Distressed communities are associated with worse outcomes after coronary artery bypass surgery

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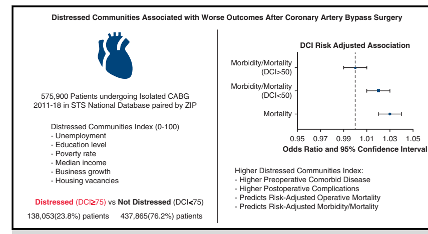
ABSTRACT

Objectives: Although low socioeconomic status has been associated with increased risk of complications after cardiac surgery, analyses have typically focused on insurance status, race, or median income. We sought to determine if the Distressed Communities Index, a composite socioeconomic metric, could predict operative mortality after coronary artery bypass grafting.

Methods: All patients who underwent isolated coronary artery bypass grafting (2011-2018) in the National Society of Thoracic Surgeons adult cardiac surgery database were analyzed. Clinical data were paired with the Distressed Communities Index, which accounts for unemployment, education level, poverty rate, median income, business growth, and housing vacancies by ZIP code. Developed by the Economic Innovation Group, Distressed Communities Index scores range from 0 (no distress) to 100 (severe distress). A distressed community was defined as one having a Distressed Communities Index of 75 or greater for univariate analyses.

Results: Of the 575,900 patients undergoing coronary artery bypass grafting with a Distressed Communities Index score, the median age was 65 years. The operative mortality rate was 2.0%, and the composite morbidity or mortality rate was 11.5%. Distressed communities were associated with increased Society of Thoracic Surgeons predicted risk of mortality (1.97% vs 1.85%, $P < .0001$) and risk of composite morbidity or mortality (12.8% vs 11.7%, $P < .0001$). After adjusting for Society of Thoracic Surgeons risk model, the Distressed Communities Index remained significantly associated with mortality (odds ratio, 1.12; $P < .0001$) and composite morbidity and mortality (odds ratio, 1.03; $P = .002$).

Conclusions: Patients from distressed communities are at increased risk for adverse events and death after coronary artery bypass grafting. The Distressed Communities Index is a useful, holistic measure of socioeconomic status that may help identify high-risk patients for quality improvement and should be considered when building risk models or comparing hospitals. (J Thorac Cardiovasc Surg 2020;160:425-32)



Patients from distressed communities are at increased risk for adverse events and death after CABG.

Central Message

The DCI is a composite measure of socioeconomic distress that is independently associated with risk-adjusted CABG outcomes.

Perspective

Patients from socioeconomically distressed communities have greater perioperative risk than traditional risk calculators would predict. As the US healthcare system continues to focus on improving quality and outcomes, incorporation of patients' SES into national databases, risk prediction models, and treatment plans is prudent.

See Commentaries on pages 433 and 434.

Socioeconomic factors are known to have a major effect on quality of life and life expectancy.[1] Fundamental characteristics such as education level, housing, employment status, and financial security are common measurements of

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Abbreviations and Acronyms

- AUC = area under the curve
- CABG = coronary artery bypass grafting
- DCI = Distressed Communities Index
- NRI = Net Reclassification Index
- SEP = socioeconomic position
- SES = socioeconomic status
- STS = Society of Thoracic Surgeons

socioeconomic status (SES). Several studies have evaluated the impact of SES on surgical outcomes using proxies such as insurance status and race, which are typically captured in surgical databases.[2-4] These surrogates of SES have been shown to predict outcomes after surgery, including mortality after bariatric surgery and failure to rescue after cancer surgery.[5-11] These findings have resulted in an increased focus on the impact of socioeconomic determinants of health from both individual and community-level factors playing important roles in health outcomes.

Although it is clear that lower SES correlates with worse surgical outcomes, the best way to measure and incorporate these factors into outcomes research and risk models remains elusive. An alternative to common surrogates was recently developed by the Economic Innovation Group, "a bipartisan public policy organization, founded in 2013, combining innovative research and data-driven advocacy to address America's most pressing economic challenges."[12] They developed the Distressed Communities Index (DCI), a composite ranking of community level SES by ZIP code that accounts for 7 component metrics. DCI scores range from 0 (no distress) to 100 (severe distress) and incorporate unemployment, education level, poverty rate, median income, business establishments, job growth, and housing vacancies.[12]

The objectives of this study were to assess associations between SES and community distress as measured by the DCI with preoperative characteristics and postoperative outcomes after coronary artery bypass grafting (CABG) in a large national dataset. Additionally, we sought to evaluate the interaction between race and DCI when comparing outcomes after CABG. We hypothesized that increasing socioeconomic distress, as measured by a higher DCI score, would correlate with risk-adjusted increased short-term morbidity and mortality.

MATERIALS AND METHODS

Study Population

All patients undergoing isolated CABG between July 1, 2011, and March 31, 2018 (n = 1,002,625), in the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database were evaluated for inclusion in this study. Patients were excluded for emergency/salvage indication or missing ZIP code as described by the Consolidated Standards of Reporting Trials diagram (Figure 1). The final study population did not significantly differ from the national cohort (Table E1). The STS Adult Cardiac Surgery Database review committee approved the study, and the Duke Clinical Research Institute performed the analysis with exemption from review by institutional review board.

Socioeconomic Status

The DCI score is available for all ZIP codes with more than 500 residents and thus captures 99% of the American population. It is a composite score based on the following 7 metrics: no high school degree, housing vacancy rate, adults not working, poverty rate, median income ratio, change in employment, and change in business establishments. The 7 evenly weighted variables are used to calculate a ZIP code's rank compared with its geographic peers and then normalized to obtain a raw distress score that ranges from 0 (no distress) to 100 (severe distress). The 7 SES indicators were obtained from the American Communities Survey 2014 5-year estimates and the Census Bureau County and ZIP Code Business Patterns. The Economic Innovation group provides a heat map of DCI score across the United States.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation or median and interquartile range as appropriate based on normality, whereas categoric variables are presented as number and percentage of the total. Patients were stratified by being distressed (DCI $\geq$ 75) or not (DCI < 75) on the basis of a data-driven break point from previous studies using DCI.[13-17] To compare groups, the Wilcoxon Mann–Whitney test was used for continuous variables and chi-square test for categoric variables. Given the large sample size, standardized differences were calculated, and a difference greater than 10% was considered clinically important. Hierarchical multivariate generalized logistic regression modeled the association between DCI and operative mortality, with risk adjustment using the 2017 STS CABG risk models, and hospital was included as a random effect.[18] DCI and mortality had a linear relationship, but for the composite morbidity and mortality model we had to create 2 linear splines at the median. The utility of the addition of DCI was assessed by effect size and significance, the change in area under the curve (AUC) for the nested models, and the Net Reclassification Index (NRI). The NRI is an index measure of how well a new model reclassifies subjects compared with an old model (correct

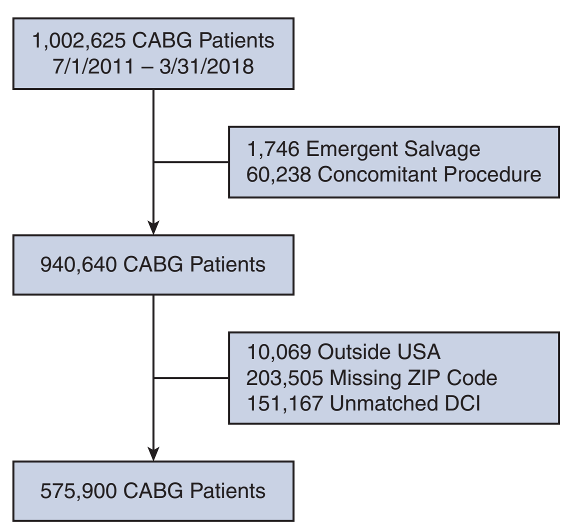

FIGURE 1. Consolidated Standards of Reporting Trials diagram. The Consolidated Standards of Reporting Trials diagram demonstrates the population as the exclusion criteria are used and shows how many patients were lost at each stage. *CABG*, Coronary artery bypass grafting; *DCI*, Distressed Communities Index.

vs incorrect changes in prediction for cases and controls separately).[19] In this case, a continuous or category-free NRI was used. Although the change in AUC represents a population-level assessment of model performance, the NRI assessed the change in risk prediction at the individual level. Alpha level for statistical significance was 0.05. All analyses were performed with SAS version 9.4 (SAS Institute, Inc, Cary, NC).

