Surgery Open Science 10 (2022) 1–6

Contents lists available at ScienceDirect

Surgery Open Science

journal homepage: https://www.journals.elsevier.com/surgery-open-science

Disparities in coronary artery bypass grafting between high- and low-volume surgeons and hospitals☆

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ARTICLE INFO

Article history:
Received 14 February 2022
Received in revised form 3 May 2022
Accepted 14 May 2022
Available online 20 May 2022

ABSTRACT

Background: High-volume surgeons and hospitals performing coronary artery bypass grafting have been associated with improved patient outcomes. However, patients of increased socioeconomic distress may have worse outcomes because of health care disparities. We sought to identify trends and outcomes in patients of elevated distress undergoing bypass grafting.
Methods: The Florida Agency for Healthcare Administration administrative data set was merged with Centers for Medicare and Medicaid Services Physician and Hospital Compare and Economic Innovation Group Distressed Community Index data sets to build a comprehensive database. The data set was queried to identify patients undergoing coronary artery bypass procedures between 2016 and 2020. High- and low-volume hospitals and surgeons were compared. Patient and hospital demographics, comorbidities, length of stay, and postoperative complications were analyzed by χ^2 and *t* test where appropriate.
Results: A total of 41,571 coronary artery bypass grafting procedures were performed by 174 surgeons at 67 Florida hospitals. Low- and high-volume hospitals did not differ with respect to hospital ownership, overall star rating, national comparisons of mortality, readmission, or cost effectiveness. Patients from at-risk and distressed communities were more likely to undergo surgery at low-volume hospitals. Hospital length of stay was increased for low-volume hospitals (10.2 vs 9.4 days, $P < .05$). Postoperative complications including pneumonia, arrhythmia, respiratory failure, acute renal failure, shock, pleural effusion, and sepsis were more frequent at low-volume hospitals and for low-volume surgeons.
Conclusion: High-volume hospitals and surgeons have improved postoperative outcomes and hospital length of stay when compared to low-volume hospitals and surgeons performing coronary artery bypass grafting. At-risk and distressed populations are more likely to undergo bypass surgery at low-volume hospitals, potentially contributing to worse patient outcome. Efforts should be made to mitigate the potential impact of low socioeconomic status to improve outcomes in this population.

BACKGROUND

Various patient-, hospital-, and surgeon-level factors affect outcomes in cardiac surgery [1–6]. The complex interplay of factors in the health care macroenvironment has been shown to significantly impact length of hospital stay, postoperative outcome, morbidity, and mortality. Surgeon and hospital coronary artery bypass grafting (CABG) procedural volume is one such factor that has previously been explored to determine its impact on health care quality, patient morbidity, and mortality with varying results [6–9]. While high-volume centers and surgeons have been associated with improved outcomes in some series, the accessibility and utilization of these centers by patients from at-risk or distressed socioeconomic communities using comprehensive metrics for socioeconomic status are largely unknown. Several socioeconomic determinants, including educational level, race, and poverty status, have been used to further characterize the relationship of low socioeconomic status with morbidity and mortality. Although these surrogates have provided some context, the ability to account for the entirety of socioeconomic factors and incorporate them in outcomes research has remained elusive. Recently, a composite ranking of community-level socioeconomic factors was developed by the Economic Innovation Group to better understand and integrate these determinants [10]. Assessing economic well-being at the zip code level, the Distressed Communities Index (DCI) integrates 7 metrics that include community educational level, poverty rate, median income, job growth, housing vacancies, unemployment, and business establishments into a composite

☆ This manuscript was presented in oral presentation format on February 3, 2022, at the 17th Annual Academic Surgical Congress, Orlando, FL.

