Influence of Race on Inpatient Treatment Intensity at the End of Life

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OBJECTIVE: To examine inpatient intensive care unit (ICU) and intensive procedure use by race among Medicare decedents, using utilization among survivors for comparison.

DESIGN: Retrospective observational analysis of inpatient claims using multivariable hierarchical logistic regression.

SETTING: United States, 1989–1999.

PARTICIPANTS: Hospitalized Medicare fee-for-service decedents ($n=976,220$) and survivors ($n=845,306$) aged 65 years or older.

MEASUREMENTS AND MAIN RESULTS: Admission to the ICU and use of one or more intensive procedures over 12 months, and, for inpatient decedents, during the terminal admission. Black decedents with one or more hospitalization in the last 12 months of life were slightly more likely than nonblacks to be admitted to the ICU during the last 12 months (49.3% vs. 47.4%, $p<.0001$) and the terminal hospitalization (41.9% vs. 40.6%, $p<.0001$), but these differences disappeared or attenuated in multivariable hierarchical logistic regressions (last 12 months adjusted odds ratio (AOR) 1.0 [0.99–1.03], $p=.36$; terminal hospitalization AOR 1.03 [1.0–1.06], $p=.01$). Black decedents were more likely to undergo an intensive procedure during the last 12 months (49.6% vs. 42.8%, $p<.0001$) and the terminal hospitalization (37.7% vs. 31.1%, $p<.0001$), a difference that persisted with adjustment (last 12 months AOR 1.1 [1.08–1.14], $p<.0001$; terminal hospitalization AOR 1.23 [1.20–1.26], $p<.0001$). Patterns of differences in inpatient treatment intensity by race were reversed among survivors: blacks had lower rates of ICU admission (31.2% vs. 32.4%, $p<.0001$; AOR 0.93 [0.91–0.95], $p<.0001$) and intensive procedure use (36.6% vs. 44.2%; AOR 0.72 [0.70–0.73], $p<.0001$). These differences were driven by greater use by blacks of life-sustaining treatments that predominate among decedents but lesser use of cardiovascular and orthopedic procedures that predominate among survivors. A hospital's black census was a strong predictor of inpatient end-of-life treatment intensity.

CONCLUSIONS: Black decedents were treated more intensively during hospitalization than nonblack decedents, whereas black survivors were treated less intensively. These differences are strongly associated with a hospital's black census. The causes and consequences of these hospital-level differences in intensity deserve further study.

KEY WORDS: medicare; end of life care; race & ethnicity; intensive care; inpatient care.

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In contrast to general patterns of racial differences in health care utilization,^{1,2} including lower rates of invasive cardiac procedures,^{3–11} surgical treatment for lung cancer¹² and renal transplantation^{13,14} among blacks, at the end of life, blacks appear to receive higher rates of intensive treatment. For example, blacks are more likely to die in the hospital¹⁵ and less likely to use hospice¹⁶ and have higher overall spending in their last 12 months than whites.^{17–19} Some have tried to explain these phenomena by citing differences in patient preferences. Indeed, several studies report that blacks and Hispanics prefer more aggressive life-sustaining treatment than whites,^{20–23} and that physicians' preferences for end-of-life treatment follow the same pattern by race as patients' preferences.²⁴ However, treatment preferences for care at the end of life do not reliably predict actual treatment.^{15,25}

Recent studies have explored the role of region,²⁶ hospital,^{27–29} and individual provider³⁰ in observed racial differences in health care utilization. With respect to end-of-life care, an analysis of Medicare claims found that aggregate ICU admissions and hospital days in the last 6 months of life are driven more by region of residence than by race³¹ and an analysis of terminal hospital discharges from 6 states found that the majority of observed differences in ICU use among black and Hispanic decedents were attributable to their use of hospitals with higher ICU use rather than to racial differences in ICU use within the same hospital.³²

Secular increases in ICU admission and intensive inpatient procedure use have occurred among both decedents and survivors³³; little is known about the respective trends by race. Building upon our previous work, we sought to describe the effect of race on inpatient ICU and intensive procedure use among Medicare decedents over 10 years, adjusting for hospital-level effects in the analyses and using utilization among survivors for comparison. We hypothesized that hospi-

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talized black decedents would be treated more intensively in their last 12 months of life, but less intensively otherwise, and that differences in end-of-life intensity would be largely attributable to greater use of life-sustaining procedures such as mechanical ventilation, feeding tube placement, and hemodialysis.

