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Permalink

<https://escholarship.org/uc/item/01j2882m>

Journal

Health Services Research, 53(6)

ISSN

0017-9124

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Publication Date

2018-12-01



DOI

10.1111/1475-6773.13027

Peer reviewed

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DOI: 10.1111/1475-6773.13027
RESEARCH ARTICLE

Do Skilled Nursing Facilities Selected to Participate in Preferred Provider Networks Have Higher Quality and Lower Costs?

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Objective. To determine whether skilled nursing facilities (SNFs) chosen by health systems to participate in preferred provider networks exhibited differences in quality, costs, and patient outcomes relative to other SNFs after accounting for differences in case mix.

Data Sources. Medicare provider and claims data, 2012 and 2013.

Study Design. We compared SNFs included in preferred networks relative to other SNFs in the same market, prior to the establishment of preferred provider networks.

Data Extraction Methods. We linked the SNFs in our sample to facility characteristics and quality data. We identified SNF admissions and hospitalizations in claims data and limited the analysis to patients discharged from the hospitals in our sample. We obtained patient characteristics from Medicare summary files and the preceding hospital stay.

Principal Findings. Preferred SNFs exhibited better performance across publicly reported quality measures. Patients admitted to preferred SNFs exhibited shorter stays, lower Medicare payments, and lower probability of SNF readmission relative to non-preferred SNFs.

Conclusions. Our results imply that health systems selected SNFs with lower resource use and better performance on quality measures. Thus, the trend toward preferred provider networks could have implications for Medicare spending and patient health.

Key Words. Health economics, rehabilitation services, referrals and referral networks

Until recently, fee-for-service Medicare provided little incentive to coordinate or make efficient use of postacute care, which observers have linked to growth in postacute care spending and high rates of readmissions (Mor et al. 2010; Medicare Payment Advisory Commission 2015). In recent years, Medicare

has implemented new payment arrangements, such as bundled payment and accountable care organizations (ACOs), where hospitals or health systems bear some degree of financial responsibility for postacute care and outcomes occurring after hospital discharge (McWilliams et al. 2016; Press, Rajkumar, and Conway 2016).

Successful participation in ACOs and bundled payment requires hospitals to coordinate care with postacute care providers. Research shows that, prior to the implementation of these reforms, hospitals' postacute care referral networks were wide, with hospitals referring patients to 58 postacute care facilities on average (Lau et al. 2014). Given the complexity of managing a wide referral network, policy makers and researchers predicted that formal "vertical integration" of hospitals and other health care providers would occur as participation in new payment models increased (e.g., Baicker and Levy 2013). Despite these predictions, early research has not found evidence of greater integration of hospitals and physician groups in markets with higher accountable care organization penetration (Neprash, Chernew, and McWilliams 2017). While the share of Medicare-covered stays occurring in hospital-based skilled nursing facilities (SNFs) and the number of hospital-based inpatient rehabilitation facilities (IRFs) have leveled in recent years relative to prior decreases, there has not been a substantial increase in use of hospital-based postacute care facilities (Medicare Payment Advisory Commission, 2016a,b, 2017). Instead, hospitals have responded by creating networks of "preferred" skilled nursing facilities (SNFs) and other postacute care providers, where preferred providers are selected on the basis of historical cost and quality (Evans 2015; Medicare Payment Advisory Commission 2015; Livingston 2016). Hospitals are not allowed to constrain fee-for-service Medicare beneficiaries' choice of provider, but may engage in "soft steering" by providing patients with lists of preferred providers (Medicare Payment Advisory Commission 2015). Prior work has shown that readmissions are lower from SNFs that comprise a higher share of hospitals' SNF discharges (Rahman

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et al. 2013). Earlier research found that four hospitals that developed formal SNF networks exhibited reductions in readmission rates relative to hospitals that did not (McHugh et al. 2017). However, the extent to which preferred SNFs differ from nonpreferred SNFs in quality and Medicare spending, and whether differences are related to care processes rather than patient characteristics, remains unknown.