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https://doi.org/10.1016/j.sopen.2022.05.010
2589-8450/

scoring system of 0 (no distress) to 100 (maximal distress). Through this composite score, the DCI aims to understand the spatial distribution of economic well-being in the United States [10]. In this study, we sought to characterize trends and outcomes in patients of distressed socioeconomic status undergoing coronary artery bypass grafting at high- and low-volume centers and with high- and low-volume surgeons. We hypothesized that patients of increased socioeconomic distress were more likely to be treated at low–CABG volume hospitals by low-volume surgeons, potentially leading to disparities in outcome.

METHODS

The Florida Agency for Healthcare Administration data set was merged with the Centers for Medicare and Medicaid Services (CMS) Physician and Hospital Compare and the Economic Innovation Group DCI data sets to build a comprehensive database. The Florida Agency for Healthcare Administration administrative data set provides data from all discharges from licensed acute care hospitals, ambulatory surgery centers, emergency departments, and cardiac catheterization laboratories in the state of Florida [11]. Combined with the CMS Physician and Hospital Compare data set, information pertaining to surgeon operative volume by National Provider Identifier and hospital case volume by Medicare identification numbers was obtainable. The Economic Innovation Group DCI covers nearly 25,500 zip codes and 99% of the United States population and is composed of 7 metrics to form a single summary statistic: adults not working, poverty rate, housing vacancy rate, median household income, change in employment, change in establishments, and no high school diploma [10]. Composite DCI scores are then classified into 5 tiers: distressed, at risk, mid-tier, comfortable, and prosperous. The merged data set was queried by *International Classification of Diseases, Tenth Revision, Procedure Coding System* procedure codes for isolated coronary artery bypass grafting surgeries between 2016 and 2020.

Data were categorized on the basis of physician and hospital CABG volume by quartile and DCI score by quintile. High- and low-volume surgeons and hospitals were compared by demographics, comorbid conditions, length of hospital stay, and postoperative complications using Pearson χ^2 and Student *t* test where appropriate. Patients were also evaluated by DCI quintile, comparing prosperous (DCI score ≥ 80) and distressed (DCI score ≤ 20) communities with respect to demographics, preoperative comorbidities, and postoperative complications.

Data preparation, database merging, cleaning, and computation of various descriptive statistics were performed using Stata software version 16 (StataCorp, College Station, TX). Analysis was conducted in R (R Core Team, 2014) using R Studio (RStudio, PBC, Boston, MA). Quantitative data are reported as number and percentage (*n*, %), and mean and standard deviation (μ, σ). This study was exempt from institutional review given the deidentified retrospective database nature of this analysis.

RESULTS

A total of 41,571 isolated coronary artery bypass surgical procedures were performed by 174 surgeons at 67 Florida hospitals between 2016 and 2020. Patients presented from 911 distinct zip codes to CABG performing hospitals located in 65 zip codes. High-volume hospitals ($n = 6$, average yearly volume range 236–509 procedures, Table 1) did not differ from low-volume hospitals ($n = 36$, average yearly volume range 16–102 procedures) with respect to hospital ownership, overall CMS hospital star rating, national comparisons of mortality, hospital readmission, patient experience, or cost-effectiveness.

High- and Low-Volume CABG Hospitals. A larger proportion of patients from at-risk (17.54% vs 17.01%, $P < .001$) and distressed (8.73% vs 6.84%, $P < .001$) communities received care at low–CABG volume hospitals (Table 2). Conversely, a higher proportion of patients from comfortable (30.78% vs 26.99%, $P < .001$) and prosperous (22.05% vs 17.57%, $P < .001$) communities were more likely present to high-volume hospitals. High volume-hospitals overall were composed of less males (75.53% vs 76.69%, $P < .05$), had less cases classified as "emergent" (28.1% vs 42.51%, $P < .001$), and had fewer patients with a Charlson Comorbidity Index classified as "severe" (66.03% vs 67.64%, $P < .05$). Additionally, high-volume hospitals had fewer patients with preoperative comorbidities including history of myocardial infarction (43.59% vs 47.59%, $P < .001$), congestive heart failure (32.51% vs 36.64%, $P < .001$), peripheral vascular disease (18.66% vs 14.39%, $P < .001$), and chronic obstructive pulmonary disease (23.51% vs 25.76%, $P < .001$). Postoperative complications also varied between high- and low-volume hospitals, with high-volume hospitals experiencing less respiratory failure (8.77% vs 17.22%, $P < .001$), acute renal failure (20.06% vs 23.54%, $P < .001$), pneumonia (4.39% vs 5.89%, $P < .001$), pleural effusion (12.11% vs 13.81%, $P < .001$), cardiac arrest (1.27% vs 1.71%, $P < .05$), and urinary tract infection (5.46% vs 6.44%, $P < .05$). Length of hospital stay was increased for low-volume hospitals (10.24 vs 9.38 days, $P < .05$).

