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Disparities in 30-day rehospitalization rates among Medicare skilled nursing facility residents by race and site of care

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Abstract

Objectives—To examine racial and site-of-care disparities in all-cause and potentially-avoidable 30-day rehospitalization rates among a national cohort of Medicare skilled nursing facility (SNF) residents.

Methods—We analyzed the 2012 Minimum Data Set, Medicare inpatient claims, and other data. Multivariable logistic regressions were used to adjust for resident demographic, functional, and diagnostic characteristics, as well as observed SNF and geographic factors. Conditional fixed-effects for SNFs were further used to adjust for both observed and unobserved factors. Independent effects of Black race and site-of-care groups were estimated, where sites were defined using proportions of Black Medicare admissions to the SNF.

Results—The 30-day all-cause and potentially-avoidable rehospitalization rates were 21.9% and 8.8%, respectively, for Black residents (n=120508), and 17.7% and 7.9% for White residents (n=1182003). Racial disparities persisted after adjustment for resident characteristics. Moreover, risk-adjusted disparities were essentially related to the type of SNFs to which residents were admitted; after controlling for SNF sites, significant racial disparity disappeared for potentially-avoidable rehospitalizations. Black residents and white residents admitted to SNFs with high proportions of Black admissions (>25%) were 31% and 19%, respectively, more likely to be rehospitalized than White residents admitted to SNFs caring for only a small percentage of Black post-acute residents (<3%).

Conclusions—Compared to White SNF residents, Black SNF residents are more likely to be rehospitalized even after adjusting for patient risk factors. Black-white disparities, especially in potentially-preventable rehospitalizations, are largely due to the fact that Black residents tend to be admitted to the small number of SNFs with very high rehospitalization rates.

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Keywords

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INTRODUCTION

Hospitalizations of vulnerable nursing home residents are common. In 2011, 25% of Medicare beneficiaries residing in nursing homes were hospitalized at a cost of \$14.3 billion.¹ At least 40% of these hospital transfers were for conditions that could be safely and effectively managed in nursing homes, or for acute flare-ups that could have been avoided under appropriate care.^{2–8} Hospital transfers of frail residents may cause additional physical and psychological suffering, expose them to iatrogenic problems such as hospital acquired infections, and increase system care cost.

Unlike long-term nursing home residents who receive custodial care for an extended period of time (e.g. >90 days), Medicare beneficiaries admitted to skilled nursing facilities (SNF) following a recent hospital stay receive skilled nursing or rehabilitative services for functional recovery typically for a relatively short period of time (e.g. <90 days). Thirty-day rehospitalization rate of these post-acute, short-term SNF residents is high, at 18% in a recent estimate of 2011,⁹ and varies over patient subgroups and facilities.^{10–15} In particular, one study has reported higher risk for 30-day rehospitalizations among Black SNF residents compared to White residents.¹¹ Reducing avoidable rehospitalizations has recently been the focus of major federal quality initiatives such as the Hospital Readmission Reduction Program aimed at improving the continuity and coordination of care.^{2,16,17} Nevertheless, little attention has been paid to the issue of racial disparities in rehospitalizations,¹⁸ either among institutionalized or community-based populations.

Racial disparities in post-acute and long-term nursing home care have been extensively reported for other quality indicators such as appropriate management of common geriatric conditions^{19–22} and receipt of vaccines.²³ Broad evidence also suggests that disparities are largely driven by the type of nursing facilities caring for the residents, due to the fact that minority residents tend to be disproportionately admitted to a small number of facilities with poorest resources and performance in care.^{22,24–26} The implications of sites of care for 30-day rehospitalization and racial disparity among Medicare post-acute residents, however, have not been well studied.

This study extended a previous report (of racial disparities in all-cause SNF rehospitalizations)¹¹ and aimed to determine racial disparities in both all-cause and potentially-avoidable 30-day rehospitalization rates among a cohort of Medicare short-term SNF residents in 2012. In particular, we investigated the role of differential sites of care in driving such racial disparities and in influencing the risk of 30-day rehospitalizations for both White and Black residents, which was not tested previously.

METHODS

Data sources and sample

We used the 2012 Minimum Data Set (MDS) 3.0, Medicare enrollment file, and Medicare Provider Analysis and Review (MedPAR) inpatient claims to define the study sample. The MDS 3.0 resident assessment file contains information about all nursing home residents in Medicare and/or Medicaid certified facilities. Comprehensive assessments are conducted at admission, annually, and when there is a substantial change in health condition. Assessment items include residents' demographics, payer status, diagnoses, functional and mental status, and treatments received. Extensive studies have confirmed the reliability, internal consistency, and validity of common MDS 3.0 items.^{9,27–33} Evidence suggests that compared to MDS 2.0, which has also been validated,³⁴ MDS 3.0 shows increased clinical utility, improved reliability and accuracy, and increased resident voice in assessments. In a national validation study, CMS contracted investigators reported overall very good to excellent reliability (e.g. kappa>0.7) of MDS 3.0;^{28,29} compared to MDS 2.0, MDS 3.0 is also of improved validity demonstrating significantly higher agreement with established measures developed based on non-MDS assessments.^{28–31} MDS 3.0 is currently being used for major federal and state initiatives such as CMS public reporting and case-mix adjusted reimbursement.