METHODS

Sample Selection

We initially drew a 20% sample of all decedents and a 5% sample of all survivors enrolled in Medicare in 1989, 1991, 1993, 1995, 1997, and 1999 from the Denominator file maintained by the Centers for Medicare and Medicaid Services. The data were initially assembled to study secular trends over time, so it was not felt that every year was necessary.³³ For the current analyses, we removed 1985 and 1987 because these years were not comparable to the years after 1989, due to the introduction of DRGs 474 and 475 in October, 1987. After those DRGs were introduced, there was a marked jump in the coding of intubation and tracheostomy procedures, the most common inpatient intensive procedures among decedents. Regarding truncation at 1999, at the time of our initial forays into analysis (2001), 1999 was the most recent year of data available.

For each beneficiary, we assembled the acute care hospital claims from the Medicare Medical Provider Analysis and Review (MedPAR) files; for decedents, we included all claims in the 365 days preceding their death and for the survivors we included claims during the calendar year. This provided a full 12 months of enrollment and utilization experience for both survivors and decedents. We limited our analysis to patients aged 65 and older and excluded Medicare beneficiaries with discontinuous enrollment in Medicare Part A or Part B, residence outside the United States or a foreign hospital admission, enrollment in a health maintenance organization, or hospitalization in a Federal hospital during the year because these persons might have incomplete hospitalization records. For beneficiaries whose claims spanned multiple years (first as survivors and later as decedents), we randomly sampled one 12-month (survivor or decedent) claims period for the current analysis so that no beneficiary appears more than once.

We abstracted each patient's age, sex, race, and ZIP code of residence from the Social Security Administration denominator file. We classified age into 5-year increments (65–69, 70–74, 75–79, 80–84, and >85), and analyzed race by grouping all beneficiaries into the categories “black” and “nonblack,” excluding all beneficiaries with “unknown” race.³⁴ We used ZIP code level measures of income and education from the area resource file (ARF) as proxies for these socioeconomic indicators. Individual socioeconomic status will generally be associated with area measures of income, with people living in wealthy areas having more assets and socioeconomic status than people living in poorer areas.^{35,36} In exploratory multivariable regressions, Charlson diagnoses provided better model fit for expenditures than Elixhauser diagnoses,^{37,38} so we used the presence or absence of these 18 ICD-9 clinical diagnoses for comorbidity risk adjustment.

We attributed a beneficiary's hospital care to the first hospital patronized in the 12-month sampling frame. Among survivors and decedents with at least one hospital admission in

the year, over 60% and 40%, respectively, had only one claim; the remainder had two or more hospitalizations. Among all patients with at least one hospital admission, 87% of survivors and 78% of decedents in 1999 received all of their inpatient care at one hospital. We used files from the American Hospital Association (AHA) survey to identify hospitals' membership in the Council of Teaching Hospitals (COTH), financial status (for profit or not for profit, including government hospitals), and bed size. A small number of hospitals care for the vast majority of elderly black Americans.³⁹ We constructed a variable “percent black” (percent of all admissions among blacks) to capture unmeasured hospital differences that vary systematically with black census.

Inpatient ICU and Procedure Use

For each beneficiary with at least one hospital admission in the 12 months, we recorded total hospital admissions, ICU admissions, and major surgical procedures. We classified a patient as having an ICU admission if the hospitalization included one or more days in a coronary care unit (CCUs) or an intensive care unit (ICUs). We condensed the International Classification of Diseases, 9th Edition (ICD-9) procedure codes into 228 categories using an algorithm nearly identical to the Clinical Classification System (CCS) developed for the Agency for Healthcare Research and Quality (AHRQ). For this study, we report data on the 88 procedure categories that are performed primarily in the inpatient setting and which were likely the primary reason for admission (see [Appendix](#)). We made exceptions to this rule for a handful of technologies that were newly introduced during the time period of study and that grew rapidly in use (e.g., automated implantable cardioverter defibrillator (AICD) implantation).

