Phase I: Disparities in Access to Advanced Medical Procedures in the Medicare Population

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Executive Summary

Racial and ethnic healthcare disparities in access to advanced interventions have stubbornly persisted for decades in U.S. healthcare, making clear the need for increased attention and policy action to reduce these disparities.

In this analysis, we set out to determine the differences in access to certain advanced interventions, including a range of surgical, medical and technological interventions. We focused primarily on differences by race in the use of certain health services by Medicare beneficiaries across a range of common clinical conditions in 2018 and 2019.

Key Findings

By comparing the rates at which White and non-White Medicare beneficiary groups use these select advanced interventions compared to both the general population and the population with a relevant diagnosis indicating need for these services, our analysis determined:

- Non-White beneficiaries were less likely to access indicated interventions for many of the cardiac, neurovascular, orthopedic, spinal, and respiratory services analyzed as well as certain cancer screenings.
- When limited to groups who have a relevant clinical condition, these disparities were reduced in some cases. However, preexisting racial and ethnic differences in access to primary or specialist care to receive a diagnosis, for example, may lead to understated clinical populations as well as understated potential disparities.

Future Analyses

While this initial analysis further supports our understanding of health disparities for racial and ethnic groups across common medical conditions, we will further analyze these differences to provide additional context and direction for policy solutions.

Specifically, our future analyses include:

- Phase II will examine what is known in the literature about disparities in the cardiovascular and neurovascular interventions included in this analysis.
- Phase III will provide deeper additional analysis to include the impact of other clinical and community factors contributing to differences in access to these interventions across groups.

Introduction

While racial and ethnic health and healthcare disparities have been documented by researchers for years,[1,2] the healthcare community has renewed attention on these issues due to recent social justice movements and the impact of the COVID-19 pandemic on people of color.

In October 2020, AdvaMed released *Principles on Health Equity*, highlighting four key values for the organization around health equity.[3] These principles articulate a clear commitment to ensuring patients have "access to innovative technologies which improve patient lives." In addition, the principles articulate the role of AdvaMed and its members in promoting health equity and educating providers and policymakers on the existence of disparities in access to innovative technologies, the reasons for these access barriers among some groups of patients, and supporting policy solutions.

The need for increased focus and policy action on health disparities is clear. Recent studies have demonstrated that disparities in access to innovative technology and advanced procedures have been stubbornly persistent. For example, Best and colleagues assessed changes in racial disparities between White and Black people for nine surgical procedures, including angioplasty, spinal fusion, carotid endarterectomy, appendectomy, colorectal resection, coronary artery bypass grafting, total hip arthroplasty, total knee arthroplasty, and heart valve replacement. [4] The study, which examined disparities between 2012 and 2017, found racial disparities in all nine procedures either remained similar over time or, in three of the 9 (including total knee and hip arthroplasty), worsened.

In this study, we examined differences in Medicare fee-for-service (FFS) beneficiaries' access to a select set of interventions for some common medical conditions (Figure 1). The goal of this study was to determine differences in access to those interventions, primarily by race and ethnicity, with additional attention paid to gender and Medicare-Medicaid enrollment status (dual eligibility status). By documenting access differences to the types of technologies developed by member companies and uncovering some of the reasons for these patterns, the study will help AdvaMed educate stakeholders and engage in activities consistent with its stated health equity principles.

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[1] Williams, D. R., & Collins, C. (1995). U.S. Socioeconomic and Racial Differences in Health: Patterns and Explanations. *Annual Review of Sociology, 21*, 349-386.

[2] Gornick ME, Eggers PW, Reilly TW, et al. (1996). Effects of race and income on mortality and use of services among medicare beneficiaries. *New England Journal of Medicine, 335*(11):791–799.

[3] https://www.advamed.org/sites/default/files/resource/principles-on-health-equity.pdf

[4] Best MJ, McFarland EG, Thakkar SC, Srikumaran U. (2021). Racial Disparities in the Use of Surgical Procedures in the US. *JAMA Surg, 156*(3):274–281. doi:10.1001/jamasurg.2020.6257

Figure 1: Interventions Selected to Measure for Potential Disparities in Utilization.

Cardiovascular	**Orthopedic**
Ablation	Total and partial hip arthroplasty
Angioplasty	Total and partial knee arthroplasty
Transcatheter aortic valve replacement	Total shoulder arthroplasty
Neurovascular	Total ankle arthroplasty
Mechanical thrombectomy	**Spinal**
Thrombolysis	Artificial disc replacement
Respiratory	Spinal fusion
Respiratory assist device (RAD)	**Cancer screening**
Positive airway pressure (PAP)	Lung cancer
Home ventilation	Colon cancer

For this set of interventions, our analysis aimed to answer the following questions:

1. Across various populations based on demographic and socioeconomic characteristics, what are the gaps in Medicare FFS beneficiaries' use of certain advanced interventions?

2. To what extent can these gaps be explained by differences in the prevalence of relevant clinical conditions across populations?

The remainder of the report is organized as follows: The next section briefly summarizes the methods, including analyses and data sources, with additional detail included in Appendices A and B; we then present the results separately for each group of services (i.e., cardiovascular, neurovascular, orthopedic, spinal, respiratory, and cancer screening), with separate presentation of each service within a group; next, we present a brief discussion of the findings and a final conclusion section that sets the stage for forthcoming additional analyses.

Methods

Analyses

We analyzed access rates—the percentage of the population that receives the studied services—first at the general population level (i.e., all FFS Medicare beneficiaries in the appropriate age group) and then at the indicated population level. The indicated population is the subset of the general population that is likely to benefit from the procedure or service of interest. For example, we calculated a rate of transaortic valve replacements for all FFS Medicare beneficiaries (general access rate) and one for the indicated population of people that have a diagnosis of aortic stenosis (indicated access rate).

We used direct standardization by gender and age-strata to remove the influence of these attributes on our estimates of the access rates for race and dual-eligibility status cohorts. We used the age and gender distribution of the Medicare FFS population to standardize the rates, using these age strata: 18-44, 45-64, 65-74, 75-84 and 85 and older.[5] We reported age and gender-adjusted rates separately for the general and indicated populations[6] by:

- **Race/ethnicity**. Race/ethnicity is defined as White non-Hispanic [White], Black non-Hispanic [Black], and Other [Other], which combines Asian, Hispanic, Native American, Other and Unknown race categories; and,
- **Dual-eligibility status**. Dual-eligibility for Medicaid and Medicare v. not.[7]

The analyses here are primarily descriptive, so interpretation of differences is somewhat limited. For example, differences in observed rates of use for procedures may have many causes such as the availability of primary and specialty care, patient choices with respect to risk, and a variety of other factors. Phase II of this study will discuss what is known about the role that these factors play for a subset of these conditions.

Study Data and Population

Analyses were conducted using the Medicare 5% Standard Analytic File for calendar years 2018 and 2019. We used the Medicare Beneficiary Summary File to determine a denominator of Medicare enrollees, and the inpatient, outpatient, carrier, and durable medical equipment data, including data from claims, revenue centers, and other associated data sources.

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[5] The cancer screenings are recommended only for specific age groups. For lung cancer, we restricted the population to ages 50-80 (50-64, 65-74, and 75-80); for colon cancer, we restricted to 45-75 (45-64 and 65-75).

[6] We also estimated logistic regressions for the indicated population to present the differences in access in terms of odds ratios. Those results, which include separate estimates of differences in access by gender, are included in Appendix B.

[7] We treated a beneficiary as "dual-eligible" if any month within the year indicated full or partial Medicaid coverage in the year. If a person were dual-eligible for a month in 2018 but not in 2019, then we treated all months in 2018 as dual-eligible and none in 2019.

The study population included adult (18 years of age or older) Medicare FFS beneficiaries in 2018 or 2019. FFS coverage was defined as one month of either Part A or Part B Medicare coverage; we tracked the number of months of FFS coverage in each year and calculated a fractional year per beneficiary. This allowed beneficiaries with partial year coverage—because they aged into Medicare mid-year, they died before the end of the year, or they transitioned between FFS and managed care coverage—to contribute all months of FFS enrollment. For each beneficiary, we calculated the fraction of the year that the person had FFS coverage.[8]

[8] Beneficiaries whose total months of enrollment in a year equaled the number of months of managed care enrollment were excluded; however, a beneficiary who switched between FFS and managed care during the year contributed the number of months for which they had FFS coverage.

Results: Cardiovascular

In the United States, cardiovascular disease is a leading cause of death for men, women, and people of all racial and ethnic groups.[9] While it can be prevented and managed through addressing behavioral risk factors such as poor nutrition and physical inactivity, once developed, it is commonly treated through medication and/or surgical interventions.

As cardiovascular disease is a leading cause of morbidity and mortality, disparate access to necessary treatment is a major driver of health inequity. Black people in the U.S. experience higher prevalence rates of cardiovascular disease and associated mortality rates than other ethnic groups.[10] We examined disparities in three procedures to treat cardiovascular diseases:

- **Cardiac ablation** is a surgical procedure that blocks irregular electrical signals in the heart to restore normal heart rhythm.[11] As a common treatment of atrial fibrillation and other cardiac arrythmias, cardiac ablation can decrease a patient's risk of stroke, heart failure, and cardiac arrest. Providers may recommend cardiac ablation based on a patient's type of arrythmia or if medications prescribed to treat the arrythmia have failed.
- **Angioplasty** is a surgical treatment for coronary artery disease, the most common type of cardiovascular disease. The procedure removes blockages in coronary arteries with a catheter and restores blood flow to the heart without open heart surgery.[12] Surgery may be recommended when a patient presents with worsening angina or cardiac arrest.
- **Transcatheter aortic valve replacement (TAVR)** is a surgical treatment of aortic valve stenosis, in which a physician replaces an aortic valve that cannot be fully opened to help restore blood flow to the heart. This procedure is an alternative to open-heart surgery and is recommended to individuals with severe symptomatic aortic stenosis, other aortic valve disorders, or those who may not tolerate open-heart surgery.