The enrollment file contains beneficiaries' demographic and enrollment information, as well as cross-referenced beneficiary ID that allows for linkage of records across the MDS and Medicare claims files. The MedPAR contains uniform administrative and clinical elements obtained from discharge abstracts for acute hospital stays of all fee-for-service beneficiaries. Patient level records include demographics, principal and secondary diagnoses classified by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes, and encrypted patient identifier. Medicare claims are frequently audited; although the ICD-9-CM and other components are not error free, the error rate is sufficiently low to ensure appropriate statistical inference on patient outcomes.^{1–8}

We used the 3 patient files to define the cohort of Medicare post-acute residents as those who were admitted to a SNF between January and November 2012 and whose MDS admission assessments were designated as Medicare part A PPS (prospective payment system) assessments. We excluded residents who were younger than 65 years or who were enrolled in a Medicare Advantage plan during any time of 2012. For the purpose of analyzing racial disparities, we retained only non-Hispanic White and Black residents (according to race/ethnicity records in the enrollment file) and further excluded the small number of residents with other race and ethnicities (4% of all 1357067 elderly fee-for-service admissions; see the Appendix Figure A1).

We merged the patient-level file to the 2012 On-line Survey, Certification, And Reporting (OSCAR) file to obtain SNF covariates, and the rural urban commuting area file (available at <http://depts.washington.edu/uwruca/ruca-data.php>) to define rural versus urban location of the SNF. The OSCAR is a facility-level file maintained by the CMS containing variables of key facility characteristics. Information in the OSCAR is generally considered to be reliable

and accurate, and has been widely used in analyses of nursing home practices and operations.

Variables

The 2 outcome variables were whether the resident had a readmission to an acute care hospital within 30 days of SNF admission (30-day rehospitalization), and whether the resident had a 30-day rehospitalization for potentially avoidable reason(s). Potentially avoidable 30-day rehospitalizations were identified using ICD-9-CM diagnoses according to the algorithm recently developed by a CMS-commissioned technical expert panel,⁵ and included rehospitalizations due to anemia, congestive heart failure, hypertension, hypotension, diabetes mellitus with ketoacidosis or hyperosmolar coma, acute renal failure, constipation, diarrhea, *Clostridium difficile*, gastroenteritis with nausea and vomiting, cellulitis, skin ulcers, pneumonia bronchitis, urinary tract infection, falls and trauma, altered mental status/acute confusion/delirium, psychosis, severe agitation, organic brain syndrome, Chronic obstructive pulmonary disease, weight loss or nutritional deficiency, and seizures.

The independent variables were race (White or Black) and racial composition of the SNF. For each SNF, we calculated the proportion of all its Medicare post-acute admissions (n=1538500, see Appendix Figure A1) who were Blacks before sample exclusions. Given the lack of prior study on site-of-care disparities in post-acute SNF care, we performed preliminary analyses and then categorized SNFs to 4 site-of-care groups: SNFs with low proportions of Blacks (<3%), with medium proportions (3–10%), with medium-high proportions (10–25%), and with high proportions (≥ 25%). The 4 groups of SNFs served approximately 50%, 25%, 15%, and 10%, respectively, of the White and Black post-acute residents in our sample. We explored alternative cutoff points for categorization in sensitivity analyses and confirmed the robustness of the results (see Appendix Tables A2–A4).

We a priori selected resident covariates from admission assessments that were potentially associated with rehospitalizations.^{5–8,10–15} They included age (in years), male gender (yes/no), whether the resident was currently married, whether the resident needed an interpreter for communication with healthcare providers, whether the beneficiary was dually eligible for Medicare and Medicaid (yes if the beneficiary was eligible for Medicaid for at least 6 months in 2012 based on enrollment information); difficulties in activities of daily living (ADLs), cognitive function scale of the resident, severity of depressive symptoms according to the Patient Health Questionnaire-9 item interview (PHQ-9) score, and the presence of an active diagnosis at admission for each of the following types of conditions: cancer, heart/circulation diseases, gastrointestinal diseases, genitourinary diseases, infections, metabolic diseases, musculoskeletal diseases, neurological diseases, malnutrition, psychiatric/mood disorders, pulmonary diseases, vision disorders.