RESULTS

Baseline Characteristics and Operative Factors

A total of 575,900 cases from 1040 centers were included in the analysis with a mean DCI score of 48.8 ± 28.9. After stratification, a total of 138,053 patients (23.8%) came from distressed communities with DCI scores greater than 75 (Table 1). Compared with patients from less distressed communities (DCI ≤ 75), those from distressed communities were slightly younger (median 64 vs 66 years), more likely to be female (29.63% vs 24.27%), and of a minority race (70.6% vs 82.5% white). Patients from distressed communities were more likely to have a history of diabetes (51.5% vs 46.1%), to be current smokers (29.6% vs 21.6%), to have a history of chronic lung disease (25.9% vs 20.9%), and to receive an intra-aortic balloon pump intraoperatively (20.5% vs

TABLE 1. Baseline and operative factors by Distressed Communities Index quartile

Preoperative variables	DCI ≤ 75 (n = 437,847)	DCI > 75 (n = 138,053)	Standard difference	*P* value
Female	106,227 (24.3%)	40,885 (29.6%)	−0.12108	<.0001
White	355,757 (82.5%)	96,186 (70.6%)	0.42229	<.0001
Age (y)	66 [15]	64 [14]	−0.12665	<.0001
BMI	29.1 [7.3]	29.3 [7.6]	0.01976	<.0001
Diabetes mellitus	201,649 (46.1%)	70,935 (51.5%)	0.10750	<.0001
Hypertension	384,003 (87.8%)	124,789 (90.5%)	0.08771	<.0001
Chronic lung disease			0.13994	<.0001
Severe	17,683 (4.1%)	7206 (5.4%)		
Moderate	22,430 (5.2%)	8966 (6.7%)		
Mild	49,827 (11.6%)	18,525 (13.8%)		
Tobacco use			0.18583	<.0001
Current	94,120 (21.6%)	40,730 (29.6%)		
Former	114,641 (26.3%)	33,331 (24.3%)		
Peripheral vascular disease	58,449 (13.4%)	20,970 (15.3%)	0.05363	<.0001
Cerebrovascular disease	74,281 (17.0%)	26,265 (19.2%)	0.05484	<.0001
Congestive heart failure	74,386 (17.1%)	24,672 (18.0%)	0.02445	<.0001
No. of diseased vessels			0.00538	.5055
3	329,814 (75.7%)	103,960 (75.8%)		
2	86,723 (19.9)	27,118 (19.8%)		
1	18,717 (4.3%)	5909 (4.3%)		
Left main disease (>50% stenosis)	140,242 (40.2%)	42,120 (37.8%)	−0.04799	<.0001
Ejection fraction (%)	55 [15]	55 [15]	−0.05584	<.0001
Cardiogenic shock	6586 (1.5%)	2152 (1.6%)	0.00453	.1405
Procedure status			0.02612	<.0001
Emergency	20,023 (4.6%)	6186 (4.5%)		
Urgent	254,765 (58.2%)	82,085 (59.5%)		
STS risk of mortality (%)	1.85 ± 3.20	1.97 ± 3.26	0.03861	<.0001
STS risk of morbidity/mortality (%)	11.7 ± 11.2	12.8 ± 11.6	0.09662	<.0001
Cardiopulmonary bypass time (min)	89 [45]	87 [45]	−0.04231	<.0001
No. of arterial grafts			0.13066	<.0001
None	15,443 (3.5%)	6231 (4.5%)		
1	368,425 (84.4%)	119,787 (87.1%)		
No. of vein grafts			0.04187	<.0001
None	28,155 (6.5%)	7677 (5.6%)		
1	81,331 (18.8%)	25,325 (18.6%)		
2	171,269 (39.6%)	54,334 (39.8%)		

DCI, Distressed Communities Index; *BMI*, body mass index; *STS*, Society of Thoracic Surgeons.

TABLE 2. Outcomes by Distressed Communities Index quartile

Preoperative variables	DCI ≤ 75 (n = 437,847)	DCI > 75 (n = 138,053)	Standard difference	*P* value
Mortality	7948 (1.9%)	2962 (2.3%)	0.02755	<.0001
Major morbidity	46,401 (10.6%)	16,335 (11.9%)	0.03986	<.0001
Stroke	5347 (1.2%)	1924 (1.4%)	0.01525	<.0001
Renal failure	7979 (1.9%)	2864 (2.2%)	0.02034	<.0001
Prolonged ventilation	33,603 (7.7%)	12,068 (8.8%)	0.03925	<.0001
Deep sternal wound infection	1342 (0.3%)	479 (0.4%)	0.00718	.0182
Reoperation	9583 (2.2%)	3044 (2.2%)	0.00120	.6985
Long length of stay (>14 d)	19,365 (4.4%)	7109 (5.2%)	0.03405	<.0001
Composite morbidity/mortality	49,048 (11.2%)	17,294 (12.5%)	0.04109	<.0001

DCI, Distressed Communities Index.

16.5%). These characteristics all had at least a 10% standardized difference between the lower 75% and upper 25% DCI scores.

Unadjusted Outcomes of Distressed Communities Index With Coronary Artery Bypass Grafting Outcomes

Operative mortality (2.3% vs 1.9%) and major morbidity (11.9% vs 10.6%) were higher in the distressed community; however, the standard difference did not meet our threshold of significance of 10% (Table 2). Likewise, each component major morbidity except reoperation was higher in the distressed group then in the nondistressed cohort but again did not reach the 10% threshold. When modeling DCI as a continuous variable, we found that for each 10-unit increase in DCI there was a 4% increase in the relative risk of mortality (Table 3). For mortality/morbidity, we used 2 linear splines and demonstrated that for each 10-unit increase until 50 there was a 4% increase in risk of mortality/morbidity. For each 10-unit increase from 50 to 100, there was a 2% increase in the risk of mortality/morbidity. The impact from 50 to 100 was slightly less than from 0 to 50.

Interaction of Race and Distressed Communities Index Score on Coronary Bypass Grafting Outcomes

Median DCI scores differed by race with black (73.6 vs 48.9, $P < .0001$), Hispanic (61.1 vs 48.0, $P < .0001$), and Native American (68.4 vs 48.7, $P < .0001$) patients having higher distress compared with white patients. Univariate logistic regression demonstrated each race was associated with increased odds of both major morbidity/mortality and mortality (Table 4). After adjusting for continuous DCI in the same model, most of the race variables had a small decrease in their association with the outcome (Table 4). The largest percent change was seen for the effect of black race on odds of mortality (−6.15%). We did not see a change for Pacific Islander, and we found an increase in the odds for Asian race after DCI adjustment.

Risk-Adjusted Association of Distressed Communities Index With Coronary Artery Bypass Grafting Outcomes

When modeling DCI as a continuous variable, we found that for each 10-unit increase in DCI there was a 3% increase in the risk of mortality (Table 5). For mortality/morbidity, linear splines demonstrated that for each 10-unit increase until 50 there was a 2% increase in risk of mortality/morbidity. For each 10-unit increase from 50 to 100, there was a 0% increase in the risk of mortality/morbidity (Tables E2 and E3).