In this study, we investigated differences in quality, patient outcomes, and Medicare spending between preferred and nonpreferred SNFs prior to being selected to participate in hospitals' preferred SNF networks, in order to understand: (1) whether there existed differences in quality, patient outcomes, and Medicare spending prior to preferred network establishment and inclusion and (2) the extent to which differences were related to patient composition. We identified six prominent health systems that were participating in Medicare ACO programs and established preferred SNF networks between 2013 and 2016; these six systems were selected because they were prominent systems and their preferred SNF lists were publicly available. Among the SNFs in a health system's market, we identified those that were selected to participate in an ACO's preferred network. First, we compared facility characteristics and publicly reported quality performance of preferred versus nonpreferred SNFs. Focusing on patients discharged from each ACO's hospitals, we compared the clinical and demographic characteristics of patients admitted to preferred and nonpreferred SNFs. Next, we compared Medicare spending and patient outcomes following admission between preferred and nonpreferred SNFs, computing unadjusted differences and adjusted differences controlling for patient characteristics. Finally, we investigated the extent to which adjusted differences between preferred and nonpreferred SNFs changed under different assumptions about omitted variables bias from unobserved patient characteristics.

DATA AND METHODS

Study Population

We identified six health systems that formed preferred SNF networks between 2013 and 2016 as a part of Medicare ACO participation, including Pioneer, Shared Savings, and Next Generation programs (Table 1). We identified all SNFs in each health systems' health care market, defining a market as one or more proximate hospital referral regions (Dartmouth Institute for Health Policy and Clinical Practice 2016). We determined whether SNFs in each market

Table 1: Health Systems Establishing Preferred SNF Networks

	<i>ACO</i>	<i>ACO Start Date</i>	<i>Preferred SNF Network Start Date</i>
Atrius Health (Newton, MA)	Pioneer	2012	2013
Banner Health (Phoenix)	Pioneer	2012	2014
Cleveland Clinic	Shared Savings	2015	2015
Henry Ford Health System (Southeastern Michigan)	Next Generation	2016	2016
Monarch HealthCare (Orange County, CA)	Pioneer	2012	2014
Partners HealthCare (Boston, MA)	Pioneer	2012	2014

were included in a systems’ preferred network based on publicly reported lists of preferred SNFs. We identified all SNF admissions in each market occurring between January 1, 2012 and September 30, 2013 that were preceded by a hospital discharge from the health systems in our sample—notably, these admissions occurred prior to (or in the case of one health system, concurrent with) the establishment of each of the preferred networks in our sample. We constructed 90-day episodes of care that were initiated by a SNF admission. We excluded episodes with hospital discharges or postacute care use in the 90 days prior to SNF admission. We also excluded episodes where a patient had either discontinuous Part A or B coverage or Medicare Advantage enrollment during the year(s) spanning a 90-day pre-episode period and the 90 days following SNF admission.

Data Sources

We obtained facility information on hospitals and skilled nursing facilities from the 2012 and 2013 Medicare Provider of Services files and from 2013 Long-Term Care Focus data (Brown University School of Public Health 2018). We used quality information from the 2012 Nursing Home Compare file (Center for Medicare and Medicaid Services 2017). We identified SNF stays, preceding hospitalizations, hospital readmissions, inpatient rehabilitation facility stays, and long-term care hospital stays for the episodes of care in our sample using Medicare Provider Analysis and Review files. We identified home health episodes in Home Health Standard Analytic Files. We identified patient characteristics, Medicare enrollment information, mortality, and patient comorbidities in the Master Beneficiary Summary files and Chronic Condition

segment. We identified long-term nursing home stays using the Minimum Data Set.