Table 1
Hospital and physician volume grouped by volume quartiles

Hospital volume quartiles			
	Hospitals, n	*Volume range*	*Procedures, n*
Bottom quartile	36	79–511	10,858
26%–50%	15	540–901	10,530
51%–75%	10	902–1171	10,078
Top quartile	6	1178–2549	10,105
Physician volume quartiles			
	Physicians, n	*Volume range*	*Procedures, n*
Bottom quartile	100	1–249	10,514
26%–50%	35	251–392	10,950
51%–75%	22	408–486	9791
Top quartile	17	494–861	10,316

High- and Low-Volume Surgeons. High-volume CABG-performing surgeons ($n = 17$ surgeons, average yearly volume 99–172 procedures) and low-volume surgeons ($n = 100$ surgeons, average yearly volume 1–50 procedures) were compared (Table 3). High- and low-volume surgeons did not differ with respect to ages of patients, Charlson Comorbidity Index category, and patients with preoperative dementia or metastatic solid tumor burden. Low-volume surgeons saw significantly more African American (8.07% vs 6.67%, $P < .001$) and Hispanic Latino (17.96% vs 11.05%, $P < .001$) patients and had more cases classified as "emergent" (39.28% vs 32.58%, $P < .001$), patients with Medicaid (5.33% vs 4.65%, $P < .001$), and patients from community classified as "distressed" by DCI (9.81% vs 8.73%, $P < .001$). Low-volume surgeons had a higher proportion of patients discharged to home (23.08% vs 12.12%, $P < .001$), inpatient rehabilitation (8.04% vs 4.54%, $P < .001$), and long-term acute care facilities (1.11% vs 0.67%, $P < .001$). The remainder of discharge locations also differed between groups (Table 3). Higher-volume surgeons saw patients with higher rates of a preoperative history of peripheral vascular disease, chronic obstructive pulmonary disease, and dementia. However, high-volume surgeons had markedly less postoperative incidences of respiratory failure (10.06% vs 15.01%, $P < .001$), acute renal failure (19.78% vs 23.44%, $P < .001$), pleural effusion (11.16% vs 14.15%, $P < .001$), congestive heart failure (25.82% vs 28.98%, $P < .001$), cardiac arrest (1.19% vs 1.54%, $P < .05$), and stroke (1.23% vs 1.88%, $P < .001$). The mean length of hospital stay was longer for lower-volume CABG-performing surgeons (10.39 vs 9.68 days, $P < .001$).

Prosperous and Distressed Communities. Patients residing in prosperous and distressed communities as classified by DCI quintile were evaluated. Overall, distressed communities were composed of more African American (20.57% vs 3.76%, $P < .001$) and Hispanic Latino (12.51% vs 10.22%, $P < .001$) patients, with a higher proportion of patients with

Table 2
Comparison of patient demographics, payer types, discharge status, preoperative comorbidities, and postoperative complications between high- and low-volume CABG hospitals. *N* is total number of procedures included in analysis; data are presented as number and percentage (*n*, %), or mean and standard deviation.