Finally, when continuous DCI (scaled by 10) was added to the isolated CABG mortality risk model, the AUC remained largely unchanged (0.79684 to 0.79765, difference 0.00081, $P < .0001$, NRI = 0.0785), whereas 5% and 3% of events and nonevents were reclassified correctly. For mortality/morbidity using continuous DCI (scaled by 10), the AUC also remained largely unchanged (0.73583 to 0.73597, difference 0.000147, $P = .0008$, NRI = 0.047439), but a large proportion of the patients were correctly reclassified (3% of events and 1% of nonevents) (Tables E4 and E5).

DISCUSSION

In this national cohort of patients undergoing CABG, increasing DCI scores, a composite measure of socioeconomic distress by ZIP code, correlated with increasing preoperative clinical risk and comorbid disease. Patients from distressed communities demonstrated worse outcomes after CABG. Univariate logistic regression demonstrated that DCI score is strongly associated with major morbidity and mortality after CABG. Furthermore, the DCI score is collinear with race as a common surrogate for SES; however, DCI is a stronger predictor of clinical outcomes in multivariate models than race. Finally, after risk adjustment, DCI remained independently associated with major morbidity and mortality after CABG, and its use led to correct reclassification of risk for a large number of patients.

A combination of patient-level and community-level factors demonstrated that patients from socioeconomically distressed communities had a higher preoperative risk with

TABLE 3. Unadjusted effects of Distressed Communities Index on Society of Thoracic Surgeons morbidity or mortality

Outcome	OR (95% CI)	*P* value
Mortality	1.04 (1.03-1.05)	<.0001
Mortality/morbidity (splines)		
DCI ≤ 50 (for each 10-point increase to 50)	1.04 (1.03-1.05)	<.0001
DCI ≥ 50 (for each 10-point increase from 50 to 100)	1.02 (1.01-1.03)	.0002

OR, Odds ratio; *CI*, confidence interval; *DCI*, Distressed Communities Index.

worse outcomes after CABG. At the community level, the DCI score is a measure of resources that includes medical providers and hospitals. Thus, distressed communities will ultimately have more limited access to care. Several studies have identified a strong relationship between access to care and surgical outcomes, particularly in the failure to rescue after adverse events.[20-23] Shi and colleagues[24] demonstrated that patients from rural settings have worse outcomes after CABG that are likely secondary to access to resources, including primary care and advanced surgical support. These effects are difficult to truly characterize because patients from distressed communities have been shown to have higher rates of comorbid disease and more advanced heart disease, which would portend worse outcomes. However, their outcomes are worse than expected even when accounting for baseline risk. The DCI represents an ideal tool to account for these risks and provide optimal risk stratification.

Race is a commonly used surrogate for socioeconomic risk adjustment in outcomes research and correlates with outcomes in surgical and medical populations.[25] However, a study by Koch and colleagues[26] at the Cleveland Clinic highlighted that race may be a surrogate for SES, but outcomes after cardiac surgery are more strongly related to direct measures of SES than race itself. The authors evaluated the interaction among race, gender, and socioeconomic position (SEP) and found that lower SEP was associated with black race and female gender, but when assessed separately, their measure of SEP was more strongly associated with outcomes after cardiac surgery and long-term survival. Although the relationship between race and SES is complex, our study corroborates the results of Koch and colleagues,[26] demonstrating DCI as a stronger predictor of outcomes than race. Although these variables interact collinearly, we have demonstrated it is important to use a measure like DCI that provides a more robust evaluation of community and patient-level SES rather than a surrogate such as race.

The STS risk model is the gold standard for surgical risk adjustment based on validated data in the national dataset. However, the current model does not account for SES factors aside from the proxies' race and gender. Given the large body of research demonstrating a strong association between SES and outcomes in surgical populations including those undergoing cardiac surgery, it is prudent to consider how this can be incorporated into the national database.[2,4,27-31] Work by the University of Virginia Center for Health Policy has demonstrated the utility of DCI as a risk-adjustment tool in cardiac, vascular, bariatric, and general surgery populations.[13-17] Cardiac surgeons have led the way in quality reporting and risk prediction models over the past 3 decades, and integration of the DCI score into the STS data provides another opportunity for continued improvement and leadership in the area of healthcare disparities.[32-35] Conveniently, the DCI score is a Health Insurance Portability and Accountability Act–compliant measure of SES by ZIP code that can be easily integrated into national databases and cost models to provide SES risk adjustment.

Study Limitations

This study is limited by its retrospective nature precluding determination of causality. Although the DCI is a comprehensive socioeconomic metric developed by an independent organization, it is based on ZIP code, which prohibits calculation of patient-specific risk profiles. However, the DCI includes community-based factors, which affect access to care and are arguably just as important as patient-specific socioeconomic factors. The DCI scores used in this analysis were calculated from a single census report and thus do not account for changes over time within communities. Finally, 20% of the population was excluded for missing ZIP code, which may introduce selection bias into this retrospective study.

CONCLUSIONS

Increasing DCI, an established composite metric for community-level socioeconomic distress, is independently associated with morbidity and mortality after CABG. We demonstrate patients from distressed communities are at increased surgical risk over and above what traditional risk

TABLE 4. Effects of race and Distressed Communities Index on morbidity or mortality

Outcome	Race	ORs (95% CI)	*P* value	AORs (95% CI)*	*P* value	% Change
Mortality	Black	1.30 (1.22-1.39)	<.0001	1.22 (1.14-1.30)	<.0001	−6.15
Mortality and morbidity	Black	1.50 (1.43-1.57)	<.0001	1.44 (1.38-1.51)	<.0001	−4.00
	Hispanic	1.18 (1.12-1.25)	<.0001	1.16 (1.10-1.22)	<.0001	−1.69
	Asian	1.17 (1.09-1.25)	<.0001	1.20 (1.12-1.29)	<.0001	2.56
	Native American	1.18 (1.04-1.33)	.0078	1.14 (1.01-1.29)	.0374	−3.39
	Pacific Islander	1.45 (1.23-1.70)	<.0001	1.45 (1.24-1.71)	<.0001	0.00

OR, Odds ratio; *CI*, confidence interval; *AOR*, adjusted odds ratio. *Adjusted OR including DCI in the model.

TABLE 5. Risk-adjusted effects of Distressed Communities Index on Society of Thoracic Surgeons morbidity or mortality

Outcome	OR (95% CI)	*P* value
Mortality	1.03 (1.02-1.04)	<.0001
Mortality/morbidity (splines)		
DCI $\leq$ 50 (for each 10-point increase to 50)	1.02 (1.01-1.02)	<.0001
DCI $\geq$ 50 (for each 10-point increase from 50 to 100)	1.00 (0.99-1.01)	.12

OR, Odds ratio; *CI*, confidence interval; *DCI*, Distressed Communities Index.

calculators predict. In addition, although the DCI is collinear with race, we highlight it is a stronger predictor of outcomes after CABG when adjusting for SES. Therefore, DCI may provide a more holistic assessment of SES and should be considered when building risk models, evaluating resource use, and comparing hospitals. Finally, in the era of bundled payments and accountable care organizations, it is important to understand and account for patient and community SES when building cost and reimbursement models.

