomes

Table 4: Patient Outcomes (All Patients)

	(1)	(2)	(3)	(4)
	Readmission			
Black	-0.016**	-0.027***	-0.026***	-0.029***
	(0.005)	(0.005)	(0.005)	(0.005)
	Complication			
Black	-0.005***	-0.003	-0.003	-0.003
	(0.001)	(0.002)	(0.002)	(0.002)
	Mortality			
Black	0.000	0.000	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Demographic Controls	X	X	X	X
Risk Factor Controls	X	X	X	X
Hospital FE		X	X	
Quarter-Year FE		X	X	
Physician FE			X	X
Hospital-Quarter FE				X

We extend these models to evaluate differences in outcomes by race conditional on receipt of DES. Table 5 presents the results. The first panel examines the impact of DES receipt and race on readmission within one year of operation. Across all four specifications, whether receiving DES or not, Black PCI patients are less likely to be readmitted by 1.7 to 3.0 percentage points. Apart from these racial differences, the estimates show that DES and BMS patients are equally likely to be readmitted.

The second panel reports the estimates for patient complications. As with readmissions, Black patients are less likely to experience complications, and these racial differences are not statistically different between DES and BMS patients. However, DES patients overall are less likely to experience complications. The third panel reports estimates for one–year mortality. Here, DES patients are less likely to die within a year of treatment, but we do not observe any differences between races.

Table 5: Patient Outcomes

	(1)	(2)	(3)	(4)
		Readmission		
Black	-0.017**	-0.030***	-0.030***	-0.023***
	(0.008)	(0.008)	(0.008)	(0.008)
DES Case	-0.000	0.000	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
Black × DES Case	0.001	0.006	0.005	-0.005
	(0.010)	(0.010)	(0.010)	(0.010)
		Complication		
Black	-0.008**	-0.006*	-0.006*	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
DES Case	-0.004***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Black × DES Case	0.004	0.004	0.004	0.004
	(0.004)	(0.004)	(0.004)	(0.004)
		Mortality		
Black	-0.000	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
DES Case	-0.002***	-0.002***	-0.002***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Black × DES Case	0.001	0.001	0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Demographic Controls	X	X	X	X
Risk Factor Controls	X	X	X	X
Hospital FE		X	X	
Quarter-Year FE		X	X	
Physician FE			X	X
Hospital-Quarter FE				X

To summarize our results so far, we have observed that Black patients are less likely to receive DES conditional on risk factors and other characteristics and instead receive the older, cheaper technology (BMS), and that those who do receive DES are observably less–risky on average than their White counterparts, yet tend to experience better clinical outcomes in terms of readmission and complication rates.

5.4 Information Shock

The results so far account for temporal differences semi–parametrically through the quarter–year fixed effects, such that they represent estimates of the differences between races and between levels of physician experience pooled across all time periods. We next leverage the information shock about DES in 2006 to assess the relationships between race, experience, and new information in physicians' treatment decisions. Specifically, we revise equation 2 and equation 3 to include an interaction term with the shock period.[3] The new regression equation is presented in Equation 4. We define the information shock as 2006 because in very late 2005, the American College of Cardiology updated its guidelines recommending longer treatment with clopidogrel after DES receipt due to findings that without sustained adherence, DES patients faced elevated risk of complications relative to BMS. This new information about DES risk resulted in physicians reducing their provision of DES to PCI patients. As evident in Figure 1b, the decline was immediate and sharp, falling from DES rates of 87.6% to 68.1%. The figure also makes clear that the decline was similar for both Black and White patients.

[3]We remove quarter–year fixed effects from the regression to avoid problems with mutlicollinearity. Other definitions of the shock period that allow for additional time fixed-effects yielded similar results.

$$
\begin{aligned}
1[DES_i] = \beta_0 + \beta_1[\text{Experience}_{j,t}] + \beta_2[1[\text{Black}_i] \times \text{Experience}_{j,t}] + \beta_3 1[\text{Black}_i] && (4)\\
+ \beta_4[\text{Shock}_t] + \beta_5[\text{Shock}_t \times 1[\text{Black}_i]] && (5)\\
+ \beta_6[\text{Shock}_t \times \text{Experience}_{j,t}] + \beta_7[\text{Shock}_t \times \text{Experience}_{j,t} \times 1[\text{Black}_i]] && (6)\\
+ X_i'\gamma + [\theta_j + \omega_h] + \varepsilon_i. && (7)
\end{aligned}
$$