	Hospitals		
	Low volume (n = *10,858*)	*High volume* (n = *10,105*)	P *value*
Sex			
Male	8327 (76.69)	7632 (75.53)	.048
Age categories (y)			<.001
≤30	4 (0.04)	6 (0.06)	
31–50	655 (6.03)	576 (5.70)	
51–70	5941 (54.72)	5318 (53.63)	
71–90	4238 (39.03)	4198 (41.54)	
90+	20 (0.18)	7 (0.07)	
Race			
White	9120 (83.99)	8540 (84.51)	<.001
Black	781 (7.19)	531 (5.52)	
Asian	141 (1.3)	129 (1.28)	
Others	816 (7.52)	905 (8.96)	
Ethnicity			
Non-Hispanic	9575 (88.18)	8910 (88.17)	.983
Hispanic Latino	1283 (11.82)	1195 (11.83)	
Charlson Comorbidity Index			.016
Low	1176 (10.83)	1206 (11.93)	
Moderate	2338 (21.53)	2227 (22.04)	
Severe	7344 (67.64)	6672 (66.03)	
Length of stay (d)	10.24 (6.41)	9.38 (6.97)	<.001
Admission priority			<.001
Emergency	4616 (42.51)	2840 (28.10)	
Urgent	1410 (12.99)	3329 (32.94)	
Elective	4826 (44.45)	3932 (38.91)	
Trauma	6 (0.06)	4 (0.04)	
Payer types			.01
Medicare	6856 (63.14)	6534 (64.66)	
Medicaid	509 (4.69)	422 (4.18)	
Commercial health insurance	2673 (24.62)	2375 (23.50)	
All others	535 (4.93)	461 (4.56)	
Self-pay	285 (2.62)	313 (3.10)	
Distressed Communities Index quintiles			<.001
Prosperous	1908 (17.57)	2228 (22.05)	
Comfortable	2931 (26.99)	3110 (30.78)	
Mid-tier	3166 (29.16)	2357 (23.33)	
At risk	1905 (17.54)	1719 (17.01)	
Distressed	948 (8.73)	691 (6.84)	
Discharge status			<.001
Home or self-care (routine discharge)	2258 (20.80)	1332 (13.18)	
To a short-term general hospital for inpatient care	49 (0.45)	33 (0.33)	
Skilled nursing facility with Medicare certification	1446 (13.32)	1601 (15.84)	
Home under care of home health care organization service	5619 (51.75)	6593 (65.24)	
Left the hospital against medical advice/discontinued care	23 (0.21)	6 (0.06)	
Expired	207 (1.91)	162 (1.60)	
Hospice	48 (0.44)	23 (0.23)	
Inpatient rehabilitation facility	1036 (9.54)	283 (2.80)	
Medicare-certified long-term care hospital	104 (0.96)	43 (0.43)	
All others	68 (0.63)	29 (0.29)	
Patient preoperative comorbidities			
Myocardial infarction	5167 (47.59)	4405 (43.59)	<.001
Congestive heart failure	3978 (36.64)	3285 (32.51)	<.001
Peripheral vascular disease	1563 (14.39)	1886 (18.66)	<.001
Chronic obstructive pulmonary disease	2797 (25.76)	2376 (23.51)	<.001
Renal disorders	2503 (23.05)	2162 (21.40)	.004
Diabetes without chronic complications	3081 (28.38)	2870 (28.40)	.996
Diabetes with chronic complications	2281 (21.01)	2086 (20.64)	.516
Dementia	192 (1.77)	150 (1.48)	.105
Metastatic solid tumor	16 (0.15)	21 (0.21)	.297
Postoperative complications			
Respiratory failure	1870 (17.22)	886 (8.77)	<.001
Acute renal failure	2556 (23.54)	2027 (20.06)	<.001
Pneumonia	639 (5.89)	444 (4.39)	<.001
Pleural effusion	1499 (13.81)	1224 (12.11)	<.001
Cardiac arrhythmia	4423 (40.73)	4527 (44.80)	<.001
Congestive heart failure	3085 (28.41)	2463 (24.37)	<.001
Cardiac arrest	186 (1.71)	128 (1.27)	<.05
Urinary tract infection	699 (6.44)	552 (5.46)	.003
Cerebral infarction	175 (1.61)	156 (1.54)	.693
Malnutrition	500 (4.60)	373 (3.69)	.001
Delirium	340 (3.13)	400 (3.96)	.001