Webcast

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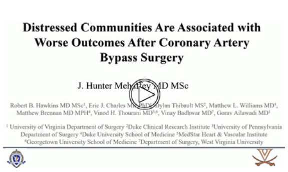

Conflict of Interest Statement

Authors have nothing to disclose with regard to commercial support. The findings expressed in this manuscript are solely those of the listed authors and not necessarily those of The Economic Innovation Group. The Economic Innovation Group does not guarantee the accuracy or reliability of, or necessarily agree with, the information provided herein.

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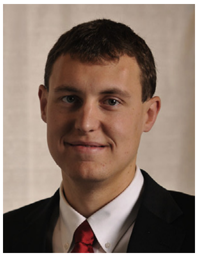
Key Words: CABG, DCI, health outcome disparities, socioeconomic status

Discussion

Dr Julie A. Swain *(New York, NY)*. In the early 1980s, our renal transplant colleagues taught us that for graft survival and patient survival one of the most important determinants was socioeconomic class, and we have since not done much with that. That needs to change a great deal.

Dr Jeffrey B. Rich *(Virginia Beach, Va)*. I congratulate you on taking the analytics to the next level. One of the challenges is converting this information to real action steps in terms of thinking about what variables preoperatively, perioperatively, and postoperatively affect outcome now that you know in these distressed communities there is a deficiency.

Do you have any insight about that, or how do you expect to explore that as a next step, because that's where we need to be leveraging this information. Fantastic as it is, now we have to figure out on action steps to execute.



Dr J. Hunter Mehaffey *(Charlottesville, Va)*. Absolutely, I think this is a really critical point that you raise. The nice thing about DCI is that it really just looks at the community level. There are wealthy patients from poor communities and poor patients from wealthy communities, but what DCI is really measuring is the resources in that area. Hospitals are looking at where are we going to put our outreach clinic, where are we going to focus our resources to prevent adverse event. Maybe these people should be going to a skilled nursing facility first before they go back home. I think it's metrics like this that we should be using to determine our resource allocation.

Dr Rich. You may argue that some of the disease manifestations in those distressed communities where they don't have preoperative diabetic care and postoperative hypertension are variables that are important from a medical standpoint as much as a process and a provider standpoint. I look forward to your further investigation of that. Great work.

Dr Valavanur A. Subramanian *(New York, NY)*. I was part of the New York Cardiac Advisory Committee for 12 years, and during this period we did some studies to look at access to care in the so-called distressed community. By the way, the distressed community index costs approximately $65,000. That's not bad, actually. Most of the young people earn only a little less than that now.

But we looked at the East Bronx. It was striking that true access to care at least was very compromised, age, family value, and the culture issues we looked at, and we looked at once you recommended treatment can you follow through with that.

I think this goes beyond coronary bypass care, because we don't have the denominator, because a lot of these people are denied or they deny, self-denial. So we have a bigger problem in our healthcare policy to look at the denominator where the surgeons deny, because bundled payer and the readmission rates are all going to be high in that population. I don't know how to address that, because that's a bigger problem. We deny a lot of patients for access to care that we think is appropriate.

Dr Mehaffey. That's an excellent point. As Dr Rich mentioned, we did start looking at several different populations in the Virginia cardiac surgery population but also other surgical populations, because I think surgeons lead the movement in collecting patient data and following outcomes. We are starting to work with some of our medicine colleagues at the University of Virginia in our Health Policy Institute to look at medical outcomes and things like heart failure readmissions using the DCI as a way to stratify these patients, because I think you make a great point: A lot of these folks have such limited access they never even make it to surgery.

Dr Thomas V. Bilfinger *(Stony Brook, NY).* Is there an association between the STS Predicted Risk of Mortality and the specific subcomponents of the DCI or is there an explanation why you chose not to look into that? In other words, do you verify the independence of the DCI components with the major risk factors used in the STS risk model, because you showed that the DCI as a whole is an independent risk factor but not the subcomponents?

Dr Mehaffey. Correct.

Dr Bilfinger. So the second question I have is, for the purpose of this study patients were assumed to have equal access to local cardiac surgical care despite their own ZIP code, although in the model, hospital was adjusted for as a random effect. Were other confounders such as distance traveled, DCI score of the hospital ZIP code, the hospital, and so forth explored, because I would argue that the hospital component alone is not the only reason for the problem we are having.

The DCI was made up in 2014 for the sake of a political discussion. It is a snapshot in time made up from temporarily disparate data and not available as contemporaneous point-of-care data, which is the hallmark of the STS model. So how do you propose to deal with that shortcoming of the DCI going forward?

Dr Mehaffey. These are all excellent questions. I will answer them in reverse order. First, the economic innovation group is a think tank outside of Washington, DC, and this highlights the importance of collaboration. They put forth an idea, a proof of concept, and we took that and applied it to real patient-level data, and I think this environment of collaboration should continue. I certainly wouldn't argue that DCI is the end all, be all, but I think that taking measures from census data, from publicly reported data and stratifying these communities is critical and will be critical to moving forward.

Your second question about travel distance and location of the specific hospital, we were not able to look at those factors in the national data set. However, we have explored this in the Virginia collaborative and found some interesting findings that are currently under review for publication. We demonstrated when patients travel beyond their closest center, they usually are higher risk but actually do really well. So I think there are some factors that we weren't able to get into with the national data that our group is certainly working on. I think those are excellent questions.

And then your first question was about collinearity of variables in DCI and the STS model. Absolutely. That's why we highlighted the relationship between DCI and race. For years our modeling has used surrogates for SES like insurance status and race, but I think that the point of this talk and this work is to show that we have to move beyond that. If we can't get patient-level economic data and adjust for those specific factors, maybe we can look at the community level, because those data are Health Insurance Portability and Accountability Act compliant, available for a wide variety of patients and easily implementable into a risk model. But I think those are all excellent points, and I appreciate your comments.

Dr Rich. But if you bring this all together, back to Bob Higgins' point and Dr Subramanian's point, maybe we ought to have a patient distress index, because there is a socioeconomic DCI, and our next article is going to discuss the lack of insurance. And your point about access. So maybe access, lack of insurance, plus a DCI will give us a more holistic picture of our patient, and we would be able to do better risk modeling, because, as you said, wealthy people live in DCIs and poor people live in non-DCI communities. So it might be important to bring this down from the patient level.

Dr Subramanian. I guess one of the questions is, how do you get away from census data, which we only had every 10 years? That's a problem.

Dr Mehaffey. That's something I can tell you the UVA Health Policy Institute is working on, aggressively looking at all types of measures, looking at payer status through our hospital economic office, travel distance, and community factors. However, the short answer is it's really difficult but we are going to continue to work on that, because I do think it is critical for our path forward in healthcare.

Dr David M. Shahian *(Boston, Mass).* In response to that last comment, STS is negotiating a contract with an external vendor that would provide us with a very robust socioeconomic index for every patient in the STS database.

I would favor adjusting for these factors for cost measures. It is more debatable whether one should adjust for them in clinical quality outcomes, because that basically justifies poorer outcomes for vulnerable, disadvantaged, or minority patients. That's wrong, certainly for short-term outcomes like mortality. On the other hand, for readmissions, it is very reasonable to account for socioeconomic and sociodemographic factors, because these have a significant impact on the probability of readmission and they are often out of the hospital's control. But even for readmission, we don't want to simply accept that because a patient comes from a disadvantaged area they are going to be readmitted more often. Rather, we should be targeting such patients for enhanced follow-up, perhaps even sending nurses or physician assistants into the community, checking their wounds, making sure they are getting the right medications, assuring they have transportation back to their follow-up appointments, and providing other types of assistance.

Dr Mehaffey. Absolutely. That's a good point that needs more attention. However, as we move into bundled payments and tying reimbursement to outcomes, it is critical to adjust for these factors.