Statistical Analyses

We performed all computations with SAS statistical software (version 6.12, SAS Corporation, Cary, NC, USA). We categorized patients with at least one hospital admission during the year into 4 subgroups: black decedents, nonblack decedents, black survivors, and nonblack survivors, and compared their demographics, comorbidities, hospital characteristics, inpatient expenditures, and ICU and intensive procedure use. We performed multivariable logistic regression on the categorical receipt of one or more ICU admission and the receipt of one or more intensive procedures using a hierarchical model to adjust for patients clustered within hospitals. We estimated this model with the restricted maximum likelihood method, assuming unstructured covariance and treating hospital as a random effect. We performed separate regressions for decedents and survivors and included calendar year of observation in all models. Due to the marked interaction between decedent status and all outcomes, this was the most appropriate modeling strategy. To calculate the 95% confidence intervals on odds ratios from our parameter estimates and standard errors, we used the Wald first-order approximation.⁴⁰

The Institutional Review Board at Stanford University approved the study. We had complete independence from the National Institute on Aging (NIA) in the design, conduct, and reporting of the study.

Table 1. Characteristics of the Study Sample, by Race and Survivor Status, 1989–1999

Characteristic	Decedents			Survivors		
	Nonblack (N=887,787)	Black (N=88,433)	p-value	Nonblack (N=781,980)	Black (N=63,326)	p-value
Demographics						
Mean age, years	80.9	79.9	<.0001	77.3	76.8	<.0001
Women, %	54.1	56.3	<.0001	58.5	61.4	<.0001
College education, %	17.2	12.8	<.0001	17.8	13.4	<.0001
Median household income, \$	30,158	22,535	<.0001	30,706	23,323	<.0001
Clinical comorbidities						
Old myocardial infarction, %	6.0	4.4	<.0001	4.9	3.6	<.0001
Recent myocardial infarction, %	13.1	9.9	<.0001	5.1	3.9	<.0001
Congestive heart failure, %	41.8	38.0	<.0001	16.5	18.9	<.0001
Peripheral vascular disease, %	8.8	11.9	<.0001	4.5	5.8	<.0001
Cerebrovascular disease, %	7.0	11.0	<.0001	3.4	6.4	<.0001
Dementia, %	9.7	11.4	<.0001	3.9	5.5	<.0001
Chronic obstructive pulmonary disease, %	31.5	23.6	<.0001	20.1	16.7	<.0001
Rheumatologic disease, %	2.3	1.8	<.0001	2.0	1.7	<.0001
Peptic ulcer disease, %	0.08	0.05	.0012	0.04	0.02	.0103
Mild liver disease, %	1.8	1.4	<.0001	0.6	0.6	.0507
Moderate or severe liver disease, %	1.5	1.2	<.0001	0.3	0.2	.0204
Diabetes, %	18.8	26.3	<.0001	14.3	23.6	<.0001
Diabetes with complications, %	3.5	6.2	<.0001	1.9	4.0	<.0001
Hemiplegia, %	6.1	8.3	<.0001	2.8	4.9	<.0001
Chronic renal failure, %	8.4	13.7	<.0001	1.9	4.5	<.0001
Metastatic solid tumor, %	17.8	18.4	<.0001	3.6	3.8	.0057
Other neoplasia, %	26.2	27.5	<.0001	10.4	10.5	.374
Human immunodeficiency virus, %	0.03	0.14	<.0001	0.01	0.06	<.0001
Hospital characteristics						
Size, mean number of beds	205	252	<.0001	214	257	<.0001
Member of COTH*, %	12.8	26.1	<.0001	13.6	26.0	<.0001
For profit ownership, %	10.6	11.9	<.0001	11.2	12.2	<.0001
Percent black, %	7.0	29.8	<.0001	6.4	26.5	<.0001

*Council of teaching hospitals.

RESULTS

Characteristics of the Study Sample

The sample included 887,787 nonblack and 88,433 black decedents and 781,980 nonblack and 63,326 black survivors with at least one admission between 1989 and 1999. There were significant differences in most measured covariables between nonblacks and blacks (Table 1).