Table 3

Comparison of patient demographics, payer types, discharge status, preoperative comorbidities, and postoperative complications between high- and low-volume physicians performing CABG. *N* is total number of procedures included in analysis; data are presented as number and percentage (*n*, %), or mean and standard deviation.

	Physicians		
	Low volume (n = *10,514*)	*High volume* (n = *10,316*)	P *value*
Sex			<.001
Male	8083 (76.88)	7690 (74.54)	
Age categories (y)			.466
≤30	4 (0.04)	8 (0.08)	
31–50	710 (6.75)	715 (6.93)	
51–70	5843 (55.57)	5742 (55.66)	
71–90	3948 (37.55)	3847 (37.29)	
90+	9 (0.09)	4 (0.04)	
Race			<.001
White	8699 (82.74)	8764 (84.96)	
Black	849 (8.07)	688 (6.67)	
Asian	152 (1.45)	150 (1.45)	
Others	814 (7.74)	714 (6.92)	
Ethnicity			<.001
Non-Hispanic	8626 (82.04)	9176 (88.95)	
Hispanic Latino	1888 (17.96)	1140 (11.05)	
Charlson Comorbidity Index			.256
Low	1219 (11.59)	1128 (10.93)	
Moderate	2253 (21.43)	2188 (21.21)	
Severe	7042 (66.98)	7000 (67.86)	
Length of stay (d)	10.39 (7.42)	9.68 (7.42)	<.001
Admission priority			<.001
Emergency	4130 (39.28)	3361 (32.58)	
Urgent	1707 (16.24)	2811 (27.25)	
Elective	4674 (44.46)	4142 (40.15)	
Trauma	3 (0.03)	2 (0.02)	
Payer types			<.001
Medicare	6295 (59.87)	6340 (61.46)	
Medicaid	560 (5.33)	480 (4.65)	
Commercial health insurance	2774 (26.38)	2545 (24.67)	
All others	557 (5.30)	486 (4.71)	
Self-pay	328 (3.21)	465 (4.51)	
Distressed Communities Index quintiles			.001
Prosperous	2299 (21.87)	2195 (21.28)	
Comfortable	2899 (27.57)	2776 (26.91)	
Mid-tier	2450 (23.30)	2629 (25.48)	
At risk	1835 (17.45)	1815 (17.59)	
Distressed	1031 (9.81)	901 (8.73)	
Discharge status			<.001
Home or self-care (routine discharge)	2427 (23.08)	1250 (12.12)	
To a short-term general hospital for inpatient care	42 (0.40)	42 (0.41)	
Skilled nursing facility with Medicare certification	1367 (13.0)	1620 (15.70)	
Home under care of home health care organization service	5372 (51.09)	6681 (64.76)	
Left the hospital against medical advice/discontinued care	24 (0.23)	9 (0.09)	
Expired	217 (2.06)	130 (1.26)	
Hospice	34 (0.32)	21 (0.20)	
Inpatient rehabilitation facility	845 (8.04)	468 (4.54)	
Medicare-certified long-term care hospital	117 (1.11)	69 (0.67)	
All others	69 (0.66)	26 (0.25)	
Patient preoperative comorbidities			
Myocardial infarction	4851 (46.14)	4884 (47.34)	.081
Congestive heart failure	3816 (36.29)	3632 (35.21)	.102
Peripheral vascular disease	1553 (14.77)	1706 (16.54)	<.001
Chronic obstructive pulmonary disease	2408 (22.90)	2629 (25.48)	<.001
Renal disorders	2403 (22.86)	2203 (21.36)	.009
Diabetes without chronic complications	2973 (28.28)	3124 (30.28)	.001
Diabetes with chronic complications	2299 (21.87)	2111 (20.46)	.013
Dementia	137 (1.30)	158 (1.53)	.163
Metastatic solid tumor	16 (0.15)	25 (0.24)	.142
Postoperative complications			
Respiratory failure	1578 (15.01)	1038 (10.06)	<.001
Acute renal failure	2465 (23.44)	2041 (19.78)	<.001
Pneumonia	604 (5.74)	530 (5.14)	.054
Pleural effusion	1488 (14.15)	1151 (11.16)	<.001
Cardiac arrhythmia	4350 (41.37)	4219 (40.90)	.485
Congestive heart failure	3047 (28.98)	2664 (25.82)	<.001
Cardiac arrest	162 (1.54)	123 (1.19)	.03
Urinary tract infection	600 (5.71)	621 (6.02)	.336
Cerebral infarction	198 (1.88)	127 (1.23)	<.001
Malnutrition	602 (5.73)	509 (4.93)	.011
Delirium	258 (2.45)	210 (2.04)	.042