The 7-component ADLs included bed mobility, transfer, dressing, eating, toilet use, personal hygiene, and bathing. We coded each component as 5 categories from 0 (independence) to 4 (total dependence), with the range of the aggregate ADL score being 0 to 28. Resident cognitive function scale was defined based on the Brief Interview for Mental Status (BIMS) score²⁷ and, for residents not able to complete the BIMS assessments, the cognitive

performance scale (CPS)³⁵ according to staff assessments. According to a recent study that validated the cognitive function scale in MDS 3.0,³² we coded the scale as 0 for being cognitively intact, 1 for mild impairment in cognition, 2 for moderate impairment, and 3 for severe impairment. Finally, we defined an indicator variable for whether the resident had moderately severe or severe depression (i.e. the PHQ-9 or an observational version PHQ-9 OV score ≥ 15).³⁰

SNF covariates included total number of beds, occupancy rate, chain affiliation (yes/no), profit status (for-profit, nonprofit, or government-owned), hospital affiliation (yes/no), percentages of Medicare residents and Medicaid residents among all current residents, nurse staffing levels for registered nurse (RN), licensed practical nurse (LPN), and certified nursing assistant (CNA), as well as the number of healthcare deficiency citations. Finally, county-level covariates included a measure of market competition based on the Herfindahl index calculated using nursing home beds, and an indicator of urban/rural location of the SNF.

Statistical analysis

We performed resident-level bivariate analyses to examine racial differences in rehospitalization rates and resident characteristics. Analyses of variance for continuous variables and chi-square tests for categorical variables were used in statistical inference. Similar bivariate analyses were performed at the SNF level to determine site-of-care differences in facility and market characteristics.

We performed multivariable analyses to determine the independent associations of race with 30-day rehospitalization and the extent to which differential sites of care drove racial disparities. Two separate sets of analyses were run first comparing residents with any hospital transfer within 30 days of SNF admission to residents not transferred, then comparing residents with any potentially-avoidable rehospitalization to residents not transferred (excluding those transferred for non-potentially-avoidable reasons). In each set of analyses, we estimated resident-level logistic regressions that had race as the independent variable and that sequentially adjusted for no covariate (model 0); resident socio-demographic covariates including age, gender, marital status, and a need for interpreter (model 1); aforementioned resident functional and diagnostic covariates (model 2); and then facility and county covariates, and dummies for states (model 3). All regressions used robust variance estimators to account for the clustering of residents admitted to the same SNF.³⁶

The sequential analyses helped elucidate the degree to which measurable site-of-care differences (i.e. given the OSCAR and other databases) underlay racial disparities in 30-day rehospitalization. However, concerns exist that other, unmeasured facility and geographic factors, such as a SNF's ability to respond to emergent situations¹² and regional hospital use patterns,³⁷ may also mediate racial disparities but were not captured by model 3 defined above.

To address this concern, we further estimated a conditional logistic regression^{38,39} for each outcome that was the same as model 2 above (i.e. adjusting for all resident "risk factors") but additionally incorporated conditional fixed-effects for SNFs. The conditional fixed-

effects regression (model 4) effectively accounted for, although did not explicitly estimate, the effects of measurable and unmeasurable cross-site attributes on rehospitalization in addition to adjusting for resident risk factors. Comparing the estimated odds ratio (OR) of race in the conditional logistic regression to the one obtained from model 2 allows for inferences about the contribution of sites of care to risk-adjusted disparities. If the OR of race is decreased after accounting for SNF fixed effects, then the attenuation in OR can be attributed to cross-site differences.

Finally, we categorized all SNF admissions according to race and site of care: (1) White residents in SNFs with low proportions of Black admissions, (2) Black residents in SNFs with low proportions of Black admissions, (3) White residents in SNFs with medium proportions, (4) Black residents in SNFs with medium proportions, (5) White residents in SNFs with medium-high proportions, (6) Black residents in SNFs with medium-high proportions, (7) White residents in SNFs with high proportions, and (8) Black residents in SNFs with high proportions of Black admissions. We then fit two logistic regressions for each outcome that had these groups as independent variables (White residents in SNFs with low proportions of Black admissions omitted) and that adjusted for all resident socio-demographic, functional, and diagnostic risk factors, as well as the clustering of residents in SNFs. The first regression (model 1) did not adjust for measured SNF or geographic factors in an attempt to estimate the overall site-of-care disparities in risk-adjusted odds of rehospitalization, while the second regression (model 2) further adjusted for SNF and geographic factors to see whether adjustment for these factors may attenuate site-of-care disparities.

RESULTS

Our sample included 1182003 White and 120508 Black residents admitted to 15041 SNFs from January to November of 2012 (Table 1). Compared to White residents, Black residents were slightly younger (79 vs 82 years on average), more likely to be male residents (38% vs 35%), less likely to be married (25% vs 34%), more likely to be dually eligible (43% vs 18%), and more physically and cognitively impaired. Active diagnoses at SNF admission also varied considerably between racial groups. For example, Black residents were less likely to be diagnosed with musculoskeletal and psychiatric/mood disorders, but more with neurological disorders.

The all-cause 30-day rehospitalization rate was 18.1% overall, 17.7% for Whites and 21.9% for Blacks (Table 1). These differential rates indicated a 30% increased odds of rehospitalization for Blacks (Table 2: unadjusted OR=1.30, 95% confidence interval [CI] 1.28–1.33, $p=0.000$). This racial disparity was attenuated after adjustments for resident risk factors (down to 1.20 in model 2), and for measurable SNF and geographic covariates (down to 1.14 in model 3). Model 4 shows that after full adjustments for resident risk factors, and measured and unmeasured site-of-care characteristics, Black residents still had 9% increased odds of all-cause 30-day rehospitalization (OR=1.09, 95% CI 1.07–1.11, $p=0.000$).