Intensive Care and Procedure Use

We present crude rates of ICU admission and the use of one or more intensive procedures by race for all years combined in Table 2 and by year in Figure 1. Black decedents with one or more hospitalization in the last 12 months of life were slightly more likely than nonblacks to be admitted to the ICU during

the last 12 months (49.3% vs. 47.4%, $p<.0001$) and the terminal hospitalization (41.9% vs. 40.6%, $p<.0001$), but these differences disappeared or attenuated in multivariable hierarchical logistic regressions (last 12 months adjusted odds ratio (AOR) 1.0 [0.99–1.03], $p=.36$; terminal hospitalization AOR 1.03 [1.0–1.06], $p=.01$). Black decedents were more likely to undergo an intensive procedure during the last 12 months (49.6% vs. 42.8%, $p<.0001$) and the terminal hospitalization (37.7% vs. 31.1%, $p<.0001$), a difference that persisted with adjustment (last 12 months AOR 1.1 [1.08–1.14], $p<.0001$; terminal hospitalization AOR 1.23 [1.20–1.26], $p<.0001$). Patterns of differences in inpatient treatment intensity by race were reversed among survivors: blacks had lower rates of ICU admission (31.2% vs. 32.4%, $p<.0001$; AOR 0.93 [0.91–0.95], $p<.0001$) and intensive procedure use (36.6% vs. 44.2%; AOR 0.72 [0.70–0.73], $p<.0001$). The black/nonblack difference in

Table 2. Inpatient Resource Use, by Race and Survivor Status, 1989–1999

	Decedents			Survivors		
	Nonblack (N=887,787)	Black (N=88,433)	p-value	Nonblack (N=781,980)	Black (N=63,326)	p-value
Annual resource use						
One or more ICU admission, %	47.4	49.3	<.0001	32.4	31.2	<.0001
Intensive procedure, %	42.8	49.6	<.0001	44.2	36.6	<.0001
Terminal admission resource use						
ICU admission, %	40.6	41.9	<.0001	–	–	–
Intensive procedure, %	31.1	37.7	<.0001	–	–	–

Figure 1. Trends in inpatient treatment intensity differences by race between 1989 and 1999. The gap in ICU admission (panel A) and intensive procedure use (panel B) between blacks and nonblacks has widened among decedents (dashed lines) but remained parallel or narrowed among survivors (solid lines). Overall procedure use (panel B) among nonblacks does not vary much by survivorship status; in contrast, procedure use among blacks is much higher for decedents than among survivors.

decedent, but not survivor, ICU and procedure use increased over time (Fig. 1).

Additional predictors of inpatient treatment intensity included educational achievement in the patient's ZIP code and hospital characteristics (Table 3). Notably, a 5% increase in the hospital's black census increased the odds of ICU admission 17-fold ([14.1–20.8], $p < .0001$) for the last 12 months and 24-fold ([18.6–31.0], $p < .0001$) for the terminal admission. This effect was much more modest among survivors (AOR 1.55 [1.23–2.95], $p = .0002$). A 5% increase in the hospital's black census increased the odds of an intensive procedure 8-fold ([6.2–10.4], $p < .0001$) for the last 12 months and 16-fold ([12.6–21.1], $p < .0001$) for the terminal admission, but decreased the odds for survivors more than 6-fold ([0.12–0.20], $p < 0.0001$).

The distinct patterns of racial differences in intensive procedure use were driven by the particular procedures that predominate among decedents compared to survivors. We list each of the procedures performed among 1.5% or more of each population in Table 4, indicating those that are more and less frequently performed among blacks compared to nonblacks. Specifically, such life-sustaining procedures as intubation/tracheostomy for mechanical ventilation and gastrostomy placement for enteral feeding predominated among decedents, and blacks were more likely than nonblacks to undergo these procedures, regardless of survivorship group. In contrast, cardiovascular and orthopedic procedures that have been classified by the Dartmouth Atlas of Health Care as preference- and supply-sensitive procedures, such as cardiac catheterization and revascularization and hip replacement, predominated