Charlson Comorbidity Index classified as "severe" (72.38% vs 61.68%, $P < .001$), and cases classified as "emergent" (40.95% vs 30.71%, $P < .001$) (Table 4). Patients from distressed communities were also more likely to have Medicaid (9.63% vs 2.94%, $P < .001$) and less likely to have commercial health insurance (20.74% vs 29.39%, $P < .001$). Distressed community patients had a higher proportion of histories of myocardial infarction, congestive heart failure, peripheral vascular disease, chronic obstructive pulmonary disease, renal disorders, diabetes, and dementia. Patients from these communities also had higher rates of postoperative respiratory failure (14.89% vs 12.62%, $P < .05$), acute renal failure (23.45% vs 21.59%, $P < .05$), pneumonia (6.45 vs 4.70, $P < .001$), congestive heart failure (29.95% vs 22.77%, $P < .001$), cardiac arrest (1.87% vs 1.48%, $P < .001$), urinary tract infection (6.5% vs 4.51%, $P < .001$), and delirium (2.66% vs 2.05%, $P < .05$). Distressed communities also experienced increased mean lengths of hospital stay when compared with prosperous communities (10.72 vs 9.32 days, $P < .001$), with a higher proportion discharged to skilled nursing facilities (16.87% vs 13.81%, $P < .001$) and inpatient rehabilitation facilities (6.75% vs 5.66%, $P < .001$).

Table 4
Comparisons of patient demographics, payer types, discharge status, preoperative comorbidities, and postoperative complications between prosperous and distressed communities. *N* is total number of procedures included in analysis; data are presented as number and percentage (*n*, %), or mean and standard deviation.