The potentially-avoidable 30-day rehospitalization rate was 8.0% overall, 7.9% for Whites and 8.8% for Blacks, suggesting a 13% increased odds for Blacks (Table 2: unadjusted

OR=1.13, 95% CI 1.10–1.16, $p=0.000$). Adjustments for resident covariates did not attenuate this racial disparity in appreciable ways, and further adjustment for measured SNF and geographic characteristics reduced the OR to 1.06 (model 3). Finally, Blacks did not show a significantly increased odds of potentially-avoidable 30-day rehospitalization after all resident risk factors and both measured and unmeasured site-of-care characteristics were adjusted for (OR=1.03, 95% CI 1.00–1.06, $p=0.053$).

Table 3 shows that 8063 SNFs (54% of the 15041 SNFs nationally) were characterized by low percentages of Black admissions. In contrast, 1911 SNFs (13% of all SNFs) nationally were characterized by high percentages of Black admissions. Table 3 also shows that SNFs with higher Black admissions tended to be larger for-profit facilities located in urban areas, and tended to have lower RN and CNA staffing levels and higher deficiency citations.

Table 4 shows that both White and Black residents had higher rehospitalization rate when admitted to SNFs serving more Black post-acute residents. For example, the all-cause rehospitalization rate was 20.1% for Whites and 22.9% for Blacks in SNFs with high proportions of Black admissions, compared to 16.7% for Whites and 17.5% for Blacks in low- proportion SNFs. Multivariable analyses adjusting for resident risk factors (model 1) confirmed that disparities in all-cause rehospitalization were largely driven by sites of care. Compared to White residents admitted to SNFs with low Black admissions, White residents had a 20% increased odds (OR=1.20, $p=0.000$) and Black residents a 34% increased odds (OR=1.34, $p=0.000$) for risk-adjusted, all-cause rehospitalization when they were admitted to SNFs with high proportions of Black admissions (i.e. 25%).

Model 2 in Table 4 shows that further adjustment for SNF and geographic factors reduced the site-of-care disparities partially. Model 2 also shows that increased SNF occupancy rate, chain affiliation, government ownership (versus for-profit ownership), and rural location of the SNF were associated with reduced likelihood of all-cause 30-day rehospitalization, while hospital affiliation and increased healthcare deficiencies of the SNF were associated with increased likelihood of rehospitalization (see Appendix Table A1 for details; similar associations were found for the likelihood of potentially-avoidable 30-day rehospitalization). In additional analyses contrasting Black-White difference within each of the medium, medium-high, and high Black-concentration groups, we found small but statistically significant racial effect (e.g. OR for Black race=1.09, $p=0.000$ within the medium Black-concentration group).

Table 4 shows similar site-of-care disparities for potentially-avoidable rehospitalizations (with somewhat smaller magnitudes than those for all-cause rehospitalization). In additional analyses contrasting Black-White difference within each Black-concentration group, we found no within-site difference (e.g. OR for Black race=1.03, $p=0.298$ within the medium Black-concentration group).

Finally, we presented in Figure 1 the predicted all-cause and potentially-avoidable 30-day rehospitalization rates by race and sites, where the predications were based on models of site-of-care disparities that adjusted for resident, SNF and geographic factors (i.e. “model 2” in Table 4).

DISCUSSION

We found that among a national cohort of Medicare post-acute SNF residents, Black residents had higher risk for 30-day all-cause and potentially-avoidable rehospitalizations than White residents. Such disparities persisted after adjustment for resident demographic, functional, and diagnostic factors. Black-white disparities were largely related to the type of admitting SNFs, specifically SNFs with different concentrations of Black residents. Both Black and White post-acute residents had higher risk for 30-day rehospitalization when admitted to SNFs with higher proportions of Black admissions, but Black and White residents had similar rates of potentially-avoidable reshospitalization within each group of SNFs of similar Black concentrations.

Although a prior study¹¹ has reported racial disparities in short-term rehospitalization rate among Medicare SNF residents, the present study, to our knowledge, is the first that focused on both site-of-care and racial disparities in all-cause and potentially-avoidable 30-day rehospitalizations. Our findings that racial disparities persisted (with attenuated magnitudes) after adjustments for differences in patient risk factors confirmed results of the previous study.¹¹ We further found that risk-adjusted racial disparities were largely explained by measured and unmeasured SNF and geographic factors. These results point to the importance of differential sites of care in affecting racial disparities in 30-day rehospitalizations.