Table 11 provides detailed regression results from Equation 4 and we summarize the key results in Figure 5. First, consistent with our expectations and prior descriptive analyses, we observe a significant reduction in DES use following the ACC's guideline update across all patient groups. Specifically, physician provision of DES declined notably in the post-shock period across all levels of experience, as evidenced by the consistently negative and statistically significant coefficients on the *Shock Period × DES Experience Quartile* interactions.

Second, when examining whether this reduction differed by patient race, the regression results reveal no robust evidence of differential responses by physicians to the information shock across racial groups. The coefficients on interactions involving race (*Black × Shock Period*, *Black × Shock Period × DES Experience Quartile*) are generally small and statistically insignificant, suggesting that the guideline change did not exacerbate racial disparities in DES utilization. Thus, although overall DES use declined, physicians did not appear to selectively restrict DES use further for Black patients following the new guidelines.

Third, a detailed examination of the triple interaction terms (*Shock Period × DES Experience Quartile × Black*) further supports this conclusion. These coefficients are generally statistically insignificant and quantitatively modest, indicating that the shock's impact on racial disparities was neither systematically moderated nor mediated by physician experience.

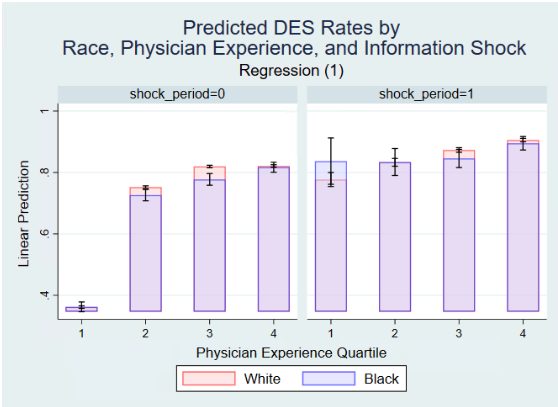
Importantly, we also evaluated whether the guideline update influenced the clinical composition of patients selected for PCI, potentially reflecting changes in the patient selection process. As reported in Table 6, patient demographics and clinical risk factors showed minimal systematic variation by race after the information shock. Specifically, there were no clinically meaningful or statistically robust racial differences in demographic characteristics or clinical risk factors pre- and post-guideline change. Hence, we find little evidence that physicians altered their patient selection criteria in response to adherence-related concerns raised by the new guidelines.

These findings collectively suggest that while physicians universally reduced DES utilization following heightened adherence concerns, the underlying racial disparities persisted largely unchanged, unaffected by shifts in physician decision-making due to the new clinical information. Consequently, the informational shock, despite significantly affecting overall practice patterns, did not amplify existing racial gaps in DES provision.[4]

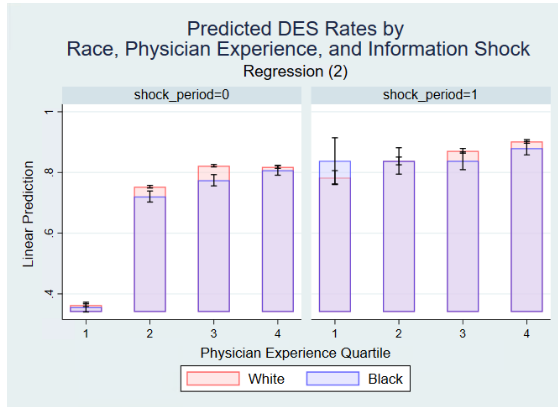
[4]For completeness Appendix H reports similar regressions with patient outcomes (complications, 1-yr readmission, and mortality) as the dependent variable.