Table 3. Adjusted Odds* of ICU Admission and Intensive Procedure Use, 1989–1999

	Decedents Adjusted OR (95% CI)		Survivors Adjusted OR (95% CI)	
	ICU admission	Intensive procedure	ICU admission	Intensive procedure
12-Month resource use				
Black race	1.01 (0.99–1.03)	1.11 (1.08–1.14)	0.93 (0.91–0.95)	0.72 (0.70–0.73)
10-Year increase in age	0.604 (0.600–0.608)	0.681 (0.675–0.686)	0.82 (0.81–0.83)	0.673 (0.668–0.679)
10% increase in college degree holders	0.04 (0.02–0.07)	0.11 (0.05–0.25)	0.02 (0.009–0.03)	1.19 (0.58–2.56)
100 bed increase in hospital size	1.066 (1.062–1.070)	1.127 (1.122–1.132)	1.064 (1.060–1.068)	1.146 (1.141–1.151)
For profit hospital	1.39 (1.37–1.41)	1.17 (1.15–1.19)	1.33 (1.31–1.35)	1.11 (1.09–1.13)
Teaching hospital	0.86 (0.85–0.88)	1.04 (1.02–1.06)	0.79 (0.78–0.81)	0.97 (0.95–0.99)
5% increase in black census	17.14 (14.14–20.79)	8.0 (6.2–10.4)	1.55 (1.23–1.95)	0.16 (0.12–0.20)
Terminal admission resource use				
Black race	1.03 (1.01–1.06)	1.23 (1.20–1.26)	–	–
10-Year increase in age	0.545 (0.541–0.550)	0.564 (0.559–0.569)	–	–
10% increase in college degree holders	0.17 (0.08–0.37)	0.07 (0.03–0.16)	–	–
100 bed increase in hospital size	1.066 (1.061–1.071)	1.113 (1.108–1.118)	–	–
For profit hospital	1.31 (1.29–1.34)	1.18 (1.16–1.20)	–	–
Teaching hospital	0.92 (0.90–0.94)	1.13 (1.11–1.16)	–	–
5% increase in black census	24.05 (18.63–31.04)	16.3 (12.6–21.1)	–	–

*Hierarchical multivariable logistic regression model adjusted for age, race, sex, ICD-9 diagnoses of old myocardial infarction (MI), recent MI, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic obstructive pulmonary disease, rheumatologic disease, peptic ulcer disease, mild liver disease, moderate-severe liver disease, diabetes, diabetes with complications, hemiplegia, chronic renal failure, neoplasia, metastatic cancer, HIV, calendar year (1989, 1991, 1993, 1995, 1997, or 1999), ZIP code measures of education (percent of persons with a college degree) and income (median income), and hospital characteristics, including membership in the Council of Teaching Hospitals (COTH), total hospital beds, hospital ownership (for profit vs. not-for-profit), and the percent of decedents who were black.

among survivors and were less frequently performed among blacks than nonblacks.

DISCUSSION

In this retrospective observational study using fee-for-service Medicare claims, we confirmed that black decedents were treated more intensively during hospitalization than nonblack decedents, whereas black survivors were treated less inten-

sively. The greater use by blacks of life-sustaining treatments that predominate among decedents but lesser use of cardiovascular and orthopedic procedures that predominate among survivors explained observed racial differences in procedure use by survivorship cohort. The relatively smaller differences in end-of-life ICU use were largely attributable to confounding factors, including hospital choice. Among the strongest predictors of ICU and intensive procedure use was a hospital's black census. Because the addition of black census to the hierarchical model decreased the size of the parameter esti-