It is not entirely clear, though, what site-of-care factors underlie the disparities in rehospitalization rate. A recent study¹⁵ found that SNF deficiency citations and nurse staffing levels were not consistently associated with 30-day rehospitalizations. A substantial body of literature also suggested that for-profit ownership of nursing facilities might be associated with lower quality of care such as increased hospital transfer rate.⁵⁻⁸ Our analyses in this study revealed that SNFs with higher proportions of Black post-acute admissions were more likely to be for-profits, and that compared to residents admitted to for-profit SNFs, residents admitted to government-owned facilities had reduced likelihoods for both all-cause (OR=0.91, $p<0.001$) and potentially-avoidable (OR=0.90, $p<0.001$; see Appendix Table A1) 30-day rehospitalization. Our sequential analyses (Table 2) found that these SNF characteristics, together with other commonly measurable SNF and geographic factors, helped explain partially risk-adjusted disparities in rehospitalizations. Nevertheless, as our conditional regression analyses demonstrated, other unmeasured differences in cross-site attributes further explained risk-adjusted disparities.

Our conditional fixed effects regression, although able to account for unmeasured effects of site attributes, did not shed light on what these attributes could be. Evidence exists that SNFs vary substantially in their on-site accessibility of technological resources (e.g. intravenous therapy, oxygen monitoring), on-site availability of medical staff, and overall ability to respond to emergent situations.^{40,41} Compared to other facilities, facilities serving higher proportions of Black residents are more likely to be financially strained with inadequate technological and staff resources.²⁴ These resource-poor facilities are thus less able to manage complex situations on-site and more likely to send their residents, both White and

Black residents, back to hospitals during emergencies, which contributes to the site-of-care disparities found in this study.

The decision of hospitalization may also be influenced by the preferences of residents and their family members. It is reported that Black patients tend to have stronger preferences for aggressive and life-sustaining care (such as hospital care) than White patients.^{42–44}

Although such preferences should be individual-based, the practice pattern of SNFs may be systematically impacted when high proportions of their residents are Blacks. In other words, physicians or registered nurses practicing in these SNFs may be more prone to transferring at-risk Black residents to hospitals, and this more aggressive transfer pattern similarly affect White residents as well.

The findings of this study have important policy implications. Frequent hospital transfers of frail post-acute SNF residents are traumatic to residents, expensive to the Medicare program, and likely to indicate problematic SNF care. Reducing hospital transfers of SNF residents thus holds the promise of improving both quality and efficiency of care. Substantial efforts have been made to reduce SNF-to-hospital transfers in recent years.^{1–4} However, this study suggests it is also important that targeted initiatives are developed to reduce racial disparities in hospital transfers. Particularly, future efforts aimed to reduce disparities could target the small number of facilities (13% of all SNFs in our sample) with high proportions of Black admissions and also the highest rehospitalization rate for their White and Black residents. These facilities care for approximately 50% of Black post-acute admissions nationally, and interventions tailored to these sites have considerable potentials to reduce both overall hospital transfer rate and racial disparities.

To our knowledge, national or state initiatives currently do not exist to address racial disparities in rehospitalizations among SNF residents, although broadly-targeted quality improvement programs have been developed to reduce overall rehospitalization rate. Concerns exist that these broadly-targeted efforts, such as bundled payment or pay for performance, may inadvertently hurt poor-resourced healthcare organizations and increase quality of care disparities across facilities.⁴⁵ Thus, future research is also needed to determine the potential impact of current broadly-targeted programs on disparities (in addition to overall improvements), so that evidence base can be developed to provide a compelling rationale for the redesign of existing programs or for the design of new ones that help reduce site-of-care disparities in SNF-to-hospital transfers.

This study has several limitations. First, we focused on non-Hispanic White and Black SNF residents, and excluded those of other races/ethnicities due to their small sample sizes. Future studies are needed to determine the potential disparities for other racial/ethnic minority groups. Second, our results were limited to fee-for-service Medicare beneficiaries and may not be directly extrapolated to Medicare Advantage beneficiaries. Third, although our analyses benefited from a large, national sample of White and Black SNF admissions, it made it possible that we identified even small differences in rehospitalization risk to be statistically significant; these differences (after covariate adjustment) might not be substantively (or “clinically”) important. Finally, although our analyses relied on detailed resident assessment records and adjusted for important resident factors such as physical and

cognitive functions as well as active diagnoses, it is possible that our cross-sectional analyses did not capture severity of disease or other risk factors (e.g. level of family support available for residents) perfectly. In addition, we had no way to adjust for patient/family preference over hospitalizations. Future research is needed to determine the potential impacts of individual preference and family supports on facility practice patterns and site-of-care disparities in 30-day rehospitalizations.

In conclusion, we demonstrated that Black Medicare SNF residents had higher risk for 30-day all-cause and potentially-avoidable rehospitalizations than White residents. Risk-adjusted disparities were largely related to the type of SNFs to which residents were admitted, with residents in sites with higher proportions of Black admissions having higher risk for 30-day rehospitalization. Efforts are needed to address site-of-care disparities.