Study Measures

SNF Episode Outcomes. We constructed patient-level outcomes for 90-day episodes of care initiated by a SNF admission including the initial SNF length of stay, whether a patient was readmitted to a SNF within the 90-day episode, whether a patient was readmitted to a hospital within the 90-day episode, total Medicare 90-day episode spending (including the initial SNF stay and any subsequent care from hospitals, SNFs, inpatient rehabilitation facilities, long-term care hospitals, and home health agencies; we prorated payments for stays extending beyond the 90-day episode), and mortality occurring during the episode.

Publicly Reported Quality Measures. We created indicator variables for whether SNFs received 5 or 4/5 of 5 stars for the following Nursing Home Compare composite quality measures: the health inspections rating (based on deficiencies identified during annual inspections), the level of overall nurse staffing, the level of registered nursing staffing, and an overall rating. The composite measures included both short stay (i.e., SNF) and long-stay patients, so we also investigated quality measures specific to SNF patients including the percentages of patients: assessed and appropriately given the pneumococcal vaccine, (newly) prescribed antipsychotic medication during the SNF stay (which is a marker of poor quality), self-reporting moderate to severe pain, assessed and appropriately given the seasonal influenza vaccine, and exhibiting new or worsening pressure ulcers.

Primary Explanatory Variable. The primary explanatory variable was whether a SNF was chosen as a preferred provider for a health system, which we derived from publicly reported lists of preferred SNFs in each network.

SNF Characteristics. We constructed measures of facility characteristics including whether a facility was located in an urban area, whether a facility belonged to a chain, ownership status (i.e., for profit vs. nonprofit), the number of certified Medicare beds, and the occupancy rate. In addition, we obtained the

proportion of a facility's residents with primary support from Medicaid from Long-Term Care Focus data.

Patient Characteristics. Patient characteristics included demographic measures (gender, age (in 5-year bands), and race and ethnicity), socioeconomic status (Medicaid coverage, eligibility for the Part D low-income subsidy, and characteristics of patients' zip code of residence based on the 2012 American Community Survey [United States Census Bureau 2016]), the Medicare Severity Diagnosis Related Group (MS-DRG) for the preceding hospital stay, the length of the preceding hospital stay, whether the preceding hospital stay included time in the intensive care unit, the comorbidities listed on the preceding hospital claim (Elixhauser et al. 1998), comorbidities from the Chronic Condition segment (based on diagnosis codes listed across Medicare claims in the preceding one or two years), and whether a patient had been admitted to the hospital within 3 days of discharge from a nursing home.

Methods

The goal of our analysis was to investigate whether ACOs chose SNFs with better performance on quality and efficiency of care used, focusing on the years immediately prior to the establishment of the networks. First, we estimated differences in facility characteristics and Nursing Home Compare quality measures for preferred versus nonpreferred SNFs within the same hospital referral regions (including SNFs where the health system had not historically sent patients), in each case controlling for health system. We investigated whether there were statistically significant differences in patient characteristics between preferred and nonpreferred SNFs adjusting for the MS-DRG from the preceding hospital stay and the discharging hospital. In our primary analysis, we compared the outcomes from episodes of care for patients admitted to preferred versus nonpreferred SNFs described above. Patients admitted to the preferred SNFs in our sample may have differed from patients admitted to nonpreferred SNFs. For example, preferred SNFs may have specialized in certain types of patients with particular conditions, or they were more selective in the types of patients they admitted. Not accounting for such differences could conflate differences in care processes with differences stemming from patient composition. To account for observable differences in the patients admitted to preferred SNFs, we estimated adjusted differences using multivariate regressions that adjusted for patient characteristics (described above) and fixed effects for the discharging hospital. First, we estimated differences

pooling episodes across the six health systems. Second, we stratified the sample and estimated health system-specific network effects.