Covariate	White Patients Pre	Post	Diff	Black Patients Pre	Post	Diff	D-i-D ($\Delta_w - \Delta_b$)
Female	0.347	0.347	0.000	0.473	0.457	-0.016	-0.017
Age	64.58	64.82	0.242	60.87	62.35	1.48***	-1.24*
NYHA	0.214	0.084	-0.129***	0.117	0.108	-0.009	-0.121***
STEMI	0.028	0.067	0.039***	0.017	0.060	0.043***	-0.004
AMI	0.079	0.143	0.065***	0.062	0.139	0.076***	-0.012
Cardshock	0.002	0.003	0.001	0.001	0.001	-0.000	0.001
CVD	0.061	0.067	0.007***	0.075	0.085	0.010	-0.003
CHF Current	0.101	0.489	0.387***	0.155	0.542	0.386***	0.001
CLD	0.098	0.113	0.015***	0.093	0.105	0.013*	0.002
CHF Past	0.051	0.060	0.010***	0.090	0.098	0.008	0.002
DH	0.245	0.221	-0.023***	0.396	0.338	-0.058***	0.035***
EF3050	0.051	0.091	0.041***	0.044	0.080	0.036***	0.005
EFLE30	0.019	0.030	0.012***	0.022	0.039	0.017***	-0.005
IABP	0.014	0.016	0.002***	0.008	0.013	0.005	-0.003
LFT Main 50	0.054	0.169	0.115***	0.051	0.126	0.075***	0.039***
LV Abnormal	0.081	0.237	0.154***	0.077	0.224	0.147***	0.007
PCI Elec	0.317	0.513	0.196***	0.399	0.495	0.095***	0.100***
PCI Urge	0.117	0.281	0.164***	0.104	0.309	0.204***	-0.040***
PCI Emer	0.053	0.123	0.071***	0.040	0.108	0.068***	0.003
PCI Salv	0.000	0.001	0.001***	0.000	0.001	0.001	0.000
Proxlad 50	0.005	0.017	0.011***	0.004	0.008	0.004**	0.007***
Renal Failure	0.014	0.024	0.009***	0.061	0.069	0.008	0.001
Thrombolysis	0.004	0.004	0.000	0.004	0.005	0.001	-0.001
TIMI	0.396	1.118	0.721***	0.451	1.294	0.844***	-0.123***
Valvsurg	0.006	0.005	-0.000	0.004	0.004	-0.000	0.000

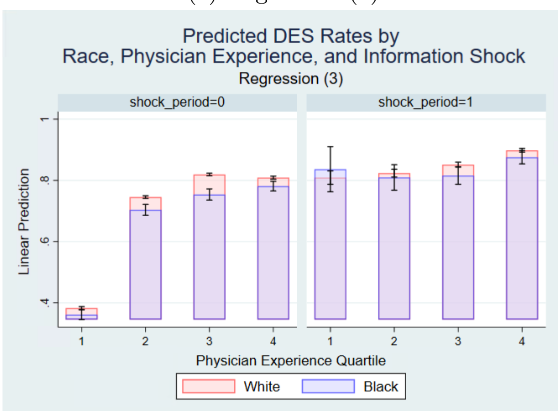
Table 6: Demographics and Risk Factors by Race and Time



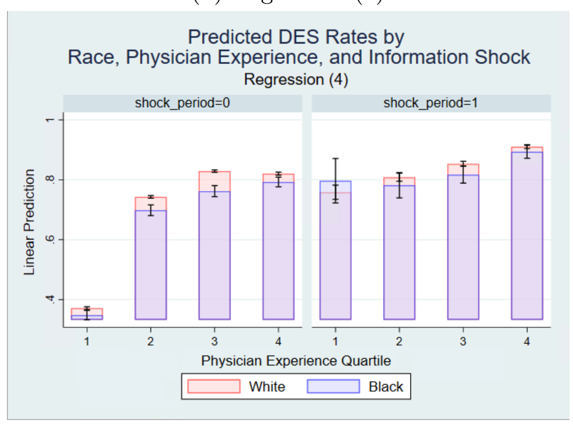
(a) Regression (1)



(b) Regression (2)



(c) Regression (3)



(d) Regression (4)

Figure 5: Shock Period Analysis Results

6 Conclusion

Our study provides new evidence on racial disparities in physician adoption of new medical technology and responses to new clinical information. Using a unique dataset of percutaneous coronary intervention procedures spanning 2003 to 2009, we examine the introduction and subsequent regulation of drug-eluting stents to assess whether physicians' treatment decisions differed by patient race.

Our findings suggest that while Black patients were no less likely to receive DES in an unconditional analysis, a more nuanced view reveals systematic disparities. Conditional on clinical risk factors, Black patients were less likely than White patients to receive DES. These racial differences in DES receipt persisted over time and were not explained by differences in physician experience, hospital characteristics, or insurance coverage. Notably, we find no evidence that statistical discrimination based on concerns about medication adherence accounts for these disparities, as physicians reduced DES use similarly for Black and White patients following the 2006 safety warning.

Moreover, our results indicate that physicians' increasing experience with DES did not mitigate racial disparities in treatment. In fact, experienced physicians were more likely to prescribe DES overall, yet the racial gap remained or even widened in certain experience quartiles. This suggests that factors beyond physician learning—such as implicit bias or structural constraints within healthcare delivery—may be influencing treatment decisions.

Importantly, our analysis of patient outcomes does not support a clinical justification for the lower provision of DES to Black patients. Black patients who did receive DES experienced lower complication rates and similar or lower readmission and mortality rates compared to White patients, indicating that physicians may be selectively providing DES to healthier Black patients.

Taken together, these findings contribute to the broader literature on racial disparities in healthcare access and the diffusion of medical technology. They highlight the need for further investigation into physician decision-making processes, particularly the role of implicit biases and structural healthcare inequities. Future research should explore potential interventions—such as provider training or decision-support tools—that could help ensure equitable access to innovative medical treatments.

A Appendix 1: Previous Literature

Here any DES represents a case where the patient received at least one DES during their procedure, while all DES represents cases in which patients only received DES during their procedure.

Table 7: Likelihood of DES Receipt (Odds Ratios) in Prior Studies

Study	Odds-Ratio	Our Sample	Paper	Odds-Ratio (95% CI)	Reported Sample	N
(1)	0.799 (0.04)	All DES Jan. 2004 - Dec 2004	(Hannan et al., 2007)	0.81 (0.66-0.91)	All DES Apr. 2004 - Dec. 2004 New York State	24,712
(2)	0.781 (0.06)	All DES Jan. 2008 - Dec 2009	(Hannan et al., 2016)	0.702 (0.657-0.849)	All DES Jan. 2011 - Dec 2012 New York State	84,634
(3)	0.781 (0.06)	Any DES Jan. 2008 - Dec 2009	(Gaglia Jr et al., 2014)	0.57 (0.40-0.82)	Any DES Jan. 2008 - Dec 2012 USC Hospital, Keck Univ.	2,763

B Appendix 1: Conditional DES Rate Difference

Table 8: Mean DES Rate by Race - Percentage (Conditional)

Year	White	Black	Difference	Percent Difference
2003	33.17	30.50	2.67***	8.05
2004	77.19	75.67	1.52*	1.97
2005	88.64	85.28	3.36*	3.79
2006	85.43	83.28	2.15**	2.52
2007	66.00	64.06	1.94	2.94
2008	68.89	68.70	0.19	0.28
2009	78.03	76.41	1.62	2.08
Controls:				
Demographics			X	
Risk Factors			X	

- Stars represent F–test significance levels *: $p< 0.1$, **: $p< 0.05$, ***: $p< 0.01$

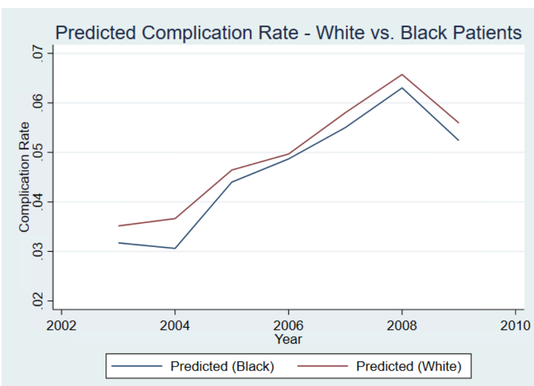
C Appendix 2: Any Stent Result Table

Table 9: Estimates from Models for Provision of Any Stent

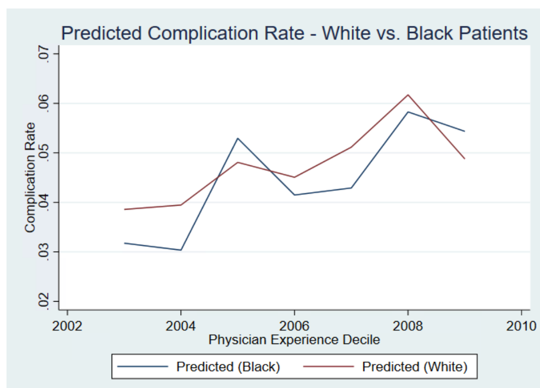
Independent Variable	(1)	(2)	(3)	(4)
Black	-0.000	-0.005	-0.013*	-0.014*
	(0.007)	(0.006)	(0.006)	(0.006)
Black × DES Exp. Quartile				
1		Reference Case		
2	-0.005	-0.001	0.009	0.010
	(0.008)	(0.008)	(0.008)	(0.008)
3	0.010	0.016**	0.025***	0.028***
	(0.008)	(0.008)	(0.008)	(0.008)
4	0.013	0.022***	0.018**	0.019***
	(0.008)	(0.008)	(0.008)	(0.008)
DES Exp. Quartile				
1		Reference Case		
2	0.110***	0.114***	0.026***	0.025***
	(0.002)	(0.002)	(0.002)	(0.002)
3	0.112***	0.132***	0.035***	0.028***
	(0.002)	(0.002)	(0.002)	(0.003)
4	0.113***	0.148***	0.048***	0.049***
	(0.002)	(0.002)	(0.003)	(0.004)
Demographic Controls	X	X	X	X
Risk Factor Controls	X	X	X	X
Hospital FE		X	X	
Quarter-Year FE		X	X	
Physician FE			X	X
Hospital-Quarter FE				X
r^2	0.0251	0.0389	0.2141	0.2238

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

D Appendix 3: Predicted Complications Any Stent



(a) Predicted Complications All Stents: LPM



(b) Predicted Complications All Stents: Random Forest

E Appendix 4: Mean Experience By Race and Time

Year	White	Black	Difference
2003	49.8	46.9	2.9*
2004	294.5	258.6	35.9***
2005	786.6	787.1	-0.5
2006	1129.2	1146.5	-17.3
2007	1428.6	1604.5	-175.9***
2008	1695.3	1986.9	-291.6***
2009	1860.7	2274.1	-413.4***
Total	682.9	791.2	-108.3***

Table 10: Mean Physician DES Experience by Race and Year

- Stars represent two tail t-test significance levels *: $p < 0.1$, **: $p < 0.05$, ***: $p < 0.01$

F Appendix 5: Shock Period Table

Table 11: Impact of Physician DES Experience and Info Shock on DES Receipt by Race - Quartiles

Independent Variable	(1)	(2)	(3)	(4)
Black	0.000	-0.015*	-0.030***	-0.027***
	(0.008)	(0.009)	(0.008)	(0.008)
Black × Shock	0.059	0.117**	0.091*	0.085*
	(0.041)	(0.050)	(0.050)	(0.049)
Black × DES Exp. Quartile				
1		Reference Case		
2	-0.027**	-0.007	0.002	-0.003
	(0.012)	(0.012)	(0.011)	(0.011)
3	-0.043***	-0.028**	-0.017	-0.021*
	(0.012)	(0.012)	(0.011)	(0.011)
4	-0.005	-0.000	0.002	-0.003
	(0.012)	(0.012)	(0.011)	(0.011)
DES Exp. Quartile				
1		Reference Case		
2	0.390***	0.408***	0.133***	0.140***
	(0.003)	(0.003)	(0.004)	(0.004)
3	0.458***	0.498***	0.164***	0.174***
	(0.003)	(0.003)	(0.004)	(0.005)
4	0.459***	0.505***	0.197***	0.206***
	(0.003)	(0.003)	(0.004)	(0.006)
DES Exp. Quartile × Shock Period				
1		Reference Case		
2	-0.334***	-0.349***	-0.131***	-0.111***
	(0.014)	(0.019)	(0.018)	(0.019)
3	-0.361***	-0.386***	-0.134***	-0.120***
	(0.013)	(0.018)	(0.017)	(0.018)
4	-0.331***	-0.376***	-0.157***	-0.143***
	(0.012)	(0.018)	(0.017)	(0.018)
DES Exp. Quartile × Shock Period × Black				
1		Reference Case		
2	-0.032	-0.080	-0.084	-0.081
	(0.048)	(0.059)	(0.059)	(0.058)
3	-0.045	-0.093*	-0.069	-0.066
	(0.045)	(0.053)	(0.053)	(0.053)
4	-0.065	-0.123**	-0.085	-0.073
	(0.044)	(0.052)	(0.052)	(0.052)
Demographic Controls		X	X	X
Risk Factor Controls		X	X	X
Hospital FE			X	X
Physician FE				X
r^2	0.1952	0.2196	0.3413	0.3553

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

G Appendix 6: Age 65+

Table 12: Impact of Physician DES Experience on DES Receipt by Race - Quartiles

Independent Variable	(1)	(2)	(3)	(4)
Black	-0.004	-0.008	-0.021**	-0.017*
	(0.011)	(0.011)	(0.010)	(0.010)
Black × DES Exp. Quartile				
1		Reference Case		
2	-0.014	-0.013	-0.012	-0.017
	(0.017)	(0.017)	(0.015)	(0.015)
3	-0.024	-0.026*	-0.019	-0.023*
	(0.016)	(0.016)	(0.015)	(0.014)
4	0.026*	0.021	0.020	0.016
	(0.015)	(0.015)	(0.015)	(0.013)
DES Exp. Quartile				
1		Reference Case		
2	0.394***	0.389***	0.122***	0.127***
	(0.004)	(0.004)	(0.005)	(0.005)
3	0.470***	0.462***	0.142***	0.148***
	(0.004)	(0.004)	(0.005)	(0.006)
4	0.482***	0.467***	0.174***	0.177***
	(0.004)	(0.004)	(0.005)	(0.007)
Demographic Controls		X	X	X
Risk Factor Controls		X	X	X
Hospital FE			X	X
Quarter-Year FE			X	X
Physician FE				X
r^2	0.1925	0.2018	0.3333	0.3499

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

H Appendix 7: Patient Outcomes - Shock Period

H.1 Appendix 7(a): Complications

Table 13: Impact of Physician DES Experience and Info Shock on DES Receipt by Race - Quartiles

Independent Variable	(1)	(2)	(3)	(4)
Black	-0.013***	-0.010***	-0.008***	-0.008***
	(0.003)	(0.003)	(0.003)	(0.003)
Black × Shock	0.022	0.028	0.028	0.022
	(0.024)	(0.025)	(0.025)	(0.025)
Black × DES Exp. Quartile				
1		Reference Case		
2	0.008	0.004	0.004	0.003
	(0.005)	(0.005)	(0.005)	(0.007)
3	0.005	0.001	0.001	0.008
	(0.005)	(0.005)	(0.005)	(0.006)
4	0.024***	0.014**	0.012**	0.013**
	(0.006)	(0.006)	(0.006)	(0.006)
DES Exp. Quartile				
1		Reference Case		
2	-0.001	-0.005***	-0.003**	-0.003**
	(0.013)	(0.001)	(0.001)	(0.001)
3	0.007***	-0.006***	-0.005***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.002)
4	0.005***	-0.014***	-0.016***	-0.019***
	(0.001)	(0.001)	(0.001)	(0.002)
DES Exp. Quartile × Shock Period				
1		Reference Case		
2	-0.001	0.007	0.004	0.003
	(0.007)	(0.007)	(0.007)	(0.007)
3	-0.011*	0.010*	0.007	0.008
	(0.006)	(0.006)	(0.006)	(0.006)
4	-0.005	0.017***	0.014**	0.013**
	(0.006)	(0.006)	(0.006)	(0.006)
DES Exp. Quartile × Shock Period × Black				
1		Reference Case		
2	-0.024	-0.026	-0.024	-0.016
	(0.027)	(0.027)	(0.027)	(0.028)
3	-0.018	-0.026	-0.026	-0.018
	(0.026)	(0.027)	(0.027)	(0.027)
4	-0.038	-0.035	-0.033	-0.027
	(0.026)	(0.027)	(0.027)	(0.027)
Demographic Controls		X	X	X
Risk Factor Controls		X	X	X
Hospital FE			X	X
Physician FE				X
r^2	0.0005	0.0708	0.0596	0.0839