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Appendix

Figure A1.
Flow chart for exclusions and study sample

Table A1

Full output of logistic regressions (i.e. Model 2 of Table 4 in the main report)

	All-cause 30-day rehospitalization		Potentially-avoidable 30-day rehospitalization	
	Odds ratio	P-value	Odds ratio	P-value
Low (<3%)				

	All-cause 30-day rehospitalization		Potentially-avoidable 30-day rehospitalization	
	Odds ratio	P-value	Odds ratio	P-value
Whites	Ref.		Ref.	
Blacks	0.98	0.542	0.93	0.231
Medium (3–10%)				
Whites	1.05	0.000	1.05	0.003
Blacks	1.15	0.000	1.08	0.018
Medium-high (10–25%)				
Whites	1.10	0.000	1.10	0.000
Blacks	1.19	0.000	1.12	0.000
High (25%)				
Whites	1.13	0.000	1.10	0.000
Blacks	1.25	0.000	1.15	0.000
Age, y	0.99	0.000	1.01	0.000
Male gender	1.05	0.000	1.00	0.787
Married	1.02	0.009	0.99	0.235
Interpreter needed	1.07	0.015	1.00	0.986
Medicare/Medicaid dually eligible	0.93	0.000	0.97	0.008
Activities of daily living at SNF admission (0–28) ^a	1.04	0.000	1.04	0.000
Cognitive function scale (0–3) ^b	1.06	0.000	1.06	0.000
PHQ-9 15	1.09	0.000	1.07	0.000
Active diagnosis at SNF admission				
Cancer	1.22	0.000	0.98	0.077
Heart/circulation	1.27	0.000	1.29	0.000
Gastrointestinal	1.07	0.000	1.04	0.000
Genitourinary	1.35	0.000	1.44	0.000
Infections	1.23	0.000	1.33	0.000
Metabolic	1.11	0.000	1.11	0.000
Musculoskeletal	0.75	0.000	0.82	0.000
Neurological	0.84	0.000	0.82	0.000
Malnutrition	1.15	0.000	1.11	0.000
Psychiatric/mood disorder	1.06	0.000	1.09	0.000
Pulmonary	1.44	0.000	1.72	0.000
Vision	0.94	0.000	0.91	0.000
Number of beds X 10	0.99	0.004	0.99	0.000
Occupancy rate X 10%	0.98	0.000	0.98	0.000
Chain affiliation	0.97	0.000	0.96	0.003
Profit status (for-profit omitted)				
Nonprofit	1.00	0.867	0.99	0.480

	All-cause 30-day rehospitalization		Potentially-avoidable 30-day rehospitalization	
	Odds ratio	P-value	Odds ratio	P-value
Government-owned	0.91	0.000	0.90	0.002
Hospital affiliation	1.08	0.014	1.04	0.324
% of Medicaid residents X 10%	1.01	0.001	1.01	0.022
% of Medicare residents X 10%	1.01	0.002	1.01	0.086
Registered nurse staffing	0.99	0.529	0.98	0.090
Licensed practical nurse staffing	1.01	0.395	1.00	0.740
Certified nursing assistant staffing	0.99	0.218	1.00	0.654
Number of healthcare deficiencies X 10	1.04	0.000	1.04	0.001
Herfindahl index	0.97	0.186	1.02	0.621
Rural county	0.96	0.000	0.96	0.012
State dummies	-----Output not shown-----			

^aSeven types of activities of daily living were coded 0 (independence) to 4 (total dependence) for a total score of 0–28.

^bCoded 0 for being cognitively intact to 3 for severely impaired cognition.

PHQ-9= Patient Health Questionnaire-9 item interview.

Table A2

Risk-adjusted odds of 30-day rehospitalizations by race and site of care (sensitivity analyses in which site-of-care groups were alternatively defined as <3%, 3–15%, 15–30%, and 30%; results compare to those in Table 4 of the main report)

Proportion of Black Medicare admissions in skilled nursing facility	30-day rehospitalization									
	All-cause					Potentially-avoidable				
	Unadjusted rate	Model 1 ^a		Model 2 ^b		Unadjusted rate	Model 1 ^a		Model 2 ^b	
		OR	P	OR	P		OR	P	OR	P
Low (<3%)										
Whites	16.7%	Ref.		Ref.		7.5%	Ref.		Ref.	
Blacks	17.5%	0.99	0.763	0.98	0.540	7.1%	0.93	0.259	0.92	0.230
Medium (3–15%)										
Whites	18.4%	1.09	0.000	1.06	0.000	8.2%	1.10	0.000	1.05	0.000
Blacks	20.7%	1.19	0.000	1.14	0.000	8.4%	1.11	0.000	1.06	0.024
Medium-high (15–30%)										
Whites	19.6%	1.17	0.000	1.12	0.000	8.8%	1.18	0.000	1.12	0.000
Blacks	22.2%	1.29	0.000	1.24	0.000	9.0%	1.21	0.000	1.15	0.000
High (30%)										
Whites	20.2%	1.20	0.000	1.13	0.000	8.6%	1.15	0.000	1.08	0.005
Blacks	22.9%	1.34	0.000	1.24	0.000	9.2%	1.24	0.000	1.16	0.000

^aModel 1: logistic regression models adjusted for patient socio-demographic, functional, and diagnostic covariates, as well as the clustering of residents in skilled nursing facilities.

^bModel 2: model 1 plus further adjustment for measured skilled nursing facility and county covariates, and state dummies.

OR=odds ratio.