Our main analysis estimated differences in episode outcomes between patients discharged to preferred and nonpreferred SNFs, including all SNFs within a market where the health system historically referred patients. However, it may be that health systems considered a more restricted set of SNFs when deciding to grant preferred status, for example, based on a SNF's distance to hospitals in the health system or other SNF characteristics. Rahman et al. (2013) found that hospitals discharged a greater proportion of patients to SNFs that were geographically proximate to the hospital and that SNFs receiving a high share of hospitals' discharges admitted a smaller percentage of Medicaid patients. We performed two sensitivity analyses to investigate whether there were differences in episode outcomes between preferred and nonpreferred SNFs using a more restricted set of facilities. First, we compared episodes in each preferred SNF to nonpreferred SNFs that were located within 4 miles of the preferred SNF, where 4 miles was the median distance from patients' residences to the SNF where they were admitted in our sample. We used this radius to approximate a set of SNFs that were geographically proximate to each preferred SNF and thus may have been considered as alternatives by health systems. We estimated differences in episode outcomes adjusting for patient characteristics as before, but we included a fixed effect for each preferred SNF and its proximate SNFs, reflecting that each nonpreferred SNF could be paired with multiple preferred SNFs.

In the second sensitivity analysis, we estimated differences in outcomes and costs between preferred and nonpreferred SNFs adjusting for the facility characteristics described above. SNF characteristics—such as size, ownership status, and the percentage of Medicaid patients—may influence health systems' choices of preferred SNFs, but also represent a mechanism through which episode outcomes could differ between preferred and nonpreferred SNFs. Thus, while these results may indicate whether preferred status was associated with better or worse outcomes independent of other observed SNF characteristics, they may also underestimate the true difference between preferred and nonpreferred SNFs as some of the differences in outcomes were likely driven by other observed SNF characteristics.

To the extent that there existed unobserved characteristics of patients that were correlated with both admission to a preferred SNF and episode outcomes, our estimated differences between preferred and nonpreferred SNFs would be biased estimates of the effect of admission to a preferred SNF. For example, preferred SNFs may have selectively admitted less severe patients

who also exhibited shorter SNF stays and were less likely to be readmitted to the hospital. One solution to this bias would be to estimate the effect of preferred SNF admission using an instrumental variables approach. Using this approach, we would identify an instrumental variable that was correlated with admission to a preferred SNF, was only related to episode outcomes through choice of SNF (i.e., the exclusion restriction), and was uncorrelated with other unobserved patient characteristics that were themselves related to episode outcomes. The benefit of this approach is that it allows for a consistent estimate of the effect of being admitted to a preferred SNF (that is, the estimate converges in probability to the true effect of preferred SNF admission as the sample size becomes large). A likely candidate for an instrument would be the differential distance from a beneficiary's residence to the closest preferred SNF relative to the closest nonpreferred SNF. Prior research has shown that distance to a SNF is a key determinant of patient's choice of facility (Tyler et al. 2017). However, we found substantial imbalance in socioeconomic status by quartile of differential distance, particularly within each health system's patients; for example, the percentage of patients who were Medicaid dual eligible ranged from 20.7 to 34 percent across differential distance quartiles in health system 2 (Table 2 in Appendix SA2). Thus, we had low confidence that this instrument would be uncorrelated with other unobserved characteristics related to patient outcomes and satisfy the exclusion restriction.

Instead, we adopted an approach developed by Oster (2017) to explore the extent to which our results may be sensitive to omitted variables bias. This method infers the potential importance of unobserved controls based on the sensitivity of coefficient estimates to the addition of *observed* characteristics relative to an uncontrolled regression, under the assumption that "selection" into preferred SNFs based on unobserved characteristics is proportionally and positively related to selection based on observed controls. We argue that the assumption is likely valid, as plausible unobserved patient characteristics related to selection into preferred SNFs may include severity and socioeconomic status, which are positively related with the observed measures of patient clinical and socioeconomic status that we include in our estimation (e.g., comorbidities, reason for the initial hospitalization, and Medicaid and Part D low-income subsidy enrollment). Thus, a greater sensitivity of our results to accounting for selection on observables suggests a larger role of omitted variable bias in explaining our results. In addition, this approach incorporates information from the change in explained variation (R^2) after adding observed controls relative to a regression without controls, noting that coefficient estimates could be stable with the addition of observed control

variables if those variables explain little of the overall variance in the outcome. Thus, a greater increase in R^2 but little change in coefficient estimates in regressions accounting for observable selection may suggest that coefficient estimates are also robust to selection into preferred SNFs based on unobserved characteristics.