Cardiac Ablation: Age and Gender-Standardized Rates

We found that Black and Other race beneficiaries, dual-eligible beneficiaries, and older beneficiaries were less likely to receive cardiac ablation than their respective comparison groups. Across all cohorts (i.e., combinations of race/ethnicity and dual-eligibility status) in the general Medicare population, fewer than 0.5% of beneficiaries received this treatment, with White non-dual-eligible beneficiaries getting the procedure roughly twice as often as Black and Other race non-dual-eligible beneficiaries.

We next looked at the percentage of beneficiaries included in the indicated population for this service. For cardiac ablation, the diagnosis of interest is a primary diagnosis of atrial fibrillation or cardiac arrhythmia. White beneficiaries had the largest proportion of beneficiaries within the Indicated

[9] https://www.cdc.gov/heartdisease/facts.htm

[10] https://journalofethics.ama-assn.org/article/race-discrimination-and-cardiovascular-disease/2014-06

[11] https://www.mayoclinic.org/tests-procedures/cardiac-ablation/about/pac-20384993#:~:text=Cardiac%20ablation%20is%20a%20procedure,blood%20vessels%20to%20the%20heart.

[12] https://www.mayoclinic.org/tests-procedures/coronary-angioplasty/about/pac-20384761.

population (15.0% and 15.1% for non-dual and dual-eligible). Black beneficiaries and Other racial minorities were identified with arrhythmias at a lower rate than White beneficiaries: Black non-duals and duals comprised 8.5% and 12.1% of the Black Medicare population, respectively; for Other race, the respective rates were 6.9% and 10.6%.

Limiting to the indicated population raised the access rates for all groups, as expected. The standardized access rate within the indicated population increased for all cohorts. We estimated 4.5% of White non-dual eligible beneficiaries used cardiac ablation compared to 3.4% for Black non-dual and 3.8% for Other race non-dual-eligibles, a 32% difference for Black non-duals and 19% difference for Other non-duals. Access rates for duals were lower than for non-duals, and the disparities relative to White beneficiaries decreased: White dual-eligibles accessed ablation at a 9% higher rate than Black dual-eligibles, and Other race dual-eligibles were actually 6% more likely than White dual-eligibles to receive ablation.

Angioplasty Age and Gender-Standardized Rates

In the general Medicare population, overall access to this intervention ranged between 1.2% and 2.7%, while the proportion of beneficiaries in the indicated population ranged from about 35% to 49%. White beneficiaries were more likely to be identified with a primary diagnosis of acute myocardial infarction (AMI) or angina than Black beneficiaries, although the differences were smaller, especially among dual-eligibles (e.g., identified White duals, 3.9% v. Black duals, 3.7%; identified White non-dual, 3.0 v. Black non-dual, 2.5%). Other race dual-eligible beneficiaries had a slightly higher rate of angina or AMI relative to White dual-eligibles (4.1% v. 3.9%).

Within the indicated population, among those not dually-eligible for Medicaid, White beneficiaries had the highest angioplasty access rates followed by Black and Other race (43.8% v. 43.0% v. 36.6%, respectively). Among those dually-eligible, White beneficiaries (45.1%) were less likely to receive angioplasty than Black dual-eligibles (48.7%) but more likely than Other races (35.2%).

Limiting to the indicated population narrowed the access rate differences relative to White beneficiaries. For example, White non-dual beneficiaries went from using 25% more than Black non-dual beneficiaries in the general population to only 2% more when limiting to the indicated population. Among dual-eligibles, White beneficiaries went from 7% more utilization than Black beneficiaries 7% less than Black beneficiaries in the indicated population. Relative to Other race non-duals, White non-duals had 60% greater access rates in the general population but only 20% greater within the indicated population; the corresponding rates among dual-eligibles were 30% and 28%.

Note, however, that the reduction in the access rate difference that results from limiting to the indicated population seems race-neutral at first—when limiting to patients for whom the service is clinically appropriate, the race differences disappear. In fact, this suggests that the disparity issue may lie upstream from the point at which angioplasty is or is not provided to whether the Black and Other race beneficiaries are identified with the condition in the first place. The difference in identification, particularly given the higher risk factors among minorities, suggests there may be additional opportunities to improve patient health.

Transcatheter Aortic Valve Replacement (TAVR) Age and Gender-Standardized Rates

Across all general Medicare population cohorts, the rate of TAVR was less than 0.25%, with Black and Other race beneficiaries having procedure rates less than 0.10%. The proportion of beneficiaries who were included in the indicated population—patients with any diagnosis of aortic stenosis—ranged from 1.80% to 4.1% across the cohorts. Compared to Black and Other race beneficiaries, more White beneficiaries were included in the indicated population. For example, about 4.1% of White non-dual beneficiaries were identified with aortic stenosis compared to 2.0% of Black non-dual and 1.8% of Other non-dual beneficiaries.

Within the indicated population and among those not dually eligible, White beneficiaries were most likely to receive TAVR (5.1%), followed by Other race beneficiaries (3.3%) and Black beneficiaries (3.3%). Dually eligible beneficiaries of Black and Other race were more likely than White non-dual peers to receive the service (3.4% v. 3.3% and 4.3% v. 3.3% respectively). White dual-eligible beneficiaries (4.5%) were more likely than either race category to receive TAVR.

As with cardiac ablation, restricting analysis to the indicated population reduced the White-Black and White-Other differences in TAVR receipt. In the general population, white non-duals were 2.5 times more likely to receive TAVR than Black non-duals, but after restricting to the indicated population the ratio fell to 1.5 times more likely. A similar pattern was seen for Other race and within the dual-eligible populations.

An important consideration for interpreting these results is that TAVR is only recommended for severe cases of aortic stenosis. However, the diagnostic information available in the claims does not permit us to target the indicated population more narrowly. As a result, apparent differences in utilization may reflect differences in case mix with respect to severity of aortic stenosis.

Figure 2: Age and Gender Standardized Rates of Cardiovascular Technologies, 2018-2019.

Procedure	Population	N (people)	Adjusted Access Rate, General (%)	Indicated Pop-ulation (%)	Adjusted Access Rate, Indicated (%)	Ratio of White to Non-White Access, General	Ratio of White to Non-White Access, Indicated
Cardiac Ablation	Black, Non-dual	116,108	0.25	8.47	3.38	2.05	1.32
	Black, Dual-eligible	68,681	0.28	12.10	2.00	1.20	1.09
	Other, Non-dual	121,036	0.25	6.93	3.76	2.08	1.19
	Other, Dual-eligible	66,507	0.22	10.62	2.31	1.55	0.94
	White, Non-dual	1,329,893	0.52	15.03	4.47	1.00	1.00
	White, Dual-eligible	230,733	0.33	15.09	2.18	1.00	1.00
Angioplasty	Black, Non-dual	116,108	1.47	2.52	42.98	1.25	1.02
	Black, Dual-eligible	68,681	2.51	3.70	48.67	1.07	0.93
	Other, Non-dual	121,036	1.15	1.97	36.56	1.60	1.20
	Other, Dual-eligible	66,507	2.07	4.05	35.21	1.30	1.28
	White, Non-dual	1,329,893	1.84	3.01	43.80	1.00	1.00
	White, Dual-eligible	230,733	2.69	3.89	45.11	1.00	1.00
TAVR	Black, Non-dual	116,108	0.09	1.97	3.31	2.53	1.53
	Black, Dual-eligible	68,681	0.09	2.13	3.38	2.32	1.34
	Other, Non-dual	121,036	0.09	1.82	3.33	2.58	1.52
	Other, Dual-eligible	66,507	0.10	2.52	4.30	2.04	1.05
	White, Non-dual	1,329,893	0.22	4.08	5.05	1.00	1.00
	White, Dual-eligible	230,733	0.21	3.45	4.52	1.00	1.00

Results: Neurovascular

Stroke is a leading cause of mortality and morbidity in the United States. Ischemic stroke, the most common type, results from a blockage in the blood vessels that supply the brain with oxygenated blood. There is substantial evidence of racial and ethnic disparity in stroke care, and stroke mortality rates are higher among people of color compared to white Americans.[13]

- **Mechanical thrombectomy** is a procedure used to treat ischemic stroke. Whereas traditional thrombectomy is a surgical procedure to remove blood clots from a blood vessel to help restore blood flow, mechanical thrombectomy is a less invasive procedure that removes blood clots using a catheter.[14] Use of this procedure is very time-sensitive (must be completed within a few hours of the stroke) to prevent severe disability or death.
- **Thrombolysis** is a medical intervention that uses medication to break up blood clots in blood vessels and prevent new clots from forming.[15] This analysis focuses on its use for patients that present with ischemic stroke rather than other conditions that use this technique.

Mechanical Thrombectomy Age and Gender-Standardized Rates

Rates of mechanical thrombectomy across the general Medicare cohorts were generally less than 1.0%. In the general Medicare population, Black beneficiaries had higher rates of mechanical thrombectomy than White beneficiaries for both non-dual (0.60% v. 0.38%) and dual-eligible beneficiaries (1.22% v. 0.69%).

Black Medicare beneficiaries were more likely than White or Other race Medicare beneficiaries to be diagnosed with ischemic stroke: among non-duals, 3.7% of Black beneficiaries were identified compared to 1.9% of Other race and 3.2% of White race beneficiaries; among duals, the respective identification rates were 7.7%, 4.5% and 5.5%.

Restricting analysis to the indicated population reduced the observed difference in White and Black access rates. Whereas White non-duals in the general Medicare population were 36% less likely to receive the thrombectomy, restricting to the indicated population meant a difference of about half that size (18%), bringing the access rates between racial groups closer to parity.