Table A3

Risk-adjusted odds of 30-day rehospitalizations by race and site of care (sensitivity analyses in which site-of-care groups were alternatively defined as <3%, 3–20%, 20–40%, and 40%; results compare to those in Table 4 of the main report)

Medicare admissions in skilled nursing facility	30-day rehospitalization									
	All-cause					Potentially-avoidable				
	Unadjusted rate	Model 1 ^a		Model 2 ^b		Unadjusted rate	Model 1 ^a		Model 2 ^b	
		OR	P	OR	P		OR	P	OR	P
Low (<3%)										
Whites	16.7%	Ref.		Ref.		7.5%	Ref.		Ref.	
Blacks	17.5%	0.99	0.761	0.97	0.533	7.1%	0.93	0.258	0.92	0.227
Medium (3–20%)										
Whites	18.5%	1.10	0.000	1.06	0.000	8.3%	1.10	0.000	1.06	0.000
Blacks	21.0%	1.21	0.000	1.16	0.000	8.5%	1.14	0.000	1.09	0.000
Medium-high (20–40%)										
Whites	19.8%	1.18	0.000	1.12	0.000	8.8%	1.18	0.000	1.11	0.000
Blacks	22.3%	1.29	0.000	1.23	0.000	9.1%	1.22	0.000	1.15	0.000
High (40%)										
Whites	20.5%	1.21	0.000	1.12	0.000	8.5%	1.15	0.000	1.06	0.068
Blacks	23.2%	1.36	0.000	1.25	0.000	9.2%	1.24	0.000	1.14	0.000

^aModel 1: logistic regression models adjusted for patient socio-demographic, functional, and diagnostic covariates, as well as the clustering of residents in skilled nursing facilities.

^bModel 2: model 1 plus further adjustment for measured skilled nursing facility and county covariates, and state dummies.

OR=odds ratio.

Table A4

Risk-adjusted odds of 30-day rehospitalizations by race and site of care (sensitivity analyses in which site-of-care groups were alternatively defined as whether the proportion of Black post-acute admissions to the SNF is less than the mean of the whole sample [8.87%] or not)

Proportion of Black Medicare admissions in skilled nursing facility	30-day rehospitalization									
	All-cause					Potentially-avoidable				
	Unadjusted rate	Model 1 ^a		Model 2 ^b		Unadjusted rate	Model 1 ^a		Model 2 ^b	
		OR	P	OR	P		OR	P	OR	P
Low (<8.87%)										
Whites	17.2%	Ref.		Ref.		7.7%	Ref.		Ref.	
Blacks	19.7%	1.10	0.000	1.07	0.000	8.1%	1.05	0.141	1.03	0.419
High (8.87%)										
Whites	19.4%	1.12	0.000	1.08	0.000	8.6%	1.12	0.000	1.07	0.000
Blacks	22.4%	1.27	0.000	1.20	0.000	9.0%	1.17	0.000	1.11	0.000

^aModel 1: logistic regression models adjusted for patient socio-demographic, functional, and diagnostic covariates, as well as the clustering of residents in skilled nursing facilities.

^bModel 2: model 1 plus further adjustment for measured skilled nursing facility and county covariates, and state dummies.
OR=odds ratio.

(a) Predicted all-cause 30-day rehospitalization rate

(b) Predicted potentially-avoidable 30-day rehospitalization rate

Figure 1.

Predicted rates of (a) all-cause 30-day rehospitalization and (b) potentially-avoidable 30-day rehospitalization, by race (White vs. Black) and facility groups characterized by concentrations of Black post-acute admissions (low: <3%; medium: 3–10%; medium-high: 10–25%; and high: ≥25%)

Note: predictions are based on logistic regression models that estimated the likelihoods of rehospitalization as a function of race, facility groups of Black concentrations; patient socio-demographic, functional, and diagnostic covariates; measured skilled nursing facility and county covariates; and state dummies.

***: $p < 0.001$ for the Black-White difference within each of the facility groups of low, medium, medium-high, and high proportions of Black admissions. ns:

$p > 0.10$ for the Black-White difference within each of the facility groups of medium, medium-high, and high proportions of Black admissions.

Table 1

Characteristics of Medicare skilled nursing facility patients by race: January – November 2012*

	White (n=1182003)	Black (n=120508)
	% or mean±SD	
Rehospitalization within 30 days of SNF admission		
All-cause	17.7%	21.9%
Potentially avoidable	7.9%	8.8%
Age, y	81.6±8.1	78.6±8.3
Male gender	35.4%	38.4%
Married	34.1%	24.5%
Interpreter needed	1.3%	0.9%
Medicare/Medicaid dually eligible	17.8%	42.9%
Activities of daily living at SNF admission (0–28) ^a	17.7±4.2	18.9±4.7
Cognitive function scale (0–3) ^b	0.7±0.9	0.9±1.0
PHQ-9 15	5.3%	4.9%
Active diagnosis at SNF admission		
Cancer	9.5%	10.7%
Heart/circulation	90.5%	93.7%
Gastrointestinal	33.5%	28.9%
Genitourinary	22.4%	28.6%
Infections	30.9%	27.2%
Metabolic	66.3%	67.3%
Musculoskeletal	47.5%	33.2%
Neurological	37.8%	46.6%
Malnutrition	3.3%	4.2%
Psychiatric/mood disorder	41.4%	26.9%
Pulmonary	25.7%	22.1%
Vision	9.6%	9.8%

* P<0.001 for comparisons of all characteristics across patient groups, based on analyses of variance for continuous variables and chi-square tests for categorical variables.