Using this approach, we estimated differences in patient outcomes between preferred and nonpreferred SNF admissions assuming that selection into preferred SNFs based on unobservable characteristics was equal to selection into preferred SNFs based on observed characteristics. Thus, this bound can be interpreted as a robustness test for how much our estimates would change in the event that unobserved and observed characteristics were equally related to preferred SNF admission and we were able to control for that selection in our estimation. In particular, we were interested in the extent to which this bound was closer to zero relative to the main estimate with observed controls and whether the interval between the main estimate and this bound included zero. In addition, we estimated the extent of unobserved selection into preferred SNFs (as a proportion of selection based on observed controls) that would be necessary to eliminate the estimated differences between preferred and nonpreferred SNFs in the main specification. This methodology is described in more detail in the Appendix SA2.

The key limitation of this approach is that the consistency of the estimated bounds is subject to strong assumptions about the extent of selection based on unobserved characteristics and its relationship with selection on observed characteristics (described above; Oster 2017). The benefit of this method is that it provides useful information on the extent to which our main estimates are driven by selection on unobserved characteristics, in the absence of a valid instrumental variables strategy or other means of causal inference.

RESULTS

Comparing the Characteristics of Preferred versus Nonpreferred SNFs

Preferred SNFs were all in urban areas, were more likely to be nonprofit, housed more Medicare-certified beds, and delivered care to a lower proportion of Medicaid enrollees relative to nonpreferred SNFs in the same market (Table 2). Preferred SNFs were more likely to receive 5 (or 4 or 5) stars on each of the composite quality measures from Nursing Home Compare (overall rating, health inspections rating, staffing rating, and RN staffing rating). Preferred SNFs were more likely to appropriately provide the pneumococcal and

Table 2: Characteristics and Quality Performance of Preferred and Nonpreferred SNFs

	<i>Means</i>		<i>Difference</i>
	<i>Preferred</i>	<i>Nonpreferred</i>	
Number of SNFs	162	1,092	
Facility characteristics			
Urban (%)	100.0	96.5	4.3***
Chain status (%)	56.8	52.4	-0.7
For profit (%)	68.5	82.9	-13.4**
Nonprofit (%)	30.8	16.1	14.1***
Government ownership (%)	0.6	1.0	-0.8
Certified beds	126.8	108.5	11.0*
Census occupancy (%)	82.3	84.1	0.0
Medicaid resident share (%)	46.7	62.3	-15.0***
Quality performance			
Overall rating			
5 star (% of SNF/quarters)	42.0	20.2	20.0***
4 or 5 star (% of SNF/quarters)	69.0	45.1	21.6***
Health inspections rating			
5 star quarters (%)	18.6	7.7	9.1**
4 or 5 star quarters (%)	47.2	25.2	17.3***
Staffing rating			
5 star quarters (%)	18.7	10.6	8.2**
4 or 5 star quarters (%)	71.7	56.4	11.5**
RN staffing robust rating			
5 star quarters (%)	36.2	19.6	13.6***
4 or 5 star quarters (%)	67.1	45.5	12.1**
Short stay resident quality measures			
Assessed and appropriately given the pneumococcal vaccine (%)	85.6	79.9	4.6**
Newly received an antipsychotic medication (%)	1.9	2.3	-0.6***
Self-reported moderate to severe pain (%)	17.7	18.5	-2.2*
Assessed and appropriately given the seasonal influenza vaccine (%)	85.3	81.3	3.3*
Pressure ulcers that were new or worsened (%)	0.7	1.0	-0.4***

Notes. Table displays mean characteristics and within-health system differences between preferred and nonpreferred SNFs. Standard errors are robust. * $p < .05$, ** $p < .01$, *** $p < .001$.

seasonal influenza vaccines and were less likely to initiate antipsychotic medication. Preferred SNFs had a lower fraction of patients reporting moderate to severe pain and new or worsening pressure ulcers.