Table 4. Common* Intensive Procedure Use by Race and Survivor Status, 1989–1999

Procedure	Decedents		Survivors	
	Nonblack (N=887,787)	Black (N=88,433)	Nonblack (N=781,980)	Black (N=63,326)
Greater use among blacks				
Intubation and tracheostomy, %	14.5	19.2	2.0	2.7
Feeding tube placement, %	5.5	11.6	1.1	2.5
Arteriogram or venogram (not heart or head), %	2.5	3.1	2.2	2.8
Hemodialysis, %	2.2	5.9	0.6	2.7
Revision/repair of vessel/vascular procedure, %	1.3	2.2	1.1	2.5
Creation of arteriovenous fistula, %	0.7	2.4	0.3	1.3
Lesser use among blacks				
Cardiac catheterization, coronary arteriography, %	4.6	3.1	8.4	5.7
Treatment, fracture of hip and femur, %	3.6	1.5	2.9	1.3
Hip replacement, total and partial, %	1.9	1.0	3.0	1.4
Insert/replace/revise/remove permanent pacemaker, %	1.6	1.4	1.9	1.5
Ileostomy and colostomy, %	1.6	1.5	0.6	0.5
Coronary artery bypass graft, %	1.6	0.7	3.1	1.2
Percutaneous transluminal coronary angioplasty, %	1.1	0.6	2.9	1.3
Knee replacement, %	0.3	0.2	2.8	1.7
Open cholecystectomy, %	1.2	1.1	1.7	1.2
Laminectomy, discectomy, arthrodesis, %	0.4	0.3	1.7	0.9
Carotid endarterectomy, %	0.5	0.2	1.5	0.5
Little difference or variable by survivorship group				
Transurethral prostatectomy, %	1.5	1.6	3.2	2.8
Colon resection, %	2.7	2.6	2.4	2.0
Excision, lysis peritoneal tissue, %	1.9	2.0	1.7	1.5

*Procedures with a prevalence of 1.5% or greater among black or nonblack decedents or survivors in the sample.

mate on black race, our study suggests that blacks' hospital choice/access in part mediates the observed relationship between treatment intensity and race.⁴¹ These systematic differences in hospital-level practice patterns may reflect local patient and community factors (e.g., preferences) or provider factors (e.g., hospital resources, staffing and organization, or process and outcomes of communication and decision making).

This is the first nationally representative study of fee-for-service Medicare beneficiaries to explore racial differences in ICU and intensive procedure use at the end of life. Most previous Medicare claims studies have focused on overall inpatient spending^{18,19} and none have used multilevel modeling to account for individual hospital effects. The study by Levinsky et al. that analyzed ICU and life-sustaining procedure use by age in California and Massachusetts only reported a demographic- and comorbidity-adjusted effect of black race on spending due to limited sample size of blacks.¹⁷ The multicenter Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment (SUPPORT) trial reported that black patients received less intervention than white patients among their sample of seriously ill adults that included younger patients and a mix of decedents and survivors.⁴²

Both end-of-life health service use and racial differences in treatment receive a great deal of policy attention. End-of-life utilization attracts interest because per person expenditures for Medicare beneficiaries who die each year are 5 times higher than for survivors.⁴³ Indeed, between 1985 and 1999 real spending on inpatient services for fee-for-service decedents increased 60%, to \$23 billion in 1999.³³ This increase in spending was neither driven by an increase in the population nor a significant increase in the age-adjusted likelihood of admission; instead, increases in per capita treatment intensity explained much of this expenditure growth. Racial differences in health service use attract interest because they may reflect differences in access or uptake that contribute to observed health disparities. Curiously, as reported by other authors, it is only at the end of life that blacks appear to have greater health services expenditures than nonblacks, particularly for inpatient services.^{17,19,44} In part, this is due to a higher likelihood of dying in the hospital.³³ Findings from the present study additionally suggest that blacks' greater use of intensive procedures, particularly highly remunerated (pre-2006) DRGs 475 and 483 associated with intubation/tracheostomy and mechanical ventilation >96 hours, help to explain this higher spending.

The lower rates of cardiovascular and orthopedic procedures among blacks have been previously documented, and may be due to differences in physician referral^{8,11,45} or to differences in patients' perceptions of outcomes and their attendant willingness to undergo surgery.^{46,47} Higher rates of intubation and tracheostomy and feeding tube placement are consistent with previous studies of hypothetical and real end-of-life decisions suggesting that blacks are less likely to forego life-sustaining treatments.^{20-24,48} Higher rates of vascular and hemodialysis access procedures and lower rates of surgical repair of hip fracture are likely attributable to the well-documented differences in burden of vascular disease, end-stage renal disease, and osteoporosis among blacks compared to nonblacks.

The secular trends demonstrating a widening of the difference in end-of-life inpatient treatment intensity between blacks and nonblacks in the latter half of the 1990s could be explained by progressively higher rates of hospice enrollment^{16, 32} and

attendant limitation of ICU admission, mechanical ventilation, and enteral feeding among nonblacks during this period. Furthermore, the minority of U.S. hospitals that care for most of America's black patients are more likely to have medical ICUs³⁹; other structures and processes related to treatment intensity also likely differ.