^a Seven types of activities of daily living were coded 0 (independence) to 4 (total dependence) for a total score of 0–28.

^b Coded 0 for being cognitively intact to 3 for severely impaired cognition.

SD=Standard Deviation; PHQ-9= Patient Health Questionnaire-9 item interview.

Table 2
Racial disparities in 30-day rehospitalization among Medicare skilled nursing facility patients

Effect of Black race compared to white	30-day rehospitalization			
	All-cause		Potentially-avoidable	
	OR (95% CI)	P	OR (95% CI)	P
Model 0 ^a	1.30 (1.28 – 1.33)	0.000	1.13 (1.10 – 1.16)	0.000
Model 1 ^b	1.28 (1.25 – 1.30)	0.000	1.14 (1.11 – 1.17)	0.000
Model 2 ^c	1.20 (1.17 – 1.22)	0.000	1.11 (1.08 – 1.15)	0.000
Model 3 ^d	1.14 (1.11 – 1.16)	0.000	1.06 (1.03 – 1.10)	0.000
Model 4 ^e	1.09 (1.07 – 1.11)	0.000	1.03 (1.00 – 1.06)	0.053

^aModel 0: no covariates but adjusted for the clustering of patients in skilled nursing facilities.

^bModel 1: model 0 plus patient socio-demographic covariates (age, male gender, married, interpreter needed, and dual eligibility).

^cModel 2: model 1 plus patient functional and diagnostic covariates (table 1).

^dModel 3: model 2 plus measured skilled nursing facility and county covariates, and state dummies.

^eModel 4: model 2 plus both measured and unmeasured facility, county, and state covariates (i.e. through facility's conditional fixed effects).

OR=odds ratio; CI=confidence interval.

Table 3

Skilled nursing facility and county characteristics in 2012

Characteristic	Skilled nursing facility by concentration of Black Medicare admissions			
	Low (<3%) (N=8063)	Medium (3–10%) (N=2992)	Medium-high (10–25%) (N=2075)	High (25%) (N=1911)
	% or mean±SD			
Skilled nursing facility				
Black concentration *	0.5%	6.0%	15.9%	48.6%
Number of beds	93.7±50.8	120.4±64.2	125.4±64.8	133.3±77.3
Occupancy rate, %	82.0%±15.5%	83.3%±14.4%	82.5%±14.7%	82.7%±14.5%
Chain affiliation	53.9%	58.0%	59.7%	59.9%
Profit status				
For-profit	62.9%	75.6%	80.9%	83.5%
Nonprofit	31.4%	20.3%	15.9%	14.2%
Government-owned	5.8%	4.1%	3.2%	2.3%
Hospital affiliation	4.8%	4.6%	4.0%	3.5%
% of Medicare residents	34.4%±28.1%	37.9%±27.5%	38.3%±29.4%	42.5%±33.5%
% of Medicaid residents	37.0%±28.2%	38.9%±27.9%	42.9%±29.8%	44.3%±33.8%
Nursing hours per patient day				
Registered nurse	0.6±1.0	0.5±0.9	0.5±1.0	0.4±0.8
Licensed practical nurse	0.8±0.8	0.9±0.8	0.9±0.7	0.9±0.8
Certified nursing assistant	2.4±1.0	2.4±1.0	2.3±0.7	2.3±0.8
Number of healthcare deficiencies	5.6±4.8	6.1±5.0	6.5±5.3	6.7±5.3
County				
Competition for nursing home care	0.8±0.3	0.8±0.2	0.8±0.2	0.8±0.2
Urban	59.8%	81.9%	81.3%	82.4%

* Percentage of post-acute admissions to the skilled nursing facility who were Black residents.

SD=Standard Deviation.

Table 4

Risk-adjusted odds of 30-day rehospitalizations by race and site of care

Proportion of Black Medicare admissions in skilled nursing facility	30-day rehospitalization									
	All-cause					Potentially-avoidable				
	Unadjusted rate	Model 1 ^a		Model 2 ^b		Unadjusted rate	Model 1 ^a		Model 2 ^b	
		OR	P	OR	P		OR	P	OR	P
Low (<3%)										
Whites	16.7%					7.5%				
Blacks										
Medium (3–10%)										
Whites										
Blacks										
Medium-high (10–25%)										
Whites										
Blacks										
High (≥ 25%)										
Whites										
Blacks										

^aModel 1: logistic regression models adjusted for patient socio-demographic, functional, and diagnostic covariates, as well as the clustering of residents in skilled nursing facilities.

^bModel 2: model 1 plus further adjustment for measured skilled nursing facility and county covariates, and state dummies.

OR=odds ratio.