Focusing on the ten most frequent MS-DRGs for hospitalizations preceding SNF admissions in our data, 14.4 percent of admissions in preferred SNFs followed a hospitalization for lower extremity joint replacement relative

to 8.2 percent in nonpreferred SNFs (Table 3). Differences in the prevalence of other conditions were mixed and smaller in magnitude. Including fixed effects for the discharging hospital and the MS-DRG from the preceding hospital stay, a higher percentage of preferred SNF admissions were female and preferred SNF admissions were slightly older (Table 3, Column 3). Patients admitted to preferred SNFs were 9.0 percentage points less likely to be eligible for Medicaid ($p < .001$, unadjusted percentages were 18.7 percent for preferred vs. 31.2 percent for nonpreferred SNFs) and 8.9 percentage points less likely to be eligible or enrolled in the Part D low-income subsidy ($p < .001$, unadjusted percentages were 20.5 percent for preferred vs. 32.7 percent for nonpreferred SNFs). We found no statistically significant difference in other zip code level measures of socioeconomic status, the number of comorbidities listed on the index hospital claim, or the number of chronic conditions between patients admitted to preferred and nonpreferred SNFs. Preferred SNF admissions exhibited 0.2-day shorter preceding hospital stays ($p = .001$, unadjusted averages were 6.1 for preferred vs. 6.5 days for nonpreferred SNFs). Once we adjusted for SNF characteristics, we found a similar, albeit attenuated, pattern of differences (Table 3, Column 4). Focusing on the most prevalent chronic conditions, we found slightly higher levels of hyperlipidemia and rheumatoid or osteoarthritis among patients admitted to preferred SNFs. Overall, these results suggest that preferred SNF admissions were more likely to be higher socioeconomic status, but imply limited difference in severity within MS-DRGs.

Health Care Use, Medicare Episode Spending, and Outcomes for Patients in Preferred versus Nonpreferred SNFs

Pooling episodes across the health systems in our sample, we found that preferred SNFs exhibited shorter length of stay, lower Medicare spending per postdischarge episode, lower SNF and hospital readmission rates, and lower mortality (Table 1 in Appendix SA2). After adjusting for patient characteristics (including the reason for the initial hospitalization), however, we only found statistically significant differences between preferred and nonpreferred SNFs in the initial length of stay (3.5 days shorter, $p < .001$, unadjusted averages were 24.0 days for preferred vs. 29.6 days for nonpreferred SNFs), Medicare spending for the postdischarge episode (\$687 lower, $p = .03$, unadjusted averages were \$20,878 for preferred vs. \$22,864 for nonpreferred SNFs), and SNF readmission rates (1.4 percentage points lower, $p = .002$; Table 1 in

Table 3: Characteristics of Patients Admitted to Preferred and Nonpreferred Skilled Nursing Facilities