Our study is subject to several limitations. First, our study relies upon the frequently used "look back" approach to understand how dying patients are treated, though patients may not have been known to be "dying" at the time treatments were initiated.^{49,50} Additionally, we focused only on inpatient services and did not study trends in outpatient or postacute treatment intensity because the hospital remains the site of the most expensive and technologically intensive medical care. Our measures of utilization may have underestimated treatment intensity by calculating the receipt of one or more ICU admission or procedure over 12 months rather than the mean number of admissions and procedures. Our findings for the terminal hospitalization and for total expenditures which more closely track service volume (not reported) followed the same patterns by race and suggest that our measure of utilization does not confound the observations. Despite statistical adjustment for measured confounders, the large differences in characteristics of black and nonblack patients raise the possibility that differences are attributable to unmeasured confounders. Finally, the observations are based only upon fee-for-service Medicare and cannot be generalized to those in managed "risk plans."

Our study does not offer any information about patient preferences or the appropriateness of end-of-life treatment intensity. It does, however, raise provocative questions about differences in practice patterns at hospitals caring for black patients that deserve further study.

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APPENDIX

Intensive procedures included in the study (in alphabetical order)

Amputation of lower extremity
Ankle/foot joint replacement
Aortic resection with replacement
Appendectomy
Arteriogram and venogram (not heart or head)
Automated implantable cardioverter defibrillator (AICD)
Biopsy of spinal cord
Bone marrow transplant
Cardiac assist device/ECMO/bypass
Cardiac catheterization, coronary arteriography
Carotid endarterectomy
Central vessel endarterectomy/thrombectomy
Cerebral arteriogram
Cholecystectomy and common duct exploration
Closed control of UGIB
Colon resection
Coronary artery bypass graft (CABG)
Creation of arteriovenous fistula
Cycstectomy
Electrophysiology study (EPS) +/- ablation
Enterostomy
Esophageal dilation
Esophageal reanastomosis/repair
Esophagectomy
Excision, lysis peritoneal tissue
Exploratory laparotomy
Feeding tube placement
Fundoplication
Genitourinary incontinence procedures
Hemodialysis
Hip replacement, total and partial
Hysterectomy
Ileostomy and colostomy
Injection or ligation of esophageal varices
Insert/repl/revise/remove permanent pacemaker
Insertion, temporary cardiac pacemaker
Intracoronary artery thrombolytic infusion

Intubation and Tracheostomy
Jaw fracture repair
Kidney transplant
Knee replacement
Laminectomy, discectomy, arthrodesis
Laparoscopic cholecystectomy
Laryngectomy
Lobectomy
Local excision lung/bronchus
Mastectomy
Mastoidectomy
Mediastinoscopy
Nephrectomy
Oophorectomy, unilateral and bilateral
Open biopsy lung/bronchus
Open cholecystectomy
Open CNS biopsy
Open CNS diagnostic procedures
Open CNS therapeutic procedures
Open control of UGIB
Open heart repair of septal defects, etc.
Open or closed cardiac massage
Open Prostatectomy
Orchiectomy
Pancreatectomy/pancreaticoduodenectomy
Partial/total gastrectomy and gastric bypass
Pelvic exenteration
Percutaneous CNS biopsy (stereotactic/burr hole)
Percutaneous transluminal coronary angioplasty (PTCA)
Pericardial procedure
Peripheral vascular bypass
Peripheral vessel endarterectomy/thrombectomy
Pneumonectomy
Pyloroplasty
Radical Prostatectomy
Regional/radical lymph-node dissection
Revision/repair of vessel/vascular Procedure
Skin graft
Small bowel resection
Splenectomy
Surgical removal of urinary calculus
Thoracotomy
Thyroidectomy
Transurethral Prostatectomy (TURP)
Treatment, fracture of hip and femur
Treatment, fracture of lower extremity
Treatment, fracture of radius and ulna
Vagotomy
Valve procedures (including replacement)
Vena cava interruption
Ventricular shunt

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