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[13] Cruz-Flores S, Rabinstein A, Biller J, Elkind MS, Griffith P, Gorelick PB, Howard G, Leira EC, Morgenstern LB, Ovbiagele B, et al; American Heart Association Stroke Council; Council on Cardiovascular Nursing; Council on Epidemiology and Prevention; Council on Quality of Care and Outcomes Research. Racial-ethnic disparities in stroke care: the American experience: a statement for healthcare professionals from the American Heart Association/ American Stroke Association. Stroke. 2011;42:2091–2116. doi: 10.1161/STR.0b013e3182213e24.
[14] Munich, S. A., Vakharia, K., & Levy, E. I. (2019). Overview of mechanical thrombectomy techniques. Neurosurgery, 85(suppl_1), S60-S67.
[15] Miller DJ, Simpson JR, Silver B. (2011). Safety of Thrombolysis in Acute Ischemic Stroke: A Review of Complications, Risk Factors, and Newer Technologies. *The Neurohospitalist, 1*(3):138-147. doi:10.1177/1941875211408731

Relative to Other race beneficiaries, White beneficiaries went from using 3% more often in the general population to using 28% less often among the indicated population. Among dual-eligibiles, Whites went from 28% lower utilization in the general population to 43% less likely in the indicated population.

Thrombolysis Age and Gender-Standardized Rates

Across all general Medicare population cohorts, access rates for thrombolysis were less than half a percent. The primary racial difference was among Other races for both dual and non-dual populations: access rates among White beneficiaries were 49% and 32% higher than for Other race beneficiaries among the non-dual and dual-eligible, respectively. In contrast, Black non-duals and duals were somewhat more likely to receive thrombolysis than White beneficiaries (White to Black access rates of 0.84 and 0.69 for non-dual and dual-eligibles, respectively).

The indicated population for thrombolysis is the same as for mechanical thrombectomy, so we see the same patterns of identification by race. After limiting to the indicated population, White non-dual and dual eligible beneficiaries shifted to being slightly more likely to receive thrombolysis than Black beneficiaries: the White to Black access rates in the non-dual population were 7% higher and in the dual-eligible population 1% higher. Limiting to the indicated population reduced the differences between White and Other race beneficiaries: among non-duals, White beneficiaries were only 6% more likely to use the service than Other race beneficiaries; among duals, White beneficiaries were about 7% less likely to use the service Other race beneficiaries.

Figure 3: Age and Gender Direct Standardized Rates of Neurovascular Technologies, 2018-2019.

Procedure	Population	N (people)	Adjusted Access Rate, General (%)	Indicated Population (%)	Adjusted Access Rate, Indicated (%)	Ratio of White to Non-White Access, General	Ratio of White to Non-White Access, Indicated
Mechanical Thrombectomy	Black, Non-dual	116,108	0.60	3.72	18.47	0.64	0.82
	Black, Dual-eligible	68,681	1.22	7.67	14.86	0.57	0.80
	Other, Non-dual	121,036	0.37	1.86	20.91	1.03	0.72
	Other, Dual-eligible	66,507	0.84	4.45	20.99	0.82	0.57
	White, Non-dual	1,329,893	0.38	3.19	15.16	1.00	1.00
	White, Dual-eligible	230,733	0.69	5.47	11.90	1.00	1.00
Thrombolysis	Black, Non-dual	116,108	0.32	3.72	9.04	0.84	1.07
	Black, Dual-eligible	68,681	0.68	7.67	7.52	0.69	1.01
	Other, Non-dual	121,036	0.18	1.86	9.14	1.49	1.06
	Other, Dual-eligible	66,507	0.36	4.45	8.22	1.32	0.93
	White, Non-dual	1,329,893	0.27	3.19	9.65	1.00	1.00
	White, Dual-eligible	230,733	0.47	5.47	7.63	1.00	1.00

Results: Orthopedic

Musculoskeletal impairments, or conditions and injuries related to bones, joints, muscles, and connective tissue, are the leading cause of disability in the United States.[16] Roughly half of all American adults suffer from some type of musculoskeletal impairment, making it more prevalent than circulatory and respiratory conditions. As the nation's population continues to age, the prevalence and related burden and cost of musculoskeletal impairments will continue to increase. Health disparities in the management of osteoarthritis and joint replacement are well-documented.[17]

Our analysis focused on hip and knee replacements, ankle replacements, and shoulder replacements. We limited our analysis to osteoarthritis and rheumatoid arthritis and excluded trauma-related replacements. As a result, differences may result in part due to likelihood of a diagnosis and potential issues with access to orthopedic specialists.

- **Hip arthroplasty**, or hip replacement, is among the most common surgical procedures in the United States. Done to improve function or relieve pain that has resulted from a traumatic injury to the hip or degenerative disease (i.e., osteoarthritis), the procedure involves removing damaged bone and cartilage and replacing it with prosthetic components. Total hip replacements are more common, but we examined both partial and total hip replacements and restricted analysis to non-traumatic joint replacement (i.e., osteoarthritis-related rather than fracture-related).
- **Knee arthroplasty**, also known as knee replacement, is a very common surgical procedure in the United States. Knee replacement is performed to improve mobility and physical function, relieve pain, and correct leg deformities, most commonly for osteoarthritis. During the procedure, damaged cartilage on the surface of the femur and tibia and some underlying bone are removed and replaced with an implant. Total knee replacements are also more common than partial knee replacements, but we examined both partial and total knee replacements and restricted analysis to non-traumatic joint replacements.
- **Total ankle arthroplasty** treats swelling, inflammation, and pain that result in mobility issues, primarily among patients with osteoarthritis. The damaged ankle joint is replaced with a prosthetic. Ankle replacement is less common than hip or knee replacements due in part to the complexity of the joint, alignment of the ankle relative to other joints, and weight bearing.
- **Total shoulder arthroplasty** is an effective procedure to treat shoulder pain and disability, typically caused by osteoarthritis but also rotator cuff injuries and avascular necrosis. The analysis includes both anatomical and reverse replacement of the deteriorated parts of the shoulder joint with a prosthesis.

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[16] https://www.boneandjointburden.org/

[17] Reyes AM, Katz JN. (2021). Racial/Ethnic and Socioeconomic Disparities in Osteoarthritis Management. *Rheum Dis Clin North Am, 47*(1):21-40. doi: 10.1016/j.rdc.2020.09.006. Epub 2020 Oct 29. PMID: 34042052; PMCID: PMC8161947.

Partial Hip Replacement Age and Gender-Standardized Rates

The proportion of the general population that received a hip replacement varied from 0.11% for the Black non-dual-eligible population to 0.58% for the White dual-eligible population. White beneficiaries were two to three times more likely to receive the procedure than Black or Other race beneficiaries. Access rates were higher for dual-eligibles of all races.

The proportion of beneficiaries in the indicated population ranged from 3.0% to 6.6% across all cohorts. This translated to access rates in the indicated population ranging from 1.8% to 7.2%. Limiting to the indicated population reduced but did not eliminate the observed racial differences of White to Black or White to Other race beneficiaries. White beneficiaries were a little more than twice as likely to obtain partial hip replacements as Black beneficiaries among non-dual and dual beneficiaries, and 1.1 to 1.7 times more likely to obtain the procedure relative to beneficiaries in Other race categories.

Total Hip Replacement Age and Gender-Standardized Rates

White beneficiaries had the highest access rates for total hip replacement, regardless of dual-eligibility status. Across all groups, access rates in the general population varied from less than 0.3% for Other dual-eligible beneficiaries to over 1.0% for White non-dual-eligible beneficiaries. White beneficiaries were 1.41 (dual) to 1.78 (non-dual) times more likely to receive the procedure than Black beneficiaries; and, White beneficiaries were more than twice as likely to receive total hip replacement as those in the Other race category for both dual (2.35 times) and non-dual (2.12 times) populations.

Total hip replacement shared the same indicated population as partial hip replacement, so the indicated population breakdown was identical. Limiting to the indicated population reduced the relative disparity in access rates: the disparity for the indicated population of Black non-duals declined to 1.48 from 1.78; among Other race beneficiaries there was a more substantial reduction in the White-to-Other access ratio, to 1.14 from 2.12 among non-duals and 1.28 from 2.35 among duals. Here the reduction in disparity is driven by higher rates of arthritis diagnoses. For example, the White diagnosis rate (6.2%) was more than twice that observed among Other race beneficiaries (3.0%); similar but less extreme differences were observed for diagnosis among White versus Black non-dual-eligible Medicare beneficiaries.

Partial Knee Replacement Age and Gender-Standardized Rates

Access rates in the general population for partial knee replacement varied from 0.01% for Black dual-eligible beneficiaries to 0.1% for White non-dual-eligible beneficiaries. A comparison by race showed sizable differences relative to the White population regardless of dual-eligibility status. White beneficiaries were three to four times as likely to receive a partial knee replacement as Black beneficiaries and were 1.2 to 1.8 times more likely to receive the procedure than beneficiaries in the Other race category.

The indicated population varied from 9.2% of other non-dual-eligible beneficiaries to 19.8% of dual-eligible Black enrollees. Within the indicated population, the access rate varied from 0.2% in Black dual-eligible beneficiaries to 0.8% in White non-dual-eligible beneficiaries. Compared to the general population, there was an even greater relative difference in access for Black beneficiaries compared to White beneficiaries: White beneficiaries were 4.1 (non-dual) to 4.8 (dual) times as likely to receive the procedure as Black beneficiaries. The results by dual-eligibility for both the general and indicated population showed a higher access rate for non-dual-eligible beneficiaries.

Total Knee Replacement Age and Gender-Standardized Rates

Access rates in the general population for total knee replacement varied from 0.8% for Black dual-eligible beneficiaries to 1.8% for White non-dual-eligible beneficiaries. White beneficiaries, on the other hand, had access rates in the 1.0% to 1.8% range. While the access disparity ratios were sizable, they were smaller than those observed for partial knee replacements. In terms of dual-eligibility status, the non-dual population had higher access rates across all racial groups.

The indicated population was the same as for partial knee replacement. Within the indicated population, the access rate for non-dual-eligible beneficiaries was approximately twice that of dual-eligible beneficiaries across all racial groups. For instance, Black non-dual-eligible beneficiaries had a 7.0% access rate, compared to 3.4% for the dual-eligible black population, and 9.5% v. 5.3% for Other race, and 12.6% v. 5.7% for White beneficiaries. In terms of relative differences, there was divergence by race. Black beneficiaries had higher disparity ratios relative to Whites (1.68 for dual, 1.8- for non-dual) in the indicated population compared to the general population than observed for Other races (1.08 for dual, 1.33 for non-dual).