	<i>Means</i>			
	(1) <i>Preferred</i>	(2) <i>Nonpreferred</i>	(3) <i>Adjusted Difference</i>	(4) <i>Adjusted Difference (with Facility Controls)</i>
Number of SNF episodes	27,876	33,086		
Top 10 Medicare Severity-Diagnosis Related Groups (%)				
470 (major joint replacement of lower extremity w/o MCC)	14.4	8.2	6.3***	3.1***
871 (septicemia or severe sepsis w/o MV > 96 hours w MCC)	3.1	4.2	-1.0***	-0.4*
481 (hip and femur procedures except major joint w CC)	3.3	3.0	0.5**	0.4*
690 (kidney and urinary tract infections w/o MCC)	2.4	2.9	-0.6**	-0.2
291 (heart failure and shock w MCC)	1.7	1.8	-0.1	0.0
194 (simple pneumonia and pleurisy w CC)	1.7	1.9	-0.3*	-0.2
683 (renal failure w CC)	1.6	1.9	-0.2	0.0
292 (heart failure and shock w CC)	1.8	1.5	0.1	0.1
552 (medical back problems w/o MCC)	1.7	1.5	0.2	0.2
193 (simple pneumonia and pleurisy w MCC)	1.3	1.4	-0.1	0.0
Demographic characteristics				
Female (%)	66.7	63.0	1.9***	1.4*
Age (years)	81.3	80.4	1.1***	0.4
Non-white (%)	11.4	16.6	-2.0	0.3
Socioeconomic status				
Dual eligible (%)	18.7	31.2	-9.0***	-3.6**
Low-income subsidy eligibility (%)				
Eligible or enrolled	20.5	32.7	-8.9***	-3.4**
No low-income subsidy eligibility, Part D enrolled	38.4	31.8	4.7***	1.3
No low-income subsidy eligibility, not Part D enrolled (%)	41.0	35.5	4.1***	2.1**
Characteristics of beneficiary residence location (by zip code)				
Median household income (\$)	68,699	66,763	761	-493
Households below poverty (%)	11.3	11.9	-0.2	0.3
Hispanic/Latino population (%)	9.9	13.2	-0.3	0.0
Non-white population (%)	22.7	24.2	1.4	2.0**
Clinical status				
Length of index hospital stay (days)	6.1	6.5	-0.2**	-0.1*
Comorbidities, index hospital stay	3.4	3.5	0.0	0.0

continued

Table 3. *Continued*

	<i>Means</i>			
	(1) <i>Preferred</i>	(2) <i>Nonpreferred</i>	(3) <i>Adjusted Difference</i>	(4) <i>Adjusted Difference (with Facility Controls)</i>
Number of chronic conditions	7.5	7.6	0.0	0.0
Selected chronic conditions (%)				
Hypertension	90.0	89.9	0.6	0.4
Anemia	66.2	67.7	-0.4	-0.3
Hyperlipidemia	68.3	65.5	2.2***	1.3*
Rheumatoid/osteoarthritis	61.5	56.2	2.4***	0.7
Ischemic heart disease	57.3	57.9	0.3	0.0