TABLE E1. Study population compared with all patients

Preoperative variables	All patients (n = 930,640)	DCI patients (n = 575,900)	Standard difference	*P* value
Female	147,112 (25.6%)	88,018 (24.8%)	0.01683	<.0001
White	451,943 (79.6%)	278,447 (79.6%)	0.04933	.0053
Age (y)	65 [14]	66 [14]	0.01869	<.0001
BMI*	29.2 [7.3]	29.1 [7.3]	−0.00338	.0018
Diabetes mellitus	272,584 (47.4%)	167,159 (47.2%)	−0.00388	.0694
Hypertension	508,792 (88.5%)	312,611 (88.3%)	−0.00644	.2324
Chronic lung disease			0.04951	<.0001
Severe	24,889 (4.4%)	13,810 (4.0%)		
Moderate	31,396 (5.6%)	17,782 (5.1%)		
Mild	68,352 (12.1)	38,322 (11.0%)		
Tobacco use			0.02763	<.0001
Current	134,850 (23.5%)	79,322 (22.5%)		
Former	147,972 (25.8%)	94,103 (26.7%)		
Peripheral vascular disease	494,359 (86.2%)	303,679 (86.0%)	0.00512	.0166
Cerebrovascular disease	62,797 (17.6%)	62,797 (17.8%)	0.00594	.0055
Congestive heart failure	99,058 (17.3%)	65,390 (18.5%)	0.03244	.0242
No. of diseased vessels			0.02512	<.0001
3	433,774 (75.7%)	270,265 (76.6%)		
2	113,841 (19.9%)	68,125 (19.3%)		
1	24,626 (4.3%)	13,834 (3.9%)		
Left main disease (>50% stenosis)	182,362 (39.6%)	116,001 (41.5%)	0.03738	<.0001
Ejection fraction (%)	55 [15]	55 [15]	−0.00343	.8924
Cardiogenic shock	8738 (1.5%)	5773 (1.6%)	0.00894	<.0001
Procedure status			0.03101	<.0001
Emergency	26,209 (4.6%)	16,032 (4.5%)		
Urgent	336,850 (58.5%)	202,284 (57.1%)		
STS risk of mortality (%)	1.88 ± 3.21	1.91 ± 3.34	0.00916	.0100
STS risk of morbidity/mortality (%)	12.0 ± 11.3	12.1 ± 11.5	0.01211	.0100
Cardiopulmonary bypass time (min)	89 [44]	89 [45]	−0.00215	.1337
No. of arterial grafts			0.01023	.4120
None	21,674 (3.8%)	12,939 (3.7%)		
1	488,212 (85.0%)	299,026 (85.2%)		
No. of vein grafts			0.01093	.1797
None	35,832 (6.3%)	22,194 (6.4%)		
1	106,656 (18.7%)	64,938 (18.6%)		
2	225,603 (39.6%)	138,865 (39.9%)		
Mortality	10,910 (2.0%)	6871 (2.1%)	0.00592	.0076
Major morbidity	62,736 (10.9%)	41,044 (11.6%)	0.02124	<.0001
Stroke	7271 (1.3%)	4684 (1.3%)	0.00514	.0158
Renal failure	10,843 (2.0%)	7287 (2.1%)	0.01312	<.0001
Prolonged ventilation	45,671 (8.0%)	30,242 (8.5%)	0.02154	<.0001
Deep sternal wound infection	1821 (0.3%)	1073 (0.3%)	−0.00249	.2460
Reoperation	12,627 (2.2%)	8098 (2.3%)	0.00617	.0038
Long length of stay (>14 d)	26,474 (4.6%)	17,971 (5.1%)	0.02192	<.0001
Composite morbidity/mortality	66,342 (11.5%)	43,169 (12.2%)	0.02019	<.0001

DCI, Distressed Communities Index; *BMI*, body mass index; *STS*, Society of Thoracic Surgeons. *Statistically significant with $P < .05$.

TABLE E2. Full regression model for mortality without Distressed Communities Index

Variable	OR (95% CI)	Standard error	*P* value
BSA quadratic	3.55	0.1312	<.0001
Dialysis	2.595	0.0445	<.0001
Emergency salvage	2.579	0.1083	<.0001
Previous CAB	2.446	0.2359	.0001
Creatinine change of slope at 1.0	2.258	0.1483	<.0001
Shock or ECMO or catheter-based assist	2.237	0.0453	<.0001
Tricuspid insufficiency - severe	2.15	0.1044	<.0001
Emergency	2.084	0.0482	<.0001
Recent CVA	1.961	0.1212	<.0001
CLD - severe	1.739	0.0351	<.0001
Home oxygen	1.598	0.0499	<.0001
Liver disease	1.58	0.0479	<.0001
Recent continuous atrial fibrillation	1.514	0.0561	<.0001
Aortic insufficiency - severe	1.457	0.3111	.2263
MI ≤6 h	1.43	0.0705	<.0001
Inotrope	1.415	0.0479	<.0001
Mitral insufficiency - severe	1.414	0.0883	<.0001
PVD	1.381	0.0247	<.0001
Recent third-degree HB	1.35	0.1084	.0056
PCI within episode of care within 6 h of surgery	1.34	0.0694	<.0001
Recent paroxysmal atrial fibrillation	1.337	0.0366	<.0001
Female	1.331	0.0317	<.0001
Medicare + Medicaid (age <65 y)	1.324	0.0717	<.0001
MI 6-24 h	1.319	0.0613	<.0001
Tricuspid insufficiency - moderate	1.313	0.043	<.0001
Recent CHF NYHA IV	1.294	0.0362	<.0001
CLD - moderate	1.291	0.0376	<.0001
Remote CVA	1.269	0.0332	<.0001
Medicare without Medicaid (age <65 y)	1.256	0.0487	<.0001
Mitral stenosis	1.248	0.1036	.0325
Cardiac presentation on admission - STEMI	1.245	0.0568	.0001
Aortic insufficiency - moderate	1.236	0.0642	.001
Mediastinal radiation	1.223	0.088	.0223

(Continued)

TABLE E2. Continued

Variable	OR (95% CI)	Standard error	*P* value
Carotid stenosis - double side	1.222	0.1299	.1225
Recent CHF NYHA I-III	1.22	0.0272	<.0001
CVD without CVA or TIA	1.201	0.0368	<.0001
Steroid	1.196	0.0498	.0003
Prior HF	1.191	0.0435	<.0001
Self/none only (age <65 y)	1.19	0.0573	.0024
Unresponsive neurologic status	1.188	0.1181	.1457
Recent ventricular fibrillation	1.182	0.0531	.0016
Black	1.182	0.0344	<.0001
MI 1-21 d	1.17	0.0413	.0001
Immunosuppressive treatment	1.164	0.0496	.0022
Medicaid without Medicare (age <65 y)	1.143	0.0557	.0165
No. of diseased vessels	1.138	0.0205	<.0001
Glycoprotein IIb/IIIa inhibitor	1.137	0.0565	.023
Platelets quadratic	1.132	0.0142	<.0001
Syncope	1.13	0.0465	.0086
Urgent	1.126	0.0281	<.0001
Previous carotid surgery	1.123	0.0461	.0117
Creatinine linear	1.11	0.1007	.299
Aortic stenosis	1.106	0.0475	.0341
Mitral insufficiency - moderate	1.098	0.0338	.0058
TIA	1.091	0.0524	.0959
Diabetes with insulin	1.089	0.0278	.0022
Remote arrhythmia	1.089	0.06	.1574
Left main disease	1.084	0.0213	.0002
WBC linear spline function max (6.6, 0)	1.077	0.00388	<.0001
CLD - mild	1.067	0.0312	.0381
PCI before the episode of care	1.054	0.0246	.0329
Cardiac presentation on admission - non-STEMI	1.051	0.0475	.2952
ADP within 5 d	1.043	0.0448	.3473
Preoperative IABP	1.034	0.033	.3124
Age change of slope at 60	1.026	0.00649	<.0001
Age change of slope at 50	1.025	0.00484	<.0001
PCI within episode not within 6 h of surgery	1.019	0.0534	.722
HCT linear* female	1.017	0.00393	<.0001
BMI linear	1.01	0.00294	.0004
Alcohol 8+/wk	1.004	0.0446	.9241
Age change of slope at 75 y	1.002	0.00551	.7653