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

H.2 Appendix 7(b): Readmission

Table 14: Impact of Physician DES Experience and Info Shock on DES Receipt by Race - Quartiles

Independent Variable	(1)	(2)	(3)	(4)
Black	-0.028***	-0.022**	-0.037***	-0.037***
	(0.010)	(0.010)	(0.009)	(0.010)
Black × Shock	0.035	0.040	0.054	0.024
	(0.055)	(0.056)	(0.055)	(0.056)
Black × DES Exp. Quartile				
1		Reference Case		
2	0.018	0.014	0.019	0.021
	(0.015)	(0.016)	(0.014)	(0.014)
3	0.016	0.015	0.015	0.017
	(0.014)	(0.014)	(0.014)	(0.013)
4	0.005	0.068	0.002	-0.002
	(0.014)	(0.014)	(0.014)	(0.014)
DES Exp. Quartile				
1		Reference Case		
2	0.003	-0.014***	-0.014***-0.016***	
	(0.004)	(0.004)	(0.004)	(0.004)
3	0.021***	-0.014***	-0.013***	-0.021***
	(0.004)	(0.004)	(0.004)	(0.004)
4	0.055***	0.002	0.008*	-0.000
	(0.004)	(0.004)	(0.005)	(0.005)
DES Exp. Quartile × Shock Period				
1		Reference Case		
2	0.014	0.032**	0.039**	0.034**
	(0.016)	(0.016)	(0.016)	(0.017)
3	0.013	0.053***	0.046***	0.047***
	(0.015)	(0.015)	(0.015)	(0.016)
4	0.007	0.068***	0.055***	0.051***
	(0.014)	(0.014)	(0.014)	(0.015)
DES Exp. Quartile × Shock Period × Black				
1		Reference Case		
2	-0.022	-0.038	-0.048	-0.012
	(0.066)	(0.066)	(0.065)	(0.066)
3	-0.024	-0.050	-0.060	-0.032
	(0.059)	(0.060)	(0.059)	(0.060)
4	-0.012	-0.023	-0.036	-0.007
	(0.059)	(0.060)	(0.059)	0.059
Demographic Controls		X	X	X
Risk Factor Controls		X	X	X
Hospital FE			X	X
Physician FE				X
r^2	0.0042	0.0264	0.0465	0.0574

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

H.3 Appendix 7(c): 1-year Mortality

Table 15: Impact of Physician DES Experience and Info Shock on DES Receipt by Race - Quartiles

Independent Variable	(1)	(2)	(3)	(4)
Black	-0.000	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Black × Shock	-0.004*	-0.003	-0.003	-0.004
	(0.002)	(0.002)	(0.002)	(0.003)
Black × DES Exp. Quartile				
1		Reference Case		
2	0.000	-0.001	-0.001	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)
3	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)
4	-0.002	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
DES Exp. Quartile				
1		Reference Case		
2	0.000	-0.000	-0.001	-0.000
	(0.000)	(0.004)	(0.001)	(0.000)
3	0.002***	-0.000	-0.001	-0.001
	(0.000)	(0.004)	(0.001)	(0.000)
4	0.003***	-0.000	-0.001**	-0.001*
	(0.000)	(0.000)	(0.001)	(0.001)
DES Exp. Quartile × Shock Period				
1		Reference Case		
2	0.003	0.004*	0.005**	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
3	-0.001	0.004*	0.003*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
4	-0.002	0.003	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
DES Exp. Quartile × Shock Period × Black				
1		Reference Case		
2	-0.004	-0.003	-0.003	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
3	0.008	0.007	0.006	0.007
	(0.005)	(0.005)	(0.005)	(0.005)
4	0.004	0.005	0.004	0.005
	(0.004)	0.004	(0.004)	(0.004)
Demographic Controls		X	X	X
Risk Factor Controls		X	X	X
Hospital FE			X	X
Physician FE				X
r^2	0.004	0.0912	0.0931	0.0947

Robust standard errors reported in parentheses. Significance denoted as follows *: $p < 0.10$, **: $p < 0.05$,***: $p < 0.01$.

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