	Distressed (n = *3646*)	*Prosperous* (n = *9081*)	P *value*
Sex			
Male	2562 (70.27)	7241 (79.74)	<.001
Age categories (y)			<.001
≤30	3 (0.08)	4 (0.04)	
31–50	297 (8.15)	539 (5.94)	
51–70	2178 (59.74)	4828 (53.17)	
71–90	1167 (32.01)	3704 (40.79)	
90+	1 (0.03)	6 (0.07)	
Race			
White	2710 (74.33)	8022 (88.34)	
Black	750 (20.57)	341 (3.76)	
Asian	19 (0.52)	193 (2.13)	
Others	167 (4.58)	525 (5.78)	
Ethnicity			<.001
Non-Hispanic	3190 (87.49)	8153 (89.78)	
Hispanic Latino	456 (12.51)	928 (10.22)	
Charlson Comorbidity Index			<.001
Low	329 (9.02)	1307 (14.39)	
Moderate	678 (18.60)	2173 (23.93)	
Severe	2639 (72.38)	5601 (61.68)	
Length of stay (d)	10.72 (7.87)	9.32 (6.72)	<.001
Admission priority			<.001
Emergency	1493 (40.95)	2789 (30.71)	
Urgent	786 (21.56)	2519 (27.74)	
Elective	1365 (37.44)	3770 (41.52)	
Trauma	2 (0.05)	3 (0.03)	
Payer types			<.001
Medicare	2132 (58.48)	5545 (61.06)	
Medicaid	351 (9.63)	267 (2.94)	
Commercial health insurance	756 (20.74)	2669 (29.39)	
All others	247 (6.77)	351 (3.87)	
Self-pay	160 (4.39)	249 (2.74)	
Discharge status			<.001
Home or self-care (routine discharge)	763 (20.93)	1344 (14.80)	
To a short-term general hospital for inpatient care	27 (0.74)	39 (0.43)	
Skilled nursing facility with Medicare certification	615 (16.87)	1254 (13.81)	
Home under care of home health care organization service	1815 (49.78)	5681 (62.56)	
Left the hospital against medical advice/discontinued care	8 (0.22)	3 (0.03)	
Expired	66 (1.81)	135 (1.49)	
Hospice	13 (0.36)	22 (0.24)	
Inpatient rehabilitation facility	246 (6.75)	514 (5.66)	
Medicare-certified long-term care hospital	38 (1.04)	70 (0.77)	
All others	55 (1.51)	19 (0.21)	
Patient preoperative comorbidities			
Myocardial infarction	1827 (50.11)	3979 (42.82)	<.001
Congestive heart failure	1405 (38.54)	2857 (31.46)	<.001
Peripheral vascular disease	591 (16.21)	1330 (14.65)	0.026
Chronic obstructive pulmonary disease	1037 (28.44)	1795 (19.77)	<.001
Renal disorders	865 (23.72)	1849 (20.36)	<.001
Diabetes without chronic complications	1101 (30.20)	2489 (27.41)	.002
Diabetes with chronic complications	893 (24.49)	1625 (17.89)	<.001
Dementia	57 (1.56)	109 (1.20)	.103
Metastatic solid tumor	4 (0.11)	25 (0.28)	.077
Postoperative complications			
Respiratory failure	543 (14.89)	1146 (12.62)	.001
Acute renal failure	855 (23.45)	1961 (21.59)	.023
Pneumonia	235 (6.45)	427 (4.70)	<.001
Pleural effusion	469 (12.86)	1218 (13.41)	.409
Cardiac arrhythmia	1292 (35.44)	3927 (43.24)	<.001
Congestive heart failure	1092 (29.95)	2068 (22.77)	<.001
Cardiac arrest	68 (1.87)	134 (1.48)	.112
Urinary tract infection	237 (6.50)	410 (4.51)	<.001
Cerebral infarction	69 (1.89)	137 (1.51)	.121
Malnutrition	172 (4.72)	451 (4.97)	.556
Delirium	97 (2.66)	186 (2.05)	.034

DISCUSSION

The impact of low socioeconomic status using discrete metrics has been associated with worse health outcomes and may result in decreased overall life expectancy [12–15]. This analysis outlines trends of high- and low-volume CABG-performing hospitals and surgeons and finds potential disparities in patients of high socioeconomic distress, as measured by increased DCI score, which may contribute to worse postoperative outcome and longer lengths of hospital stay.

Traditional socioeconomic metrics, including race, median household income, and educational achievement, have been commonly used in risk-adjusted outcomes research and in risk prediction modeling [16,17]. However, when used in isolation, these metrics may not provide an accurate representation of high socioeconomic burden and consequently may underestimate actual risk in this cohort. In accounting for both patient- and community-level factors, including regional access to health care, the DCI aims to provide superior insight over these conventional methods. Previous analyses have demonstrated worse outcomes following CABG for patients from rural communities likely as a result of worse preoperative comorbidities and access to health care resources [18–20]. Despite this, current risk models do not consistently incorporate data on community-level median household income, poverty level, and housing vacancy rate. By integrating conventional socioeconomic metrics together with distance to area hospitals and primary care clinics, among other factors included in the DCI, the influence of depressed socioeconomic status may be better realized.