(Continued)

TABLE E2. Continued

Variable	OR (95% CI)	Standard error	*P* value
BMI quadratic	1.002	0.000186	<.0001
Cardiac presentation on admission - unstable angina	0.996	0.0343	.9019
HCT linear	0.984	0.00242	<.0001
Discontinuation timing of ADP	0.982	0.0166	.2644
Ejection fraction truncated at 50	0.977	0.00112	<.0001
Recent second-degree HB or SSS	0.946	0.137	.683
Commercial/HMO w/o Medicare/Medicaid (age 65+ y)	0.935	0.0425	.1139
Diabetes with oral control	0.923	0.0268	.0028
Diabetes with other control	0.901	0.0588	.0771
Alcohol 2-7/wk	0.872	0.0384	.0004
Cardiac presentation on admission - stable angina	0.833	0.0436	<.0001
Platelets linear	0.798	0.0182	<.0001
Creatinine change of slope at 1.5	0.482	0.0871	<.0001
BSA linear	0.39	0.0917	<.0001

OR, Odds ratio; *CI*, confidence interval; *BSA*, body surface area; *CAB*, coronary artery bypass; *ECMO*, extracorporeal membrane oxygenation; *CVA*, cerebrovascular accident; *CLD*, chronic lung disease; *MI*, myocardial infarction; *PVD*, peripheral vascular disease; *HB*, heart block; *CHF*, congestive heart failure; *NYHA*, New York Heart Association; *STEMI*, ST-elevation myocardial infarction; *CVD*, cardiovascular disease; *TIA*, transient ischemic attack; *WBC*, white blood cell; *PCI*, percutaneous coronary intervention; *IABP*, intra-aortic balloon pump; *HCT*, hematocrit; *BMI*, body mass index; *SSS*, sick sinus syndrome; *HMO*, Health Maintenance Organization. *Statistically significant with $P < .05$.

TABLE E3. Full regression model for mortality with Distressed Communities Index

Variable	OR (95% CI)	Standard error	*P* value
BSA quadratic	3.579	0.1312	<.0001
Dialysis	2.605	0.0445	<.0001
Emergency salvage	2.58	0.1084	<.0001
Previous CAB	2.437	0.2358	.0002
Creatinine change of slope at 1.0	2.243	0.1483	<.0001
Shock or ECMO or catheter-based assist	2.235	0.0453	<.0001
Tricuspid insufficiency - severe	2.148	0.1044	<.0001
Emergency	2.088	0.0482	<.0001
Recent CVA	1.963	0.1212	<.0001
CLD - severe	1.724	0.0351	<.0001
Home oxygen	1.584	0.0499	<.0001
Liver disease	1.574	0.0479	<.0001
Recent continuous atrial fibrillation	1.52	0.0561	<.0001
Aortic insufficiency - severe	1.457	0.3114	.2269
MI ≤6 h	1.435	0.0704	<.0001
Inotrope	1.416	0.0479	<.0001
Mitral insufficiency - severe	1.413	0.0884	<.0001
PVD	1.377	0.0247	<.0001
Recent third-degree HB	1.355	0.1084	.0051
PCI within episode of care within 6 h of surgery	1.34	0.0695	<.0001
Recent paroxysmal atrial fibrillation	1.339	0.0366	<.0001
Female	1.325	0.0317	<.0001
MI 6-24 h	1.322	0.0613	<.0001
Tricuspid insufficiency - moderate	1.314	0.043	<.0001
Recent CHF NYHA IV	1.298	0.0362	<.0001
Medicare + Medicaid (age <65 y)	1.282	0.0718	.0005
CLD - moderate	1.28	0.0376	<.0001
Remote CVA	1.263	0.0332	<.0001
Mitral stenosis	1.249	0.1036	.0321
Aortic insufficiency - moderate	1.236	0.0642	.001
Medicare without Medicaid (age <65 y)	1.233	0.0487	<.0001
Cardiac presentation on admission - STEMI	1.232	0.0568	.0002
Mediastinal radiation	1.231	0.088	.0182
Recent CHF NYHA I-III	1.221	0.0272	<.0001
Carotid stenosis - double side	1.211	0.1299	.1408
CVD without CVA or TIA	1.198	0.0368	<.0001
Unresponsive neurologic status	1.193	0.1183	.1356

(Continued)

TABLE E3. Continued

Variable	OR (95% CI)	Standard error	*P* value
Steroid	1.191	0.0498	.0004
Prior HF	1.189	0.0435	<.0001
Recent ventricular fibrillation	1.188	0.0531	.0012
Immunosuppressive treatment	1.174	0.0496	.0012
MI 1-21 d	1.17	0.0413	.0001
Self/none only (age <65 y)	1.166	0.0574	.0073
No. of diseased vessels	1.138	0.0205	<.0001
Glycoprotein IIb/IIIa inhibitor	1.136	0.0565	.0241
Platelets quadratic	1.133	0.0142	<.0001
Urgent	1.13	0.0281	<.0001
Syncope	1.128	0.0465	.0096
Black	1.127	0.0349	.0006
Previous carotid surgery	1.125	0.0461	.0107
Medicaid without Medicare (age <65 y)	1.114	0.0558	.0536
Creatinine linear	1.113	0.1007	.2873
Aortic stenosis	1.108	0.0475	.0304
Mitral insufficiency - moderate	1.1	0.0338	.005
Remote arrhythmia	1.094	0.06	.1356
TIA	1.091	0.0525	.0968
Diabetes with insulin	1.086	0.0278	.003
Left main disease	1.086	0.0213	.0001
WBC linear spline function max (6.6, 0)	1.076	0.00388	<.0001
CLD - mild	1.06	0.0312	.0602
PCI before the episode of care	1.055	0.0246	.0301
ADP within 5 d	1.046	0.0448	.3182
Cardiac presentation on admission - non-STEMI	1.041	0.0475	.403
Preoperative IABP	1.04	0.033	.238
Continuous DCI (10-point scale)	1.03	0.00359	<.0001
Age change of slope at 50	1.026	0.00484	<.0001
Age change of slope at 60	1.026	0.0065	<.0001
PCI within episode not within 6 h of surgery	1.021	0.0534	.7024
HCT linear* female	1.017	0.00393	<.0001
Alcohol 8+/wk	1.011	0.0447	.8096
BMI linear	1.011	0.00294	.0004
Age change of slope at 75	1.003	0.00551	.6127
BMI quadratic	1.002	0.000186	<.0001
Cardiac presentation on admission - unstable angina	0.987	0.0343	.7063
HCT linear	0.984	0.00242	<.0001
Discontinuation timing of ADP	0.981	0.0166	.2597

(Continued)

TABLE E3. Continued

Variable	OR (95% CI)	Standard error	*P* value
Ejection fraction truncated at 50	0.977	0.00112	<.0001
Recent second-degree HB or SSS	0.942	0.1371	.6607
Commercial/HMO w/o Medicare/ Medicaid (age 65+)	0.941	0.0425	.1531
Diabetes with oral control	0.92	0.0268	.0019
Diabetes with other control	0.901	0.0588	.077
Alcohol 2-7/wk	0.885	0.0384	.0016
Cardiac presentation on admission - stable angina	0.831	0.0436	<.0001
Platelets linear	0.798	0.0182	<.0001
Creatinine change of slope at 1.5	0.485	0.0871	<.0001
BSA linear	0.39	0.0917	<.0001