Total Ankle Replacement Age and Gender-Standardized Rates

The access rates in the general population for total ankle replacement were relatively low, varying from less than 0.01% to 0.2%, too low to report for Other dual-eligibles. A comparison by race shows access rates were highest amongst White beneficiaries, regardless of dual-eligibility status. There were sizable relative differences in access, particularly between White and Black race beneficiaries: White beneficiaries were 4 (non-dual) to 11 (dual) times more likely to receive a total ankle replacement than Black beneficiaries. The variation in the magnitude of the difference reflected the relatively small number of total ankle replacements overall.

The indicated population varied from 2.0% of other non-dual-eligible beneficiaries to 5.4% of dual-eligible Black enrollees. Even within the indicated population, access rates were relatively low, varying from less than 0.1% for Black dual-eligible beneficiaries to 0.7% for White non-dual-eligible beneficiaries. Compared to the general population, the ratio of White to Black access rates was even more skewed in favor of White beneficiaries.

Total Shoulder Replacement Age and Gender-Standardized Rates

Shoulder replacement is also a relatively low volume procedure compared to total hip and knee replacements. Access rates in the general Medicare population for total shoulder replacement varied from 0.1% for Other dual-eligible beneficiaries to 0.4% for White non-dual-eligible beneficiaries. In the non-dual-eligible population, White non-dual-eligible beneficiaries were 2.7 times as likely to receive a total shoulder replacement as Black beneficiaries; for dual-eligibles, the corresponding ratio was 2.3. For the Other race non-dual-eligible population, White beneficiaries were 2.5 times more likely to receive the procedure than beneficiaries; among dual-eligible beneficiaries, the White to Other access ratio was 2.9.

The indicated population varied from 3.5% (Other non-dual-eligible beneficiaries) to 7.3% (Black dual-eligible beneficiaries). Within the indicated population, the access rate varied from 1.6% in Black dual-eligible beneficiaries to 7.2% among White non-dual-eligible beneficiaries. Compared to the general population, there was a decline in the relative differences by race for all beneficiaries compared to White beneficiaries. Across racial categories, non-dual-eligible beneficiaries were more likely to access shoulder replacement surgery.

Figure 4: Age and Gender Standardized Rates of Orthopedic Technologies, 2018-2019.

Procedure	Population	N (people)	Adjusted Access Rate, General (%)	Indicated Population (%)	Adjusted Access Rate, Indicated (%)	Ratio of White to Non-White Access, General	Ratio of White to Non-White Access, Indicated
Partial Hip Arthroplasty	Black, Non-dual	116,108	0.11	4.86	1.80	2.55	2.06
	Black, Dual-eligible	68,681	0.27	6.59	3.54	2.13	2.03
	Other, Non-dual	121,036	0.12	3.03	3.33	2.33	1.12
	Other, Dual-eligible	66,507	0.19	3.93	4.13	3.01	1.74
	White, Non-dual	1,329,893	0.29	6.22	3.71	1.00	1.00
	White, Dual-eligible	230,733	0.58	6.49	7.17	1.00	1.00
Total Hip Arthroplasty	Black, Non-dual	116,108	0.58	4.86	12.59	1.78	1.48
	Black, Dual-eligible	68,681	0.42	6.59	6.30	1.41	1.41
	Other, Non-dual	121,036	0.49	3.03	16.33	2.12	1.14
	Other, Dual-eligible	66,507	0.26	3.93	6.94	2.35	1.28
	White, Non-dual	1,329,893	1.03	6.22	18.62	1.00	1.00
	White, Dual-eligible	230,733	0.60	6.49	8.90	1.00	1.00
Partial Knee Arthroplasty	Black, Non-dual	116,108	0.03	14.70	0.19	3.92	4.13
	Black, Dual-eligible	68,681	0.01	19.77	0.05	3.39	4.79
	Other, Non-dual	121,036	0.06	9.19	0.60	1.80	1.32
	Other, Dual-eligible	66,507	0.03	17.65	0.17	1.17	1.43
	White, Non-dual	1,329,893	0.10	14.55	0.79	1.00	1.00
	White, Dual-eligible	230,733	0.04	15.81	0.24	1.00	1.00
Total Knee Arthroplasty	Black, Non-dual	116,108	1.08	14.70	6.95	1.62	1.80
	Black, Dual-eligible	68,681	0.78	19.77	3.39	1.30	1.68
	Other, Non-dual	121,036	0.90	9.19	9.46	1.94	1.33
	Other, Dual-eligible	66,507	0.98	17.65	5.28	1.02	1.08
	White, Non-dual	1,329,893	1.75	14.55	12.55	1.00	1.00
	White, Dual-eligible	230,733	1.00	15.81	5.68	1.00	1.00
Total Ankle Arthroplasty	Black, Non-dual	116,108	0.01	3.32	0.15	4.15	4.66
	Black, Dual-eligible	68,681	0.00	5.41	0.02	10.94	13.26
	Other, Non-dual	121,036	0.01	1.98	0.65	1.87	1.08
	Other, Dual-eligible	66,507	*	3.49	*	*	*
	White, Non-dual	1,329,893	0.02	3.71	0.70	1.00	1.00
	White, Dual-eligible	230,733	0.01	4.81	0.23	1.00	1.00
Total Shoulder Arthroplasty	Black, Non-dual	116,108	0.15	5.11	2.68	2.74	2.66
	Black, Dual-eligible	68,681	0.12	7.32	1.58	2.34	2.33
	Other, Non-dual	121,036	0.17	3.47	4.78	2.49	1.50
	Other, Dual-eligible	66,507	0.10	5.35	1.72	2.91	2.13
	White, Non-dual	1,329,893	0.41	5.91	7.15	1.00	1.00
	White, Dual-eligible	230,733	0.29	6.87	3.67	1.00	1.00

Results: Spine

A major cause of disability and healthcare spending in the United States, spinal disorder, like lower back and neck pain, impacts 1 in 4 American adults. Lower back pain, specifically, has been cited as a primary reason for premature retirement and has cost American workers more than $131 billion annually.[18] Recent work has documented differences in treatment patterns and outcomes associated with race for interventions treating these conditions.[19]

- **Artificial disc replacement** is a relatively new surgical procedure, approved in the U.S. in 2004, that has emerged as an alternative to spinal fusion. The procedure involves the removal of damaged disc material between the vertebrae and replacement with artificial discs, allowing for a normal range of motion.[20]
- **Spinal fusion** is the most common surgical treatment option for back pain. During the procedure, a surgical team will join vertebrae to prevent painful movement or improve spinal stability.[21]

Artificial Disc Replacement Age and Gender-Standardized Rates

The proportion of the general population that received a cervical disc replacement varied from 0.3% (Other race dual-eligible) to 0.6% (White non-duals). Across racial categories, the Black and Other race populations generally had lower access rates than the White population. White beneficiaries were 1.21 (dual) to 1.57 (non-dual) times more likely to receive a disc replacement than Black beneficiaries. The corresponding differences for Other race beneficiaries (1.60 and 1.82) were even greater.

Identification rates for the eligible population were generally four to seven percentage points higher for dual-eligibles across races (White=25.7% v. 21.6%; Black=22.5% v. 16.5%; and, Other=19.3% v. 12.1%). As a result of the higher indicated populations, the relative differences in access within the indicated population declined (i.e., the ratios moved closer to parity of 1.0 between groups).

Spinal Fusion Age and Gender-Standardized Rates

Less than 1% of the general population received spinal fusion surgery. However, there was substantial variation in the access rate across racial groups and by dual-eligibility status. White beneficiaries were 1.2 to 1.6 times more likely to get the procedure relative to Black beneficiaries and 1.6 to 1.9 times more likely than beneficiaries in the Other category. White and Black non-duals were somewhat more likely to receive disc fusion than White and Black dual eligibles, while Other race duals were more likely to receive the procedure than Other race non-duals.

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[18] https://www.boneandjointburden.org/docs/By%20The%20Numbers%20-%20Back%20Pain.pdf

[19] Cardinal T, Bonney PA, Strickland BA, Lechtholz-Zey E, Mendoza J, Pangal DJ, Liu J, Attenello F, Mack W, Giannotta S, Zada G. (2022). Disparities in the Surgical Treatment of Adult Spine Diseases: A Systematic Review. *World Neurosurg, 158*:290-304.e1. doi: 10.1016/j.wneu.2021.10.121. Epub 2021 Oct 21. PMID: 34688939.

[20] Othman YA, Verma R, Qureshi SA. (2019). Artificial disc replacement in spine surgery. *Ann Transl Med, 7(Suppl 5):*S170. doi: 10.21037/atm.2019.08.26. PMID: 31624736; PMCID: PMC6778281.

[21] https://orthoinfo.aaos.org/en/treatment/artificial-disk-replacement-in-the-lumbar-spine/

The identification rates by race and dual-eligibility status were comparable to those observed for the disc replacement procedure. The access patterns by race and dual eligibility shifted for the indicated population similar to what was observed for disc replacement. Access rates varied from a low of 2.5% for Other non-dual-eligibles to 4.6% for White non-dual-eligibles. White beneficiaries in the indicated population were more likely to receive the procedure, but the disparity in access rates was smaller: White beneficiaries were 1.07 (dual) to 1.24 (non-dual) times as likely to receive a disc fusion, compared to 1.17 for dual and non-dual eligibles in the Other race category.

Figure 5: Age and Gender Direct Standardized Rates of Spinal Technologies, 2018-2019.

Procedure	Population	N (people)	Adjusted Access Rate, General (%)	Indicated Population (%)	Adjusted Access Rate, Indicated (%)	Ratio of White to Non-White Access, General	Ratio of White to Non-White Access, Indicated
Artificial Disc Replacement	Black, Non-dual	116,108	0.38	16.53	2.27	1.57	1.29
	Black, Dual-eligible	68,681	0.40	22.51	1.66	1.21	1.11
	Other, Non-dual	121,036	0.33	12.08	2.63	1.82	1.11
	Other, Dual-eligible	66,507	0.30	19.25	1.58	1.60	1.17
	White, Non-dual	1,329,893	0.60	21.61	2.92	1.00	1.00
	White, Dual-eligible	230,733	0.48	25.66	1.84	1.00	1.00
Spinal Fusion	Black, Non-dual	116,108	0.62	16.95	3.68	1.57	1.24
	Black, Dual-eligible	68,681	0.66	23.46	2.68	1.20	1.07
	Other, Non-dual	121,036	0.50	12.55	3.92	1.93	1.17
	Other, Dual-eligible	66,507	0.48	20.29	2.46	1.63	1.17
	White, Non-dual	1,329,893	0.97	22.53	4.57	1.00	1.00
	White, Dual-eligible	230,733	0.79	27.40	2.88	1.00	1.00

Results: Respiratory

Respiratory diseases are among the leading cause of morbidity and mortality around the world. One of the most common respiratory diseases, chronic obstructive pulmonary disease (COPD), was the fourth-leading cause of death in the United States in 2018. Additionally, researchers identified a 3% increase in mortality associated with acute respiratory failure annually between 2014 and 2018, [22] a condition that only increased in prevalence and lethality during the COVID-19 pandemic. Due to the differences in major risk factors for respiratory disease across racial and socioeconomic groups, health disparities in the treatment of respiratory disease are common.[23]

- A **respiratory assist device** (RAD) is any device "intended to help patients in need of support for breathing, removal of carbon dioxide, and therapy to reduce disuse atrophy of abdominal wall muscles."[24] We examined use of this intervention among patients with COPD and disorders affecting breathing (e.g., amyotrophic lateral sclerosis and restrictive lung disease).
- **Positive airway pressure (PAP)** therapies refers to sleep apnea treatment that uses a stream of compressed air to support the airway during sleep. A machine blows pressurized air into the patient's upper airways through a tube connected to a full or partial mask to prevent the airway from collapsing.[25]
- **At-home mechanical ventilators**, like their hospital versions, are used to treat severe respiratory failure.[26] Generally, these machines operate in one of two ways: either by applying a positive pressure on airways (more common), or by applying a negative pressure on the chest. We examined use in an indicated population of COPD or Chronic Respiratory Failure.

Respiratory Assist Device Age and Gender-Standardized Rates

There was limited variation in the rate of respiratory assist device use amongst the general population groups. Use of a RAD in the general population varied from a low of 0.3% (Other race) to 0.7% (White non-dual). The rates of device use by dual-eligibility status were also similar within race.

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[22] Parcha V, Kalra R, Bhatt SP, Berra L, Arora G, Arora P. (2021). Trends and Geographic Variation in Acute Respiratory Failure and ARDS Mortality in the United States. *Chest, 159*(4):1460-1472. doi: 10.1016/j.chest.2020.10.042. Epub 2020 Oct 22. PMID: 33393472; PMCID: PMC7581392.

[23] Celedón JC, Roman J, Schraufnagel DE, Thomas A, Samet J. (2014). Respiratory health equality in the United States. The American thoracic society perspective. *Ann Am Thorac Soc, 11*(4):473-9. doi: 10.1513/AnnalsATS.201402-059PS. PMID: 24625275; PMCID: PMC4225793.

[24] https://www.fda.gov/medical-devices/coronavirus-disease-2019-covid-19-emergency-use-authorizations-medical-devices/respiratory-assist-devices-euas#:~:text=Respiratory%20assist%20devices%20include%20devices,atrophy%20of%20abdominal%20wall%20muscles

[25] Pinto VL, Sharma S. Continuous Positive Airway Pressure. [Updated 2022 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482178/

[26] Park S, Suh ES. (2020). Home mechanical ventilation: back to basics. *Acute Crit Care, 35*(3):131-141. doi: 10.4266/acc.2020.00514. Epub 2020 Aug 31. PMID: 32907307; PMCID: PMC7483009.

White beneficiaries were most likely to be in the indicated population (13.2% to 27.6%) compared to Black (9.1% to 19.8%) and Other (5.6% to 13.2%) race. Dual-eligibles of all races were twice as likely to be in the indicated population as non-dual-eligibles.

Within the indicated population, however, the pattern for adjusted access rates changed. Other race non-duals (6.2%) were most likely to use respiratory assist devices compared to White (5.5%) and Black (4.7%) beneficiaries. A similar pattern was observed among dual-eligibles. Restricting to the indicated population, with the higher identification rates among the White population, eliminated the White access advantage in the general population, even leading to a reversal in direction among Other race beneficiaries.

Positive Airway Pressure (PAP) Age and Gender-Standardized Rates

The PAP utilization rate in the general population ranged from 1.7% for Other racial minorities who were dual-eligibles to 3.3% for Whites that were non-duals. Overall in the general population, non-duals of any race tended to access PAP at a higher rate than dual-eligibles.

White and Black race beneficiaries were more likely to be in the indicated population (i.e., have an apnea diagnosis): White dual-eligible (14.2%) and non-dual-eligible (12.9%) had the highest rates of apnea diagnosis, compared to Black (dual=13.2%, non-dual 10.6%) and Other (dual=7.9%, non-dual 7.9%) race beneficiaries.

Access rates in the indicated population for non-duals were relatively similar: 26.0% for White, 24.7% for Black and 25.7% for Other race beneficiaries. Among the dual-eligible, racial minorities had higher adjusted access rates: Other race beneficiaries had an access rate of 22.9% compared to 19.1% for Black and 18.4 for White. We saw this narrowing of racial differences in access in the White-to-Black and White-to-Other access ratios: The White-to-Black access ratio fell from 1.29 and 1.13 for non-dual and dual eligibles, respectively, to 1.05 and 0.96; the White-to-Other access ratio fell an even greater amount, from 1.74 and 1.47 for non-dual and dual eligibles to 1.01 and 0.81.

Home Ventilation Age and Gender-Standardized Rates

Dual-eligibles in the general population were more likely to use home ventilators, with access rates at least three times greater than their same race peers in the non-dual eligible category. Regardless of dual status, Black Medicare beneficiaries had slightly higher rates of home ventilation use (dual=1.86, non-dual=0.53) than White (dual=1.51, non-dual 0.45) Medicare beneficiaries, with Other race beneficiaries accessing at the lowest rates (dual=0.81, non-dual=0.27).

In contrast, White Medicare beneficiaries were more likely to have a diagnosis that placed them in the indicated population than Black or Other race beneficiaries, regardless of dual status. White Medicare beneficiaries were more than twice as likely as Other race beneficiaries and about 40% more likely to have a qualifying diagnosis as Black race beneficiaries.

As a result of this disparity in identification, the access rates, which already slightly favored minorities in the general population seem to suggest even better access among the indicated population: White

Medicare beneficiaries were about 36-40% less likely to access home ventilators than Black Medicare beneficiaries and 21-25% less likely than Other race Medicare beneficiaries.

Figure 6: Age and Gender Direct Standardized Rates of Respiratory Technologies, 2018-2019.

Procedure	Population	N (beneficiaries)	Adjusted Access Rate, General (%)	Indicated Population (%)	Adjusted Access Rate, Indicated (%)	Ratio of White to Non-White Access, General	Ratio of White to Non-White Access, Indicated
Respiratory Assist Device	Black, Non-dual	116,108	0.40	9.10	4.66	1.64	1.19
	Black, Dual-eligible	68,681	0.52	19.84	2.55	1.34	1.00
	Other, Non-dual	121,036	0.34	5.58	6.16	1.91	0.90
	Other, Dual-eligible	66,507	0.34	13.22	2.87	2.08	0.89
	White, Non-dual	1,329,893	0.66	13.22	5.54	1.00	1.00
	White, Dual-eligible	230,733	0.70	27.58	2.54	1.00	1.00
PAP	Black, Non-dual	116,108	2.58	10.58	24.69	1.29	1.05
	Black, Dual-eligible	68,681	2.25	13.18	19.14	1.13	0.96
	Other, Non-dual	121,036	1.91	7.91	25.73	1.74	1.01
	Other, Dual-eligible	66,507	1.73	7.86	22.86	1.47	0.81
	White, Non-dual	1,329,893	3.33	12.88	25.99	1.00	1.00
	White, Dual-eligible	230,733	2.54	14.17	18.44	1.00	1.00
Home Ventilator	Black, Non-dual	116,108	0.53	8.86	6.56	0.85	0.60
	Black, Dual-eligible	68,681	1.86	19.82	8.04	0.82	0.64
	Other, Non-dual	121,036	0.27	5.29	5.25	1.63	0.75
	Other, Dual-eligible	66,507	0.81	13.06	6.54	1.87	0.79
	White, Non-dual	1,329,893	0.45	12.82	3.92	1.00	1.00
	White, Dual-eligible	230,733	1.51	27.52	5.15	1.00	1.00

Results: Cancer Screening

Lung and colon cancer are relatively common cancers that can be managed with early detection and that have evidence supporting screening.[27] Because these conditions emerge over the course of a lifetime and have important time-dependent qualifications,[28] these annual access rates understate the prevalence of screenings. For lung cancer in particular, differences by race are difficult to interpret because the guidelines recommend screening only among smokers (20 pack-year history) and because of differential rates of smoking by race. Nevertheless, we present them for an annualized insight into potential racial disparities in their utilization.

Lung Cancer Age and Gender-Standardized Rates

The lung cancer screening rates for non-dual-eligibles ages 50 to 80 years old varied from 0.6% to 1.8% and from 1.0% to 2.9% among dual-eligibles in the general Medicare population. White Medicare beneficiaries were the most likely to receive lung cancer screening among dual and non-duals, and those of Other race were least likely.

The indicated population was limited to those in the general population not diagnosed in the prior year with lung cancer. (This avoided excluding cases who might screen positive for lung cancer in the current year.) However, because relatively few people are diagnosed with lung cancer, the adjusted access rates did not change appreciably.

Colon Cancer Age and Gender-Standardized Rates

Relative to lung cancer, the colon cancer screening rates among Medicare beneficiaries ages 45 to 75 years old were much higher in the general population. This likely is due in part to the broader applicability of screening recommendations. Among non-duals, White beneficiaries were more likely than either Black (22%) or Other race (25%) beneficiaries to receive a colon cancer screening. Because relatively few people were diagnosed with colon cancer, restricting to the indicated population did not change the results very much.

Among dual-eligibles, White beneficiaries were somewhat less likely to receive cancer screenings than Black (2%) and Other race (20%) beneficiaries, with comparable findings when restricted to the indicated population.

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[27] U.S. Preventive Services Task Force has guidelines for lung cancer (https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/lung-cancer-screening) and colon cancer (https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/colorectal-cancer-screening).

[28] The eligibility guidelines for lung cancer, for example, are tied to current smoking status, which we do not have available. Guidelines for colon cancer screening recommend screening up to every 10 years (interval varies by testing method), which is beyond the scope of the data available for the current study.

Figure 7: Age and Gender Direct Standardized Rates of Cancer Screening, 2018-2019.

Procedure	Population	N (beneficiaries)	Adjusted Access Rate, General (%)	Indicated Population (%)	Adjusted Access Rate, Indicated (%)	Ratio of White to Non-White Access, General	Ratio of White to Non-White Access, Indicated
Cancer Screening, Lung	Black, Non-dual	96,031	0.89	99.57	0.89	1.82	1.82
	Black, Dual-eligible	45,810	1.82	99.20	1.84	1.60	1.60
	Other, Non-dual	104,546	0.61	99.70	0.62	2.64	2.65
	Other, Dual-eligible	43,525	0.95	99.49	0.96	3.05	3.06
	White, Non-dual	1,056,107	1.62	99.35	1.63	1.00	1.00
	White, Dual-eligible	151,455	2.91	99.07	2.94	1.00	1.00
Cancer Screening, Colon	Black, Non-dual	85,050	20.40	99.36	20.54	1.22	1.22
	Black, Dual-eligible	45,108	25.43	99.14	25.71	0.98	0.98
	Other, Non-dual	95,110	19.83	99.53	19.93	1.25	1.26
	Other, Dual-eligible	37,226	31.32	99.23	31.57	0.79	0.80
	White, Non-dual	866,362	24.88	99.34	25.05	1.00	1.00
	White, Dual-eligible	144,817	24.86	99.17	25.11	1.00	1.00

Discussion

This analysis of age and gender standardized access rates identified several important patterns in terms of potential disparities in the use of interventions for common chronic and acute conditions. First, it has documented evidence of differential access to key interventions across a wide range of clinical conditions. Some of these disparities, such as in hip and knee replacement, are well known in the literature.[29] They appear across a broad mix of clinical systems from cardiovascular and neurovascular to spinal, respiratory, and primary prevention activities like lung and colon cancer screenings.

The interpretation of these differences depends upon the relevant comparison groups, whether we are looking at the general Medicare population or the subset of cases with a diagnosis appropriate to the condition being treated. This analysis highlighted the potential impact of differences in identification rates in interpreting differences in utilization.

For example, the disparity between White and Black Medicare beneficiaries in cardiac ablation were less pronounced in the indicated population of patients with arrhythmias than in the general population. If one takes the indicated population as defining who is appropriate to receive treatment, then the fact the disparity declines seems encouraging because a portion of the greater utilization in the population was due to higher clinical need.

However, the higher rate of identification of cardiac arrhythmias itself reflects differences in access to services that could detect arrhythmias. Black patients have higher rates of clinical risk factors for cardiac arrhythmias and yet are diagnosed less frequently.[30] Thus, narrowly focusing on the population that is clinically indicated for treatment understates the degree of disparity. That is, the rate observed in the general population may be a better estimate of the true difference between Black and White Medicare beneficiaries. We will explore some of these potential issues in more depth in the forthcoming Phase II report.

The analysis also identified potential disparities by dual-eligibility status.[31] The dual-eligibility patterns were similar in magnitude to the racial disparities. However, for certain interventions (e.g., angioplasty) the differences due to dual-eligibility status were less extreme. This may reflect the narrowness of the clinical population examined (e.g., using only primary diagnosis) and the urgency or time-sensitivity of the treatment (e.g., presenting with acute myocardial infarction). Disparities in access by gender were more varied.[32] For some interventions like partial hip replacement and colon cancer screening, women were

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[29] Chun DS, Leonard AK, Enchill Z, Suleiman LI. (2021). Racial Disparities in Total Joint Arthroplasty. *Curr Rev Musculoskelet Med, 14*(6):434-440. doi: 10.1007/s12178-021-09718-3. Epub 2021 Oct 9. PMID: 34626322; PMCID: PMC8733080.

[30] Nanda A, Kabra R. (2019). Racial Differences in Atrial Fibrillation Epidemiology, Management, and Outcomes. *Curr Treat Options Cardiovasc Med, 21*(12):85. doi: 10.1007/s11936-019-0793-5. PMID: 31820122.

[31] Gender is also considered and included in the appendix.

[32] The age and gender-standardized access rates remove the gender differences. See Appendix B for logistic regression results for the separate impact of gender.

more likely to access the service, and for several others (e.g., total knee replacement, home ventilator use), the odds of using the service were within plus or minus 5% of male beneficiaries.

The patterns across age, especially among the surgical interventions, seemed consistent with a mix of risk avoidance in the use of surgery for older adults and perhaps more limited time horizon for clinical benefits. The exception to this pattern was in the valve replacement procedure, where the oldest age categories were more likely to receive the service. In this case, the intervention itself represents a less-invasive treatment option that makes the service more available relative to the current standard of care.

Conclusion

This Phase I analysis presents an initial picture of the magnitude of differences in access to a broad set of technologies used to treat common health conditions. Whether these differences represent disparities requires additional consideration of the factors that give rise to these differences and that may potentially explain the differences. Factors include differential access to services more broadly, differential health status and complications, and community factors influencing the availability of services and clinical practice patterns.

Subsequent analyses, to be presented in Phase II and Phase III, will focus on cardiovascular and neurovascular conditions for several reasons. First, a large number of studies substantiate significant racial disparities in the use of orthopedic procedures, particularly hip and knee replacements. Additional analysis within the Medicare population would contribute little additional insight into the magnitude or reasons for these disparities. Second, the cardiovascular and neurovascular interventions exhibited a meaningful pattern of racial disparity compared to the other conditions selected. These services also had relatively high frequency of utilization for common conditions that translate into meaningful opportunity for improvement. Third, the eligible populations for the cardiovascular and neurovascular interventions are clinically related, which will allow us to examine a broader pattern of disparity. For example, failure to identify and treat arrhythmias and atrial fibrillation potentially shifts patients from one eligible population (e.g., cardiac ablation) to another (e.g., the ischemic stroke population eligible to receive mechanical thrombectomy and thrombolysis).

Phase II will address what is known about racial disparities for the cardiovascular and neurovascular conditions and identify potential opportunities for intervention to reduce disparities. Phase III will extend the Phase I analysis to address additional sources of utilization differences, including clinical factors beyond diagnosis (e.g., comorbid conditions) and community-level factors, to assess the impact of incorporating these differences in determining the degree of difference between groups and help assess whether the difference represents a disparity.

Appendix A: Methods

Data Sources

Data for this analysis came from the 5 percent sample of the Medicare Standard Analytic File and the Medicare Beneficiary Summary Files for calendar years 2018 and 2019:

- 100% Medicare Beneficiary Summary File (subset to the 5 percent sample)
- 100% Medicare Inpatient Standard Analytic Files (subset to the 5 percent sample)
    - Claims file – identifies clinical diagnoses, procedure codes, and DRGs.
    - Revenue code file – identifies hospital revenue codes and HCPCS and CPT codes.
    - Condition code file – identifies claim-related conditions (an additional CMS coding system relevant for some of the procedures/services of interest).
- 5% Medicare Outpatient Standard Analytic Files
    - Claims file – identifies clinical diagnoses and procedure codes.
    - Revenue code file – identifies hospital revenue codes and HCPCS and CPT codes for relevant procedures/services.
    - Condition code file – identifies claim-related conditions (an additional CMS coding system relevant for some of the procedures/services of interest).
- 5% Medicare Carrier Standard Analytic Files – records for services provided by clinical professionals (typically physicians) in inpatient, outpatient, or other (e.g., ambulatory surgical center) settings.
    - Claims file – identifies clinical diagnoses.
    - Line file – identifies HCPCS and CPT codes for relevant procedures/services.
- 5% Medicare Durable Medical Equipment Standard Analytic Files – records for physical devices or equipment that may be relevant to procedures/services of interest
    - Claims file – identifies clinical diagnoses.
    - Line file – identifies HCPCS and CPT codes for relevant procedures/services.

Study Variables

Dependent Variables We identified, for each service type (e.g., valve replacement, partial knee replacement) whether a beneficiary received that service at least once in the year. Each service was identified using codes from one or more of these systems, varying by service:

- ICD-10-PCS procedure codes.
- HCPCS/CPT codes.
- MS-DRGs.
- Hospital revenue codes.
- Claim-related condition codes.
- Ambulatory payment classification code.

We then identified whether the beneficiary data indicated receipt of each intervention in any of the file types and coding systems. For example, partial knee replacement used codes from the ICD-10 and CPT coding systems. We identified whether the beneficiary had any indication of partial knee replacement from any of the inpatient, outpatient, carrier and DME files using either coding system. If there was an occurrence (e.g., a partial knee replacement ICD-10 procedure code in the inpatient file), then the beneficiary will receive a "1" indicating that she received the service.

Next, we identified whether the beneficiary had any indication of a relevant diagnosis to define them as an "indicated population" for the service. For example, cardiac valve replacement is indicated for patients diagnosed with aortic stenosis. We identified whether each beneficiary had a diagnosis of aortic stenosis in the year. We repeated this process for the diagnoses relevant to each service, using logic specific to the condition (e.g., ablation required a primary diagnosis of atrial fibrillation or cardiac arrhythmia). Some procedures have multiple relevant diagnoses (e.g., partial knee replacement indications included osteoarthritis and rheumatoid arthritis). We flagged each beneficiary as having any indication of each diagnosis and then summarized for the beneficiary whether she was part of the indicated population (i.e., if the beneficiary had osteoarthritis or rheumatoid arthritis of the knee on any record then she was flagged for the partial and full knee replacement populations).

Finally, we combined the annual summaries to produce a pooled 2018-2019 analytic file by merging the annual denominator files to the claims summary files containing the service and diagnosis indicators.

Independent Variables We defined the following independent variables:

- Age: We used the age variable on the MBSF for the beneficiary in that year. The age variable on the file is the beneficiary's age on January 1. We added one year to the age category based on age at the end the year; this allows patients who start the year at age 64, for example, to count in the 65-74 age group so as not to distort the utilization patterns for those under age 65, who are more likely to be eligible through disability coverage. We created the following age categories: 18-44, 45-64, 65-74, 75-84, and 85 and older. For lung cancer and colon cancer, we restricted the ages to align with clinical guidelines:
  - Lung cancer. 45-64, 65-74, and 75-80.
  - Colon cancer. 45-64, 65-75.
- Gender: We used the gender code (male or female) on the MBSF for the beneficiary in that year.
- Race/ethnicity: We used the race/ethnicity variable from the Medicare enrollment database to classify beneficiaries into three categories: White, Black, and Other.
- Dual-eligible beneficiaries: Dual-eligible beneficiaries were identified based on the dual status variable available in the Medicare Beneficiary Summary File. A beneficiary's dual eligibility status may change over time. For simplicity, if a beneficiary was identified as dual eligible (full or partial) at any point during the year), the person and her months of coverage were classified as dual-eligible.

Table A.1. Diagnosis and Procedure Codes Used to Identify Patient Populations and Service Recipients for Selected Cardiovascular and Neurovascular Interventions.

Procedure or Service	Conditions Appropriate	Procedure code lists (ICD10, HCPCS, other)	Coding Notes
Cardiovascular			
Cardiac Ablation	**Arrhythmias**: I49x, I49xx **Atrial Fibrillation**: I48x, I48xx	**CPT**: 93653, 93654, 93656, **ICD-10-PCS Codes**: 02553ZZ, 02563ZZ, 02573ZZ, 02583ZZ, 025K3ZZ, 025L3ZZ, 025M3ZZ, 025S3ZZ, 025T3ZZ	**Diagnosis**: Primary diagnosis only
Angioplasty with and without Drug Eluting Stent	**Acute Myocardial Infarction**: I21x, I21xx **Angina**: I20.x	**CPT/HCPCS:** 92928, 92929, 92933, 92937, 92943; C1874, C9600, C9602, C9604, C9607 **Ambulatory Payment Classifications (APC)**: 5193, 5194 **MS-DRG**: 246-249	**Diagnosis**: Primary diagnosis only **Procedure:** Inpatient must have MS-DRG 246-249
Transcatheter Aortic Valve Replacement	**Aortic stenosis**: I060, I062, I350, I352	**ICD-10-PCS Codes**: 02RF37H, 02RF37Z,02RF38H,02RF38Z, 02RF3JH, 02RF3JZ, 02RF3KH, 02RF3KZ	--
Neurovascular			
Mechanical Thrombectomy	**Acute Ischemic stroke**: I63.xx	**HCPCS**: C1757, C2628, C1894, C1887 **CPT**: 36215, 36216, 36217, 36218, 36221, 36222, 36223, 36224, 36225, 36226, 61623, 61624, 61626, 61630, 61635, 61645, 61650, 61651 **ICD10 PCS**: 03CG3Z7, 03CH3Z7, 03CJ3Z7,03CK3Z7, 03CL3Z7, 03CM3Z7, 03CN3Z7, 03CP3Z7, 03CQ3Z7, 03CG3ZZ, 03CH3ZZ, 03CJ3ZZ, 03CK3ZZ, 03CL3ZZ, 03CM3ZZ, 03CN3ZZ, 03CP3ZZ, 03CQ3ZZ **MS DRG**: 023, 024	**Diagnosis**: Primary diagnosis only
Thrombolysis	**Acute Ischemic stroke**: I63.xx	**HCPCS**: J0350, J2993 **CPT**: 37195, 37211 – 37214 , 37201, 92975 **ICD10 PCS**: 3E04317, 3E03317 **ICD10 DX:** Z92.82 **MS DRG**: 061, 062, 063	**Diagnosis**: Primary diagnosis only

Table A.2. Diagnosis and Procedure Codes Used to Identify Patient Populations and Service Recipients for Selected Orthopedic Interventions.

Procedure or Service	Conditions Appropriate	Procedure code lists (ICD10, HCPCS, other)	Coding Notes
Orthopedic			
Partial Hip Arthroplasty	**Osteoarthritis of hip**: M16x, M16xx **Rheumatoid Arthritis**: M05.15x 25x 35x 45x 55x 65x 75x 85x	**ICD-10-PCS Code:** 0SRA0xx, 0SRE0xx, 0SRR0xx, 0SRS0xx **CPT Codes:** 27125	Inpatient procedure code must have MS-DRG 469 or 470
Total Hip Arthroplasty	**Osteoarthritis of hip**: M16x, M16xx **Rheumatoid Arthritis**: M05.15x 25x 35x 45x 55x 65x 75x 85x	**ICD-10-PCS Code:** 0SR90xx, 0SRB0xx **CPT Codes:** 27130	Inpatient procedure code must have MS-DRG 469 or 470
Partial Knee Arthroplasty	**Osteoarthritis of knee**: M17x, M17xx **Rheumatoid Arthritis**: M05.16x 26x 36x 46x 56x 66x 76x 86x	**ICD-10-PCS Code:** 0SRC0Mx, 0SRC0Lx, 0SRD0Mx, 0SRD0Lx **CPT Codes:** 27446, 27438	Inpatient procedure code must have MS-DRG 469 or 470
Total Knee Arthroplasty	**Osteoarthritis of knee**: M17x, M17xx **Rheumatoid Arthritis**: M05.16x 26x 36x 46x 56x 66x 76x 86x	**ICD-10-PCS Code:** 0SRC0xx excluding 0SRC0Mx and 0SRC0Lx, and 0SRD0x excluding 0SRD0Mx and 0SRD0Lx **CPT Codes:** 27447	Inpatient procedure code must have MS-DRG 469 or 470
Total Ankle Arthroplasty	**Osteoarthritis of ankle/foot**: M19.07, M19.07x, M19.27, M19.27x **Rheumatoid Arthritis**: M05.17x, 27x, 37x, 47x 57x 67x 77x 87x	**ICD-10-PCS Code:** 0SRG0xx, 0SRF0xx **CPT Codes:** 27702, 27703	Inpatient procedure code must have MS-DRG 469 or 470
Total Shoulder Arthroplasty	**Osteoarthritis of shoulder**: M19.01, M19.01x, M19.21, M19.21x **Rheumatoid Arthritis**: M05.11x 21x 31x 41x 51x 61x 71x 81x **Rotator Cuff Tear**: M75.1, M75.120, 121, 122 **Arthropathy, Avascular Necrosis**: M87.011	**ICD-10-PCS Code:** 0RRK0xx, 0RRJ0xx **CPT Codes:** 23472	Inpatient procedure code must have MS-DRG 483

Table A.3. Diagnosis and Procedure Codes Used to Identify Patient Populations and Service Recipients for Selected Spinal and Respiratory Interventions.

Procedure or Service	Conditions Appropriate	Procedure code lists (ICD10, HCPCS, other)	Coding Notes
Spinal			
Artificial Disc Replacement	**Degenerative Disk Disease**: M47.x, .xx, .xxx	**ICD-10-PCS Code:** 0SR20xx, 0SR40xx, 0RR30xx, 0RR50xx, 0RR90xx, 0RRB0xx **CPT Codes:** 0095T, 0098T, 016xT, 2285x, 2286x	None
Spinal Fusion	**Degenerative conditions**: ▪ Degenerative disk disease – spondylosis: M47.x, .xx, .xxx ▪ Disc degeneration: M51.3x ▪ Spondylolisthesis: M43.1 ▪ disc herniation (M51.0x, .1x .2x), ▪ spinal stenosis (M48.0) **Deformity**: ▪ Scoliosis:M41x, xx ▪ Kyphosis: M40.x, xx, xxx	**ICD-10-PCS Code:** 0SG0xxx-0SG8xxx **CPT Codes:** 228xx, 23800, 23802	None
Respiratory			
Respiratory Assist Devices (RAD)	**COPD**: J44.0, J44.1, J44.9 **Neuromuscular disorders (ALS)**: G12.21 **Restrictive lung disease**: J98.4	**HCPCS**: E0470, E0471, E0472	None
Positive Airway Pressure (PAP)	**Sleep Apnea**: G47.3	**HCPCS:** E0601	None
Home ventilator	**Chronic Respiratory Failure**: J96.10,.11,.12, J96.20, .21, .22 **COPD**: J44.0, J44.1, J44.9	**HCPCS**: E0465, E0466, E0467, **ICD-10-CM**: Z99.11 Dependence on respirator [ventilator] status (treat this diagnosis as a procedure code)	None

Table A.4. Diagnosis and Procedure Codes Used to Identify Patient Populations and Service Recipients for Selected Cancer Screenings.

Procedure or Service	Conditions Appropriate	Procedure code lists (ICD10, HCPCS, other)	Coding Notes
Cancer Screening			
Lung Cancer	No diagnosis of lung cancer in prior year Aged 50-80 years old	**HCPCS**: G0296 **CPT**: 71271	None
Colon Cancer	No diagnosis of colon cancer in prior year Aged 45-75 years old	**HCPCS**: G0104, G0105, G0106, G0120, G0121, G0122, G0328 **CPT**: 81528, 82270, 82272, 82274, 44388, 44389, 44390, 44391, 44392, 44394, 44401, 44402, 44403, 44404, 44405, 44406, 44407, 44408, 45330, 45331, 45332, 45333, 45334, 45335, 45337, 45338, 45340, 45341, 45342, 45378, 45379, 45380, 45381, 45382, 45384, 45385, 45386, 45391, 45392	None

Appendix B: Logistic Regression Results

We estimated logistic regression models for each intervention. We used the pooled-across-years person-level file that contains indicators of receiving the service (numerator yes) and being in the indicated population. The dependent variable was receipt of the service (1=yes or 0=no). The explanatory variables were age, gender, race, and dual eligibility status. The analysis was weighted by the proportion of the two-year interval the beneficiary was eligible for Traditional Medicare (i.e., fee-for-service). The regression allowed us to separately estimate the impact of patient gender, race, and dual eligibility status on the odds of receiving the service of interest.

The reported odds ratios are relative to the following reference groups, with values less than 1.0 indicating lower odds of receiving the service relative to the reference group and values greater than 1.0 indicating higher odds:

- Race: White
- Gender: Male
- Dual-eligibility: Non-dual eligible beneficiaries
- Age: 65-74 year old (for colon cancer: 65-75 year old)

Figure B.1: Logistic Regression Predicting Utilization of Cardiovascular Technologies, 2018-2019.

VARIABLES	Cardiac Ablation odds ratio (robust std.err.)	Angioplasty odds ratio (robust std.err.)	TAVR odds ratio (robust std.err.)
Race (ref. White)			
Black	0.719***	0.700***	0.635***
	(0.038)	(0.025)	(0.060)
Other	0.908	0.735***	0.688***
	(0.046)	(0.027)	(0.062)
Female	0.814***	0.538***	0.878***
	(0.019)	(0.010)	(0.030)
Dual-eligible for Medicaid	0.466***	0.847***	0.797***
	(0.018)	(0.021)	(0.043)
Age (ref. Age 65-74)			
Age 18-44	0.979	0.671***	0.623
	(0.130)	(0.078)	(0.332)
Age 45-64	1.004	1.117***	0.872
	(0.047)	(0.036)	(0.110)
Age 75-84	0.606***	0.917***	1.532***
	(0.015)	(0.020)	(0.071)
Age 85 and older	0.158***	0.713***	1.466***
	(0.007)	(0.021)	(0.071)
Constant	0.060***	0.531***	0.046***
	(0.001)	(0.009)	(0.002)
Observations	300,921	65,503	78,094

**** p<0.001, ** p<0.01, * p<0.05*

Source: KNG Health Consulting calculations using the 5% sample of Medicare claims in the Standard Analytic File for 2018-2019.

Figure B.2: Logistic Regression Predicting Utilization of Neurovascular Technologies, 2018-2019.

VARIABLES	Mechanical Thrombectomy odds ratio (robust std.err.)	Thrombolysis odds ratio (robust std.err.)
Race (ref. White)		
Black	1.014	0.864*
	(0.053)	(0.049)
Other	1.167*	0.931
	(0.076)	(0.068)
Female	0.949	0.967
	(0.034)	(0.035)
Dual-eligible for Medicaid	0.857***	0.808***
	(0.036)	(0.035)
Age (ref. Age 65-74)		
Age 18-44	1.258	1.013
	(0.191)	(0.189)
Age 45-64	1.003	1.041
	(0.060)	(0.069)
Age 75-84	0.797***	0.947
	(0.034)	(0.042)
Age 85 and older	0.492***	0.881*
	(0.027)	(0.044)
Constant	0.060***	0.052***
	(0.002)	(0.002)
Observations	80,581	80,581

**** p<0.001, ** p<0.01, * p<0.05*
Source: KNG Health Consulting calculations using the 5% sample of Medicare claims in the Standard Analytic File for 2018-2019.

Figure B.3: Logistic Regression Predicting Utilization of Orthopedic Technologies, 2018-2019.

VARIABLES	Partial Hip Replacement odds ratio (robust std.err.)	Total Hip Replacement odds ratio (robust std.err.)	Partial Knee Replacement odds ratio (robust std.err.)	Total Knee Replacement odds ratio (robust std.err.)	Ankle Replacement odds ratio (robust std.err.)	Total Shoulder odds ratio (robust std.err.)
Race (ref. White)						
Black	0.489***	0.639***	0.271***	0.546***	0.249***	0.401***
	(0.066)	(0.024)	(0.041)	(0.014)	(0.095)	(0.027)
Other	0.710*	0.856***	0.755*	0.771***	0.857	0.595***
	(0.102)	(0.035)	(0.083)	(0.020)	(0.210)	(0.040)
Female	1.210**	0.921***	0.627***	1.026*	0.484***	1.108***
	(0.074)	(0.016)	(0.032)	(0.013)	(0.054)	(0.030)
Dual-eligible for Medicaid	1.465***	0.399***	0.346***	0.453***	0.258***	0.480***
	(0.103)	(0.012)	(0.034)	(0.009)	(0.057)	(0.021)
Age (ref. Age 65-74)						
Age 18-44	0.580	0.868	0.486	0.265***	0.033***	0.322***
	(0.351)	(0.105)	(0.239)	(0.036)	(0.033)	(0.100)
Age 45-64	0.790	0.809***	0.780*	0.657***	0.890	0.727***
	(0.147)	(0.029)	(0.081)	(0.017)	(0.178)	(0.040)
Age 75-84	2.953***	0.675***	0.738***	0.789***	0.662**	1.005
	(0.254)	(0.013)	(0.041)	(0.011)	(0.083)	(0.029)
Age 85 and older	7.483***	0.283***	0.256***	0.251***	0.223***	0.383***
	(0.624)	(0.009)	(0.031)	(0.007)	(0.064)	(0.020)
Constant	0.004***	0.272***	0.012***	0.173***	0.011***	0.075***
	(0.000)	(0.004)	(0.000)	(0.002)	(0.001)	(0.002)
Observations	123,033	123,033	306,673	306,673	78,047	121,510

**** p<0.001, ** p<0.01, * p<0.05*
Source: KNG Health Consulting calculations using the 5% sample of Medicare claims in the Standard Analytic File for 2018-2019.

Figure B.4: Logistic Regression Predicting Utilization of Spinal Technologies, 2018-2019.

VARIABLES	Disc Replacement odds ratio (robust std.err.)	Fusion odds ratio (robust std.err.)
Race (ref. White)		
Black	0.804***	0.829***
	(0.032)	(0.026)
Other	0.834***	0.815***
	(0.037)	(0.029)
Female	0.907***	0.864***
	(0.019)	(0.014)
Dual-eligible for Medicaid	0.668***	0.642***
	(0.019)	(0.015)
Age (ref. Age 65-74)		
Age 18-44	0.985	0.887
	(0.078)	(0.057)
Age 45-64	1.206***	1.217***
	(0.036)	(0.030)
Age 75-84	0.677***	0.718***
	(0.016)	(0.014)
Age 85 and older	0.161***	0.201***
	(0.010)	(0.009)
Constant	0.035***	0.055***
	(0.001)	(0.001)
Observations	444,289	464,963

**** p<0.001, ** p<0.01, * p<0.05*
Source: KNG Health Consulting calculations using the 5% sample of Medicare claims in the Standard Analytic File for 2018-2019.

Figure B.5: Logistic Regression Predicting Utilization of Respiratory Technologies, 2018-2019.

VARIABLES	Respiratory Assist Device odds ratio (robust std.err.)	PAP odds ratio (robust std.err.)	Home Ventilator odds ratio (robust std.err.)
Race (ref. White)			
Black	0.969	0.950**	1.439***
	(0.052)	(0.016)	(0.050)
Other	0.730***	1.028	1.074
	(0.055)	(0.020)	(0.052)
Female	0.575***	1.120***	0.921***
	(0.017)	(0.011)	(0.022)
Dual-eligible for Medicaid	0.709***	0.730***	1.525***
	(0.025)	(0.010)	(0.040)
Age (ref. Age 65-74)			
Age 18-44	1.800***	1.035	2.098***
	(0.205)	(0.033)	(0.148)
Age 45-64	1.253***	0.827***	1.171***
	(0.054)	(0.013)	(0.039)
Age 75-84	0.937	0.896***	0.879***
	(0.033)	(0.010)	(0.025)
Age 85 and older	0.455***	0.612***	0.484***
	(0.026)	(0.013)	(0.021)
Constant	0.026***	0.346***	0.023***
	(0.001)	(0.003)	(0.001)
Observations	322,824	266,154	317,340

**** p<0.001, ** p<0.01, * p<0.05*

Source: KNG Health Consulting calculations using the 5% sample of Medicare claims in the Standard Analytic File for 2018-2019.

Figure B.6: Logistic Regression Predicting Utilization of Cancer Screenings, 2018-2019.

VARIABLES	Lung Cancer Screening odds ratio (robust std.err.)		VARIABLES	Colon Cancer Screening odds ratio (robust std.err.)
Race (ref. White)			Race (ref. White)	
Black	0.537***		Black	0.808***
	(0.014)			(0.006)
Other	0.359***		Other	0.842***
	(0.012)			(0.006)
Female	0.879***		Female	1.289***
	(0.012)			(0.005)
Dual-eligible for Medicaid	1.724***		Dual-eligible for Medicaid	1.143***
	(0.030)			(0.007)
Age (ref. Age 65-74)			Age (ref. Age 65-75)	
Age 50-64	1.091***		Age 45-64	0.699***
	(0.022)			(0.004)
Age 75-80	0.543***			
	(0.010)			
Constant	0.018***			0.277***
	(0.000)			(0.001)
Observations	1,777,992			1,541,059

**** p<0.001, ** p<0.01, * p<0.05*
Source: KNG Health Consulting calculations using the 5% sample of Medicare claims in the Standard Analytic File for 2018-2019.