Although high- and low-volume CABG-performing hospitals did not significantly differ with respect to hospital quality metrics in this analysis, patients seeking care at these facilities differed by race, Charlson Comorbidity Index, payer type, admission priority, and select postoperative outcomes. Patients from communities at risk or distressed by DCI score were more likely to have surgery at low-volume CABG-performing hospitals. Congruently, the proportion of distressed populations seen and outcomes between high- and low-volume surgeons also showed significant differences with respect to length of hospital stay, respiratory failure, acute renal failure, and stroke. We propose 2 likely mechanisms for the disparate findings in our analysis: the influence of poorer clinical risk profiles in distressed communities and the inherent limitations of hospitals with low CABG volume. In agreement with our findings, Mehaffey and colleagues' recent analysis using DCI scoring showed that patients from distressed communities were at increased risk from adverse outcomes and death after CABG using the Society of Thoracic Surgeons Adult Cardiac Surgery Database [1]. The complex burden of high socioeconomic distress, including access to routine care, postoperative follow-up, and cardiac rehabilitation, likely contributes to these findings. Regional distribution differences in hospitals by surgical volume also potentially influence these outcomes [21]. Consideration of these limitations may allow for mitigation strategies targeted to this population to encourage more equitable access to care and ultimately improve patient outcome.

Efforts at identifying and improving socioeconomic factors contributing to these disparate outcomes may improve health outcomes in these communities. Although the DCI affords a composite score of socioeconomic status, the individual categories (eg, poverty rate, housing vacancy rate, median household income) from which the score is derived may offer a foundation to direct initial focus. Understandably, patients from communities of increased poverty and higher housing vacancy rates may have more difficulty in attaining routine medical care and have decreased health literacy when compared to areas that are more affluent. The culmination of these factors can result in a population that may not, or cannot, seek appropriate medical care in a timely fashion. The ultimate effect may result in an overall sicker baseline population, as demonstrated in this analysis with the distressed population having a higher Charlson Comorbidity Index. Actions at the local, regional, state, and national level to address these disparities, including increased societal awareness and funding of projects to rectify these discrepancies, may improve local population health. Ensuring equitable community hospital resources and availability of referrals to larger centers for complex cases would likely improve these metrics.

Limitations of this retrospective database analysis include constraints in data elements available for inclusion and review of a single state. As a result, this analysis is unable to discern causality. Although the DCI is a robust measure of socioeconomic well-being, the collection of factors contributing to socioeconomic status is likely incomplete. Future work is needed to determine if outcomes in patients from at-risk and distressed communities may be mitigated by high-volume surgeons or hospitals and to identify opportunities to mitigate factors contributing to disparities in this cohort.

High-volume CABG-performing surgeons and hospitals have improved postoperative outcomes and hospital length of stay when compared to low-volume hospitals and surgeons. A larger proportion of patients from distressed socioeconomic communities undergo bypass surgery at low-volume facilities, potentially contributing to worse patient outcome. Efforts to further identify confounding factors and mitigate the burden of high socioeconomic distress to optimize outcomes should be considered.

Author Contribution

Conceptualization: all authors; data curation: all authors; formal analysis: MPR, HJ; methodology: all authors; roles/writing – original draft: MR; writing – review & editing: HJ, PCK.

Conflict of Interest

The authors report no conflicts of interests related to this manuscript.

Funding Source

This work received funding from the Juan Bolivar Family Endowment.

Ethics Statement

This study was exempt from institutional review board approval given the deidentified retrospective database nature of this analysis. All authors have signed and agreed to the respective data use agreements for each data set governing the use of deidentified data.

Supplementary Material

Stata and R markdown files involving various steps of deidentified data preparation and modeling for this project are available by accessing the following link: https://github.com/onetomapanalytics/.

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