OR, Odds ratio; *CI*, confidence interval; *BSA*, body surface area; *CAB*, coronary artery bypass; *ECMO*, extracorporeal membrane oxygenation; *CVA*, cerebrovascular accident; *CLD*, chronic lung disease; *MI*, myocardial infarction; *PVD*, peripheral vascular disease; *HB*, heart block; *PCI*, percutaneous coronary intervention; *CHF*, congestive heart failure; *NYHA*, New York Heart Association; *STEMI*, ST-elevation myocardial infarction; *CVD*, cardiovascular disease; *TIA*, transient ischemic attack; *HF*, heart failure; *WBC*, white blood cell; *IABP*, intra-aortic balloon pump; *DCI*, Distressed Communities Index; *HCT*, hematocrit; *BMI*, body mass index; *SSS*, sick sinus syndrome; *HMO*, Health Maintenance Organization. *Statistically significant with $P < .05$.

TABLE E4. Full regression model for morbidity/mortality without Distressed Communities Index

Variable	OR (95% CI)	Standard error	*P* value
BSA quadratic	2.798	0.0597	<.0001
Emergency salvage	2.497	0.0766	<.0001
Shock or ECMO or catheter-based assist	2.111	0.0271	<.0001
Preoperative IABP	2.064	0.0147	<.0001
Creatinine change of slope at 1.0	1.959	0.0632	<.0001
Dialysis	1.949	0.0229	<.0001
Emergency	1.739	0.0231	<.0001
Previous CAB	1.708	0.1264	<.0001
CLD - severe	1.658	0.0176	<.0001
Recent CVA	1.645	0.0645	<.0001
Tricuspid insufficiency - severe	1.619	0.0712	<.0001
Inotrope	1.578	0.0286	<.0001
Recent CHF NYHA IV	1.445	0.0186	<.0001
Recent continuous atrial fibrillation	1.413	0.0301	<.0001
Previous aortic valve procedure	1.395	0.413	.4198
Home oxygen	1.36	0.0271	<.0001
Carotid stenosis - double side	1.356	0.0641	<.0001
Unresponsive neurologic status	1.354	0.0732	<.0001
Recent third-degree HB	1.351	0.0626	<.0001
Black	1.313	0.015	<.0001
CLD - moderate	1.299	0.0172	<.0001
MI ≤6 h	1.287	0.0368	<.0001
Remote CVA	1.286	0.0153	<.0001
Pacific Islander	1.271	0.0786	.0023
MI 6-24 h	1.27	0.029	<.0001
Medicare + Medicaid (age <65 y)	1.264	0.0301	<.0001
Liver disease	1.25	0.0236	<.0001
PVD	1.227	0.0118	<.0001
ADP within 5 d	1.223	0.0208	<.0001
Recent CHF NYHA I-III	1.222	0.0123	<.0001
Aortic insufficiency - severe	1.218	0.1754	.2605
Mitral insufficiency - severe	1.217	0.0533	.0002
Other payor (age <65 y)	1.197	0.0323	<.0001
Steroid	1.193	0.0251	<.0001
Recent paroxysmal atrial fibrillation	1.189	0.0191	<.0001
	1.184	0.0233	<.0001

(Continued)

TABLE E4. Continued

Variable	OR (95% CI)	Standard error	*P* value
Tricuspid insufficiency - moderate			
Glycoprotein IIb/IIIa Inhibitor	1.182	0.0257	<.0001
Aortic insufficiency - moderate	1.178	0.0332	<.0001
Alcohol 8+/wk	1.178	0.0177	<.0001
Carotid stenosis - single side	1.168	0.029	<.0001
No. of diseased vessels	1.161	0.00866	<.0001
Current smoker	1.155	0.0119	<.0001
Creatinine linear	1.154	0.0419	.0007
Medicare without Medicaid (age <65 y)	1.147	0.0198	<.0001
Diabetes with insulin	1.146	0.0125	<.0001
Diabetes with no control	1.146	0.0189	<.0001
Asian	1.143	0.026	<.0001
Medicaid without Medicare (age <65 y)	1.143	0.0208	<.0001
Prior HF	1.142	0.0198	<.0001
Recent ventricular fibrillation	1.141	0.0267	<.0001
Recent second-degree HB or SSS	1.14	0.0611	.0313
CLD - mild	1.137	0.0132	<.0001
Female	1.135	0.0143	<.0001
PCI within episode of care within 6 h of surgery	1.131	0.0392	.0017
Self/none only (age <65 y)	1.125	0.0216	<.0001
TIA	1.107	0.0237	<.0001
Other payor (age 65+ y)	1.1	0.0298	.0014
MI 1-21 d	1.095	0.0184	<.0001
Native American	1.094	0.0576	.1197
Non-black Hispanic	1.093	0.0174	<.0001
Urgent	1.093	0.0114	<.0001
Cardiac presentation on admission - STEMI	1.085	0.0259	.0016
Recent pneumonia	1.084	0.0218	.0002
Medicare + Medicaid (age 65+ y)	1.082	0.0228	.0006
Remote arrhythmia	1.08	0.028	.0058
Platelets quadratic	1.078	0.00664	<.0001
Mitral insufficiency - moderate	1.076	0.017	<.0001
CVD without CVA or TIA	1.074	0.0172	<.0001
Immunosuppressive treatment	1.063	0.0246	.013
	1.059	0.00189	<.0001

(Continued)

TABLE E4. Continued

Variable	OR (95% CI)	Standard error	*P* value
WBC linear spline function max (6.6, 0)			
Syncope	1.057	0.0224	.0137
Hypertension	1.055	0.015	.0003
Sleep apnea	1.044	0.0139	.0018
Left main disease	1.036	0.0094	.0002
BMI linear	1.026	0.00136	<.0001
Age change of slope at 60	1.022	0.00154	<.0001
Any previous cardiac intervention	1.02	0.0099	.0435
HCT linear* female	1.011	0.00192	<.0001
Age linear	1.006	0.00117	<.0001
Cardiac presentation on admission - non-STEMI	1.001	0.0212	.9793
BMI quadratic	1.001	0.000086	<.0001
HCT quadratic	1.001	0.000119	<.0001
Diabetes with oral control	0.986	0.0117	.2425
HCT linear	0.985	0.00104	<.0001
Ejection fraction truncated at 50	0.982	0.000541	<.0001
Previous smoker	0.974	0.0108	.014
Family history of CAD	0.97	0.0104	.0031
Cardiac presentation on admission - unstable angina	0.965	0.0142	.0117
Discontinuation timing of ADP	0.965	0.00743	<.0001
Diabetes with other control	0.963	0.0256	.1353
Alcohol 2-7/wk	0.916	0.0155	<.0001
Previous ICD	0.915	0.0418	.0344
Cardiac presentation on admission - stable angina	0.897	0.017	<.0001
Platelets linear	0.866	0.00842	<.0001
Creatinine change of slope at 1.5	0.703	0.0397	<.0001
BSA linear	0.465	0.0439	<.0001

OR, Odds ratio; *CI*, confidence interval; *BSA*, body surface area; *ECMO*, extracorporeal membrane oxygenation; *IABP*, intra-aortic balloon pump; *CAB*, coronary artery bypass; *CLD*, chronic lung disease; *CVA*, cerebrovascular accident; *CHF*, congestive heart failure; *NYHA*, New York Heart Association; *HB*, heart block; *MI*, myocardial infarction; *PVD*, peripheral vascular disease; *HF*, heart failure; *SSS*, sick sinus syndrome; *PCI*, percutaneous coronary intervention; *TIA*, transient ischemic attack; *STEMI*, ST-elevation myocardial infarction; *CVD*, cardiovascular disease; *WBC*, white blood cell; *HCT*, hematocrit; *BMI*, body mass index; *ICD*, implantable cardioverter defibrillator. *Statistically significant with $P < .05$.