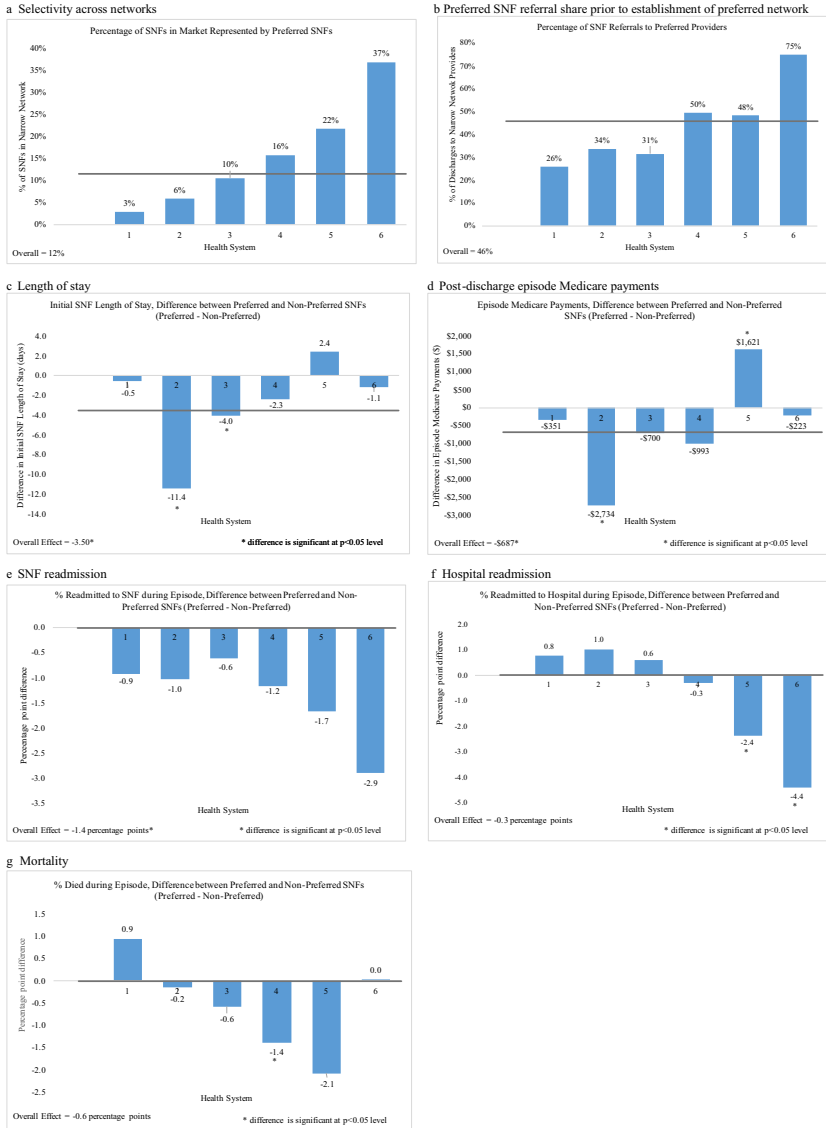
Notes. Table displays characteristics of patients admitted to preferred and nonpreferred SNFs and adjusted differences. For top 10 Medicare Severity Diagnosis Related Groups (MS-DRG), differences adjusted for hospital. For other characteristics, differences adjusted for MS-DRG and hospital. In addition, the fourth column also adjusts for SNF characteristics. Standard errors are clustered at the SNF provider level. * $p < .05$, ** $p < .01$, *** $p < .001$.

Appendix SA2). These overall differences, however, mask considerable variability across health systems.

Prior to the establishment of preferred networks, the health systems in our sample discharged patients to a wide network of SNFs, ranging from 91 providers (in health system 6) to 349 (in health system 3; Figure 1 in Appendix SA2). The selectivity of preferred networks across health systems, which we defined as the percentage of SNFs in each health system’s market that was included in the preferred network, ranged from 3 percent (in health system 1) to 37 percent (in health system 6; Figure 1, Panel a). The percentage of each health system’s SNF patients admitted to preferred SNFs prior to the establishment of the preferred network ranged between 26 and 75 percent, and was 46 percent overall (Figure 1, Panel b).

Adjusting for patient characteristics, preferred SNFs in health system 2 exhibited 11.4 day shorter stays relative to nonpreferred SNFs (unadjusted average stays were 18.0 for preferred vs. 32.3 days for nonpreferred SNFs) and preferred SNFs in health system 3 exhibited 4.0 day shorter stays relative to nonpreferred SNFs (unadjusted average stays were 22.5 days for preferred vs. 28.1 days for nonpreferred SNFs; Figure 1, Panel c and Table 1 in Appendix SA2, column 4). In contrast, health systems 2 and 3 exhibited statistically insignificant differences in hospital readmissions (Figure 1, Panel f and Table 1 in Appendix SA2, column 4). Preferred SNFs for health systems 5 and

Figure 1: Adjusted Differences in Episode Outcomes for Patients Admitted to Preferred Versus Nonpreferred SNFs, by Health System [Color figure can be viewed at wileyonlinelibrary.com]



Notes. Figures display adjusted differences in outcomes of 90-day episodes for patients admitted to preferred and nonpreferred SNFs by health system, controlling for hospital fixed effects and patient characