Geographic and Racial Patterns of Preventable Hospitalizations for Hypertension: Medicare Beneficiaries, 2004–2009

JULIE C. WILL, PhD^a
ISAAC A. NWAISE, MA, PhD^a
LINDA SCHIEB, MSPH^a
YUNA ZHONG, MSPH^a

ABSTRACT

Objectives. Hypertension as the primary reason for hospitalization is often used to indicate failure of the outpatient health-care system to prevent and control high blood pressure. Investigators have reported increased rates of these preventable hospitalizations for black people compared with white people; however, none have mapped them nationally by race.

Methods. We used Medicare Part A data to estimate preventable hypertension hospitalizations from 2004–2009 using technical specifications published by the Agency for Healthcare Research and Quality. Rates per 100,000 beneficiaries were age- and sex-standardized to 2000 U.S. Census data. We mapped county-level rates by race and identified clusters of counties with extreme rates.

Results. Black people had higher crude rates of these hospitalizations than white people for every year studied, and the test for an increasing linear time trend for the standardized rates was significant for both black and white people; that is, the gap between the races increased over time. For both races, clusters of high-rate counties occurred primarily in parts of Oklahoma, Texas, Southern Alabama, and Louisiana. High rates for white people were also found in parts of Appalachia. Large differences in rates among black and white people were found in a number of large urban areas and in parts of Florida and Alabama.

Conclusions. Racial disparities in preventable hospitalizations for hypertension persisted through 2009. The gap between black and white people is increasing, and these inequities exist unevenly across the country. Although this study was intended to be purely descriptive, future studies should use multivariate analyses to examine reasons for these unequal distributions.

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^aCenters for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division for Heart Disease and Stroke Prevention, Atlanta, GA

Address correspondence to: Julie C. Will, PhD, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy. NE, MS F-72, Atlanta, GA 30341; tel. 770-488-6024; fax 770-488-8334; e-mail <jxw6@cdc.gov>.

Both studies and expert committees have identified conditions for which hospitalization could be avoided if patients received early access to good quality health care.^{1,2} These conditions have been labeled ambulatory care sensitive conditions (ACSCs)^{1,2} and have been used by the federal government as Prevention Quality Indicators.³ It cannot be assumed that, because certain hospitalizations could have been better managed in the primary care setting, care is always available. In fact, high rates of these hospitalizations are often indicators of diminished access to care for reasons such as poverty, remoteness, or lack of insurance.⁴

Hospitalization for an ACSC of hypertension captures the failure of the outpatient health-care system to prevent and control high blood pressure.³ A number of investigators have reported racial differences in hospitalizations for hypertension. Using hospital data from 1991–1998 in California for people aged 20–64 years,⁵ investigators found that, among non-Hispanic people, black men had unadjusted rates that were seven times those of white men, and that black women had rates eight times higher than those of white women. Using 1997 data from 22 states, researchers studied a similarly aged population of non-Hispanic people and found comparable results.⁶ Other scientists studied hospitalizations for people aged 18 years and older from 23 states and found that, after adjusting for age and sex, non-Hispanic black men and women were five times as likely to be hospitalized for hypertension as their white counterparts.⁷ Similar results have been found for people aged 65 years and older using 2006 Medicare data from Maryland, where black people were three times as likely as white people to be hospitalized for hypertension.⁸

Researchers have studied preventable hospitalizations, often combining all preventable hospitalization conditions within small geographic areas (e.g., ZIP Codes, cities, counties, or health service areas) as the unit of analysis.^{1,2,6,9–16} Only a few, however, have conducted these geographic studies at the national level.^{10,12,14,17} To our knowledge, none have published national small-area analyses with a focus on preventable hospitalizations for hypertension. We used national Medicare hospital claims data to describe geographic differences in these rates by race from 2004–2009.

METHODS

Data source and definitions

We studied fee-for-service Medicare beneficiaries aged 65 years and older residing in the 50 U.S. states and the District of Columbia (DC). Patients were excluded if they were members of a health maintenance organiza-

tion, if they had not yet reached 65 years of age, or if they died before July 1 of the study year.

Data from 2004–2009 were obtained from short-stay hospital claims data included in the Medicare Provider Analysis and Review, Part A, collected by the U.S. Centers for Medicare & Medicaid Services.¹⁸ We used these data to calculate both crude rates and age- and sex-standardized rates of preventable hospitalizations for hypertension by race. We then combined data across six years to produce rates at the county level.

The population-based hospital discharge rates were calculated according to the technical specifications published by the Agency for Healthcare Research and Quality (AHRQ).¹⁹ Accordingly, we considered a preventable hospitalization to be a discharge in a person aged 65 years or older with any of the following International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) main or first-listed diagnosis codes for hypertension: 401.0, 401.9, 402.00, 402.10, 402.90, 403.00, 403.10, 403.90, 404.00, 404.10, or 404.90.²⁰ As specified by AHRQ, transfers from another institution and discharges with cardiac procedure codes in any field were also excluded. Excluded were people hospitalized with procedures such as implants and maintenance of pacemakers, surgical procedures for repair of heart valves, revascularization, coronary bypass surgery, and heart transplants. This exclusion resulted in the most serious and least preventable cases of hypertension being eliminated. Finally, discharges with any diagnosis of stage I to stage IV kidney disease were eliminated if accompanied by procedures in preparation for hemodialysis.

Our primary interests were race and geographic location. The racial categories for this analysis—white and black people—were obtained from the race code on the claim record, which is transcribed from the beneficiary file for each Medicare beneficiary. In the Medicare databases, black, Hispanic, and white racial/ethnic categories are mutually exclusive. We used county of patient residence as the smallest unit of analysis and based larger Census areas on the four U.S. Census Bureau regions of the United States: Northeast, Midwest, South, and West.²¹

To examine comorbid conditions, we used a modified version (using ICD-9 codes only) of the Elixhauser comorbidity index, which evaluates 29 chronic conditions, such as cancer, diabetes, cardiovascular disease, obesity, psychiatric conditions, and drug and alcohol abuse.^{22,23}

Statistical analysis

Rates. We calculated the crude rate of hospitalizations for hypertension per 100,000 Medicare beneficiaries

and calculated age- and sex-standardized rates by race, year, and geographic location based on the 2000 U.S. standard population. We used Poisson regression in GENMOD²⁴ to test for differences in rates (using the log likelihood ratio test) and for time trends for each racial group. We considered rates with a numerator <11 or a denominator <100 to be unreliable and eliminated them from the analysis. We also eliminated extremely high rates that fell outside three standard deviations from the mean of the log-transformed distribution.²⁵

Mapping. We mapped age- and sex-standardized county-level rates of preventable hypertension hospitalizations for white and black people using a spatial empirical Bayesian smoothing technique to improve the statistical reliability of the rates and to generate stable estimates for counties with small populations. The spatial empirical Bayes algorithm averages the raw rate for each county with a local mean calculated based on the surrounding counties; thus, rates in areas with small populations converge to the local mean.²⁶ Spatially smoothed rates were calculated using GeoDa^{TM} 0.9.5-i software,²⁷ and maps were created using ArcMap software version 10.0.²⁸

Spatial clustering. To determine whether geographic patterns of these hospitalizations were statistically significant, we undertook a two-step process to assess positive spatial autocorrelation, or clustering. We first assessed global spatial autocorrelation across counties in the U.S. by constructing weights to identify contiguous neighboring counties using a “queen” contiguity matrix and calculating the Moran’s I coefficient.²⁹ We then calculated the local indicators of spatial association³⁰ to identify where statistically significant clusters of counties with either higher- or lower-than-average rates of preventable hypertension hospitalizations occurred (statistical significance $p < 0.01$). The GeoDa software identified the counties located at the center of each cluster. Because these clustering techniques require contiguous neighboring counties, only counties located in the 48 contiguous states having at least one neighboring high- or low-rate county were included in the cluster analyses ($n = 3,105$).

Comorbid conditions. We used Chi-square tests to determine whether comorbid conditions varied by race.²⁴

RESULTS

From 2004 to 2009, there were 237,519 preventable hospitalizations for hypertension among people aged ≥ 65 years in the U.S. This number translates to an average of almost 40,000 each year during the study period.

The Table presents the distribution of hypertension hospitalizations by various demographic factors and includes crude rates and 95% confidence intervals. Rates increased with age, with people aged ≥ 85 years being 2.6 times as likely to experience a preventable hospitalization as those aged 65–74 years. The rate for women was approximately twice the rate for men. The rate for black people was three times the rate for white people, and the rate for the “other” racial group was 1.5 times the rate for white people. The rate in the South was higher than the rate in the Northeast; however, the rate in the West was significantly lower than the rate in the Northeast. The rate for the Midwest did not differ from that of the Northeast.

For each of the six years studied, black people had significantly higher age- and sex-standardized rates of preventable hospitalizations for hypertension than did white people (Figure 1). The rates for white and black people showed a statistically significant increase over time ($p < 0.0001$). The gap between black and white people increased over time. Rates increased most significantly from 2006 to 2007.

Among U.S. counties, the standardized rates ranged from 27.8 to 607.7 per 100,000 population for white people (Figure 2a). A total of 1,024 counties were excluded based on a small numerator and/or denominator, and 15 counties were excluded for extreme values. Statistically significant clusters of standardized rates for white people were found in some areas of northwest and southeast Oklahoma, northern Texas, northern Louisiana, and the Appalachian Mountain areas of Tennessee, Kentucky, and West Virginia. Areas of Midwestern states such as Minnesota, Iowa, Wisconsin, and South Dakota had clusters of low rates (Figure 2b). Clusters of low rates for white people were also found in parts of the Northeast, especially Massachusetts, Vermont, and western Maine. Additional clusters of low rates were found in the Pacific Northwest including northern California, Oregon, and Washington.

For black people, the standardized rates for counties ranged from 118.6 to 1,367.5 per 100,000 population (Figure 3a). A total of 2,465 counties were excluded based on our exclusion criteria for small numbers. Sufficient data for calculating rates at the county level for black people were available mainly for parts of Texas, the Southeast, and the Atlantic Coastal areas. Some urban areas in other regions of the country and some of the western states also had sufficient data. In those locales with sufficient data, statistically significant clusters of high rates were found mainly in northeastern Texas, northern Louisiana, and southern Alabama (Figure 3b). Clusters of low rates were found in some portions of the South, including southern Arkansas,

Table. Number and rate of preventable hospitalizations in the U.S. for hypertension per 100,000 Medicare beneficiaries (n=237,519), by year and demographic characteristics: Medicare Provider Analysis and Review data, Part A, 2004–2009

Characteristic	2004			2005			2006			2007			2008			2009			Rate ratio
	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	N	Crude rate (95% CI)	
Total	38,041	131 (130, 132)	35,061	124 (123, 126)	37,959	138 (137, 140)	43,666	156 (155, 158)	40,723	147 (145, 148)	42,069	151 (150, 153)							
Age (in years)																			
65–74	13,849	91 (90, 93)	12,511	89 (87, 90)	13,227	96 (95, 98)	14,835	103 (101, 104)	14,380	99 (97, 100)	14,821	100 (99, 102)							1.00
75–84	15,981	153 (151, 156)	14,453	141 (139, 143)	15,482	157 (154, 159)	17,677	185 (183, 188)	16,018	174 (171, 177)	16,149	180 (177, 183)							1.71 ^a
≥85	8,211	215 (211, 220)	8,097	209 (204, 214)	9,250	238 (233, 243)	11,154	284 (278, 289)	10,325	262 (257, 267)	11,099	277 (271, 282)							2.57 ^a
Total	38,041	131 (130, 132)	35,061	124 (123, 126)	37,959	138 (137, 140)	43,666	156 (155, 158)	40,723	147 (145, 148)	42,069	151 (150, 153)							
Sex																			
Male	9,278	76 (74, 77)	8,687	73 (71, 75)	9,815	84 (83, 86)	12,361	103 (101, 105)	11,363	95 (93, 97)	11,824	98 (96, 100)							1.00
Female	28,763	171 (169, 173)	26,374	162 (160, 164)	28,144	178 (176, 180)	31,305	196 (194, 198)	29,360	186 (184, 189)	30,245	193 (190, 195)							2.05 ^a
Total	38,041	131 (130, 132)	35,061	124 (123, 126)	37,959	138 (137, 140)	43,666	156 (155, 158)	40,723	147 (145, 148)	42,069	151 (150, 153)							
Race																			
White	28,421	112 (111, 113)	25,722	105 (103, 106)	28,486	119 (117, 120)	31,836	131 (129, 132)	29,184	121 (120, 122)	30,199	126 (124, 127)							1.00
Black	7,282	310 (303, 317)	7,048	312 (305, 319)	7,278	338 (330, 346)	9,083	419 (410, 427)	8,839	413 (405, 422)	9,130	422 (413, 430)							3.10 ^a
Other	2,338	175 (168, 182)	2,291	170 (163, 177)	2,195	163 (157, 170)	2,747	191 (184, 198)	2,700	182 (175, 189)	2,740	177 (170, 183)							1.48 ^a
Total	38,041	131 (130, 132)	35,061	124 (123, 126)	37,959	138 (137, 140)	43,666	156 (155, 158)	40,723	147 (145, 148)	42,069	151 (150, 153)							
Region																			
Northeast	6,995	122 (120, 125)	6,874	125 (122, 128)	7,139	133 (130, 136)	8,433	155 (152, 158)	8,063	151 (148, 154)	8,172	154 (151, 157)							1.00
Midwest	9,381	126 (123, 128)	8,718	121 (118, 124)	10,081	145 (142, 147)	11,039	159 (156, 162)	9,944	148 (145, 151)	10,049	151 (148, 154)							1.01
South	17,746	159 (157, 162)	15,916	147 (145, 149)	16,919	161 (158, 163)	19,678	183 (180, 186)	18,277	170 (167, 172)	19,086	176 (173, 178)							1.18 ^a
West	3,919	82 (80, 85)	3,553	76 (73, 78)	3,820	83 (80, 86)	4,516	94 (91, 97)	4,439	91 (88, 94)	4,762	96 (93, 99)							0.62 ^a
Total	38,041	131 (130, 132)	35,061	124 (123, 126)	37,959	138 (137, 140)	43,666	156 (155, 158)	40,723	147 (145, 148)	42,069	151 (150, 153)							

^aStatistically significantly at p<0.0001

CI = confidence interval

Figure 1. Trends in age- and sex-standardized hospitalization rates for hypertension in the U.S., by race: Medicare beneficiaries aged ≥ 65 years, 2004–2009

^aThe rate for black people increased in a significantly linear fashion from 2004 to 2009 ($p < 0.0001$), with the following RRs describing the changes in each year compared with the baseline rate: 2005 (RR=1.00, 95% CI 0.96, 1.03), 2006 (RR=1.08, 95% CI 1.05, 1.12), 2007 (RR=1.37, 95% CI 1.33, 1.41), 2008 (RR=1.36, 95% CI 1.31, 1.40), and 2009 (RR=1.38, 95% CI 1.34, 1.43).

^bThe RR for black people increased over time, indicating that the gap between black and white people increased over time: 2004 (RR=2.76, 95% CI 2.69, 2.83), 2005 (RR=2.97, 95% CI 2.90, 3.05), 2006 (RR=2.85, 95% CI 2.77, 2.92), 2007 (RR=3.23, 95% CI 3.16, 3.31), 2008 (RR=3.44, 95% CI 3.36, 3.52), and 2009 (RR=3.37, 95% CI 3.29, 3.45).

^cThe rate for white people increased in a significantly linear fashion from 2004 to 2009 ($p < 0.0001$), with the following RRs describing the changes in each year compared with the baseline rate: 2005 (RR=0.92, 95% CI 0.91, 0.94), 2006 (RR=1.05, 95% CI 1.03, 1.07), 2007 (RR=1.17, 95% CI 1.15, 1.19), 2008 (RR=1.09, 95% CI 1.07, 1.11), and 2009 (RR=1.13, 95% CI 1.11, 1.15).

RR = rate ratio

CI = confidence interval

central Mississippi, and parts of South and North Carolina. Statistically significant clusters of low rates were also found in Michigan and California.

The standardized rates for black people divided by the similar rate for white people (i.e., the rate ratio) ranged from 1.0 to 6.5 (Figure 4). Again, many areas of the U.S. lacked sufficient data to make this comparison. In those areas with sufficient data, the largest black-white ratios were found mainly in urban areas including Phoenix, Arizona; Las Vegas, Nevada; Denver, Colorado; Dallas, Texas; Houston, Texas; Miami, Florida; Chicago, Illinois; New York, New York; Newark,

New Jersey; and DC. Some other areas also had large rate ratios, including many parts of Florida and one area in southern Alabama. In some rural areas of the South, such as the Carolinas, black and white rates were less disparate than in larger urban areas.

The analysis of comorbidities showed that white people (9%) were significantly ($p < 0.0001$) more likely than black people (7%) to be without comorbidities (data not shown). Black people (86%) were slightly more likely than white people (85%) to have multiple (i.e., two or more) comorbidities. Also, black people were significantly ($p < 0.0001$) more likely than white

Figure 2. Distribution and clusters of age- and sex-standardized hospitalization rates for hypertension among white people in the U.S.: Medicare beneficiaries, 2004–2009

Figure 2a.

Figure 2b.

Figure 3. Distribution and clusters of age- and sex-standardized rates of preventable hospitalizations for hypertension among black people in the U.S.: Medicare beneficiaries, 2004–2009

Figure 3a.

Figure 3b.

people to have diabetes (20% and 12%, respectively), renal disease not requiring dialysis (20% and 14%, respectively), congestive heart failure (11% and 8%, respectively), and iron deficiency or other deficiency anemia (11% and 7%, respectively) as comorbid conditions (data not shown).

DISCUSSION

We found that black people had higher rates of preventable hospitalizations for hypertension than white people, rates for black and white people increased in a significantly linear fashion over time, and the gap between black and white people increased over time. Both races showed high rates of preventable hospitalization in many areas of the South, though the lowest rates for black people were in the Carolinas, where white people showed mid-range to high rates. The lowest rates for white people were in the Pacific Coastal area, including northern California, Oregon, and Washington, followed by low rates in parts of New

England. Racial disparities were mainly noted in large urban areas throughout the U.S. Although black people still had higher rates of preventable hospitalizations than white people in the Carolinas and parts of the rural South, the disparities between black and white people were less pronounced in these areas.

Nearly two decades ago, the Institute of Medicine Committee on Monitoring Access to Personal Health Care Services⁹ issued a report on access to health care in the U.S. and the existence of racial disparities in such access. According to our research and that of others,^{5,7,8,31} these disparities persist and are consistent with a lack of access to quality outpatient care.

We found only a few studies that separated preventable hospitalizations for hypertension from other preventable hospitalizations and where results were reported or mapped geographically. One study mapped county rates in Utah and found that those living in eastern Utah (a rural area) had twice the rate of preventable hospitalizations for hypertension of those living in the Wasatch Front area (an urban

Figure 4. Racial disparities (rate ratios) in age- and sex-standardized hospitalization rates for hypertension in the U.S.: Medicare beneficiaries, 2004–2009

area extending around Salt Lake City).¹⁶ Our results also showed that, for white people, rates were relatively low around Salt Lake City. Another study mapped preventable hospitalization rates for hypertension by county in South Carolina and found a relatively large cluster in the eastern part of the state, with smaller clusters occurring in the northern and southern areas of the state.¹³ Our results also found higher rates in the southeastern part of South Carolina; however, the rates for South Carolina were generally lower than those found in other southern states.

Sumner and colleagues examined rates of preventable hospitalizations for hypertension in Missouri using county-level data to help prioritize medical education topics.³² They found substantial variation (nine- to 12-fold) in these rates across counties, although they did not provide a map showing rates by county. Our study showed high rates of preventable hypertension hospitalizations for white people living in the northwestern part of Missouri. Sumner and colleagues' multivariate model explained about 80% of the variation in rates for hypertension. They proposed that strategies to address higher rates of hypertension in certain counties should focus on improving lifestyle behaviors (e.g., quitting smoking and increasing physical activity) and addressing factors associated with access to outpatient care (e.g., lack of insurance, poverty, and low physician density). Interestingly, at least for Missouri, the authors found that variation in quality of care contributed little, if anything, to preventable hospitalizations for hypertension. Also, self-reported prevalence of hypertension was not a particularly important variable in their multivariable models. Hypertension differed from other conditions such as asthma, congestive heart failure, and diabetes, where comorbid conditions and preventive care service delivery provided additional explanatory power to their statistical models. Our own data on comorbidities indicated that black people were only slightly more likely than white people to have multiple comorbidities; however, these comorbidities were more often associated with increased cardiovascular disease risk (i.e., renal failure, congestive heart failure, and diabetes). These comorbidities might be expected to contribute to a more complex hypertensive disease resulting in greater difficulty in controlling hypertension in the outpatient setting.³³

Although earlier studies show racial differences in geographic variations of hospitalizations for hypertension by counties within states, this study contributes newly to the literature in the following ways: (1) the data are mapped across the 50 states and DC; (2) national standardized rates are provided for multiple time periods, thus establishing a good baseline for

future monitoring of health disparities; and (3) maps of rate ratios are provided, indicating the locations of highest and lowest disparities.

Limitations

This study was subject to several limitations. First, we compared rates for white and black people only because, after stratification, the sample sizes were too small to include other races. Also, in the 2002 enrollment database, the probability that a person was correctly identified as any given race (sensitivity) was 97% for white people, 96% for black people, 52% for Asians, and 33% for Hispanic people.³⁴ Second, there were areas of the country where we had insufficient data to map rates by county. This lack of data was especially a problem for black people, making it difficult to study and report on disparities in areas other than large urban regions and the South. Third, because Medicare data are used for administrative purposes and not specifically for epidemiologic purposes, data quality depends on accuracy of physician reporting and coding. We found some instability in rates across time, with a large jump in the rates from 2006 to 2007, which we have been unable to explain. Also, the use of administrative data could result in geographic differences in hospital diagnostic procedures, such as whether hypertension is reported as a first or second diagnosis. One group of researchers suggested that such a coding bias would explain the sharp reductions in preventable hospitalizations for angina.³⁵ However, we found no published evidence that such a coding bias exists for hospitalizations for hypertension.

Fourth, we purposefully included repeat visits in our analyses to fully capture the number of hospitalizations; however, in some counties with a small elderly population, this inclusion of repeat visits resulted in extremely high rates. We examined the number of repeat visits during one year of our analysis (2006) and found that only 4% were repeated, which reassured us that retaining these visits would likely have only a small impact on our overall analysis. Furthermore, we eliminated extremely high rates that fell outside three standard deviations from the mean of the log-transformed distribution. Finally, our analysis only considered age, sex, geography, and comorbidities as possible explanations for the differences between black and white people. While other investigators have found factors (e.g., comorbidity, disease prevalence, physician practice style, and patient preferences) that may help to explain differences between black and white people in overall rates of preventable hospitalizations, there is a mixed and limited literature regarding factors that explain disparities in hospitalizations for hypertension.

Future research should go beyond surveillance and look at possible reasons for these unequal distributions of hospitalizations for hypertension. It might also be useful to explore enrollment in Medicare Part B³⁶ as an indicator of access to outpatient care. Doing so will require data from multiple sources and the use of multivariate analyses.

CONCLUSIONS

We described the national distribution of preventable hospitalizations for hypertension by race and geography from 2004–2009. We showed that black people had higher rates of preventable hospitalizations than white people in every year studied, and that this gap is increasing over time. This research provides a national snapshot of hospitalizations for hypertension, an ACSC that may be reduced as health reforms are implemented in 2014. Examining rates of preventable hospitalizations by race and mapping areas of the country with higher rates or greater disparities is an important public health strategy that will allow health agencies with limited funding to target those areas or populations most in need of early intervention to reduce these hospitalizations.

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Institutional Review Board approval was not necessary because secondary data were used.

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