TABLE E5. Full regression model for morbidity/mortality without Distressed Communities Index

Variable	OR (95% CI)	Standard error	*P* value
BSA quadratic	2.801	0.0597	<.0001
Emergency salvage	2.5	0.0766	<.0001
Shock or ECMO or catheter-based assist	2.111	0.0271	<.0001
Preoperative IABP	2.068	0.0148	<.0001
Creatinine change of slope at 1.0	1.954	0.0632	<.0001
Dialysis	1.952	0.0229	<.0001
Emergency	1.739	0.0231	<.0001
Previous CAB	1.705	0.1264	<.0001
CLD - severe	1.652	0.0176	<.0001
Recent CVA	1.646	0.0645	<.0001
Tricuspid insufficiency - severe	1.618	0.0712	<.0001
Inotrope	1.579	0.0286	<.0001
Recent CHF NYHA IV	1.446	0.0186	<.0001
Recent continuous atrial fibrillation	1.415	0.0301	<.0001
Previous AV procedure	1.406	0.4129	.4092
Unresponsive neurologic status	1.357	0.0732	<.0001
Home oxygen	1.356	0.0271	<.0001
Carotid stenosis - double side	1.352	0.0641	<.0001
Recent third-degree HB	1.351	0.0626	<.0001
CLD - moderate	1.295	0.0172	<.0001
Black	1.294	0.0152	<.0001
MI ≤6 h	1.289	0.0368	<.0001
Remote CVA	1.284	0.0153	<.0001
Pacific Islander	1.277	0.0786	.0019
MI 6-24 h	1.271	0.029	<.0001
Liver disease	1.249	0.0236	<.0001
Medicare + Medicaid (age <65 y)	1.249	0.0302	<.0001
PVD	1.227	0.0118	<.0001
ADP within 5 d	1.224	0.0208	<.0001
Recent CHF NYHA I-III	1.223	0.0123	<.0001
Aortic insufficiency - severe	1.22	0.1754	.2567
Mitral insufficiency - severe	1.217	0.0533	.0002
Steroid	1.191	0.0251	<.0001
Recent paroxysmal atrial fibrillation	1.189	0.0191	<.0001
Other payor (age <65 y)	1.187	0.0324	<.0001
Tricuspid insufficiency - moderate	1.184	0.0233	<.0001
Glycoprotein IIb/IIIa Inhibitor	1.182	0.0257	<.0001
Alcohol 8+/wk	1.182	0.0177	<.0001
Aortic insufficiency - moderate	1.178	0.0332	<.0001
Carotid stenosis - single side	1.167	0.029	<.0001
No. of diseased vessels	1.161	0.00866	<.0001
Asian	1.159	0.026	<.0001
Creatinine linear	1.155	0.0419	.0006
Current smoker	1.148	0.0119	<.0001
Diabetes with insulin	1.144	0.0125	<.0001
Diabetes with no control	1.144	0.0189	<.0001
Recent ventricular fibrillation	1.143	0.0267	<.0001
Prior HF	1.141	0.0198	<.0001
Recent second-degree HB or SSS	1.139	0.061	.0328
Medicare without Medicaid (age <65 y)	1.138	0.0198	<.0001
CLD - mild	1.134	0.0132	<.0001
Female	1.133	0.0143	<.0001
Medicaid without Medicare (age <65 y)	1.132	0.0208	<.0001
PCI within episode of care within 6 h of surgery	1.131	0.0392	.0017
Self/none only (age <65 y)	1.116	0.0216	<.0001
TIA	1.107	0.0237	<.0001
MI 1-21 d	1.096	0.0184	<.0001
Urgent	1.095	0.0114	<.0001
Other payor (age 65+ y)	1.094	0.0298	.0025
Recent pneumonia	1.084	0.0219	.0002
Non-black Hispanic	1.083	0.0174	<.0001
Remote arrhythmia	1.081	0.028	.0052
Cardiac presentation on admission - STEMI	1.081	0.0259	.0025
Native American	1.079	0.0576	.1867
Platelets quadratic	1.078	0.00664	<.0001
Mitral insufficiency - moderate	1.077	0.017	<.0001
CVD without CVA or TIA	1.073	0.0172	<.0001
Medicare + Medicaid (age 65+ y)	1.07	0.0228	.0029
Immunosuppressive treatment	1.066	0.0246	.0092
	1.058	0.0019	<.0001

(Continued)

TABLE E5. Continued

Variable	OR (95% CI)	Standard error	*P* value
WBC linear spline function max (6.6, 0)			
Syncope	1.056	0.0224	.0152
Hypertension	1.053	0.015	.0006
Sleep apnea	1.046	0.0139	.0012
Left main disease	1.037	0.0094	.0001
BMI linear	1.026	0.00136	<.0001
Age change of slope at 60	1.022	0.00154	<.0001
Any previous cardiac intervention	1.021	0.0099	.04
DCI ≤50 (for each 10 point increase to 50)	1.017	0.00339	<.0001
HCT linear* female	1.011	0.00192	<.0001
Age linear	1.006	0.00117	<.0001
DCI ≤50 (for each 10-point increase from 50 to 100)	1.005	0.00344	.1151
BMI quadratic	1.001	0.000086	<.0001
HCT quadratic	1.001	0.000119	<.0001
Cardiac presentation on admission - non-STEMI	0.997	0.0212	.8813
HCT linear	0.985	0.00104	<.0001
Diabetes with oral control	0.985	0.0117	.1925
Ejection fraction truncated at 50	0.982	0.000542	<.0001
Previous smoker	0.973	0.0108	.0109
Family history of CAD	0.97	0.0104	.0029
Discontinuation timing of ADP	0.965	0.00743	<.0001
Diabetes with other control	0.962	0.0256	.1315
Cardiac presentation on admission - unstable angina	0.961	0.0143	.0057
Alcohol 2-7/wk	0.922	0.0155	<.0001
Previous ICD	0.915	0.0418	.0341
Cardiac presentation on admission - stable angina	0.896	0.017	<.0001
Platelets linear	0.867	0.00842	<.0001
Creatinine change of slope at 1.5	0.705	0.0397	<.0001
BSA linear	0.465	0.0439	<.0001

OR, Odds ratio; *CI*, confidence interval; *BSA*, body surface area; *ECMO*, extracorporeal membrane oxygenation; *IABP*, intra-aortic balloon pump; *CAB*, coronary artery bypass; *CLD*, chronic lung disease; *CVA*, cerebrovascular accident; *CHF*, congestive heart failure; *NYHA*, New York Heart Association; *AV*, atrioventricular; *HB*, heart block; *MI*, myocardial infarction; *PVD*, peripheral vascular disease; *HF*, heart failure; *SSS*, sick sinus syndrome; *PCI*, percutaneous coronary intervention; *TIA*, transient ischemic attack; *STEMI*, ST-elevation myocardial infarction; *CVD*, cardiovascular disease; *WBC*, white blood cell; *BMI*, body mass index; *DCI*, Distressed Communities Index; *HCT*, hematocrit; *ICD*, implantable cardioverter defibrillator. *Statistically significant with $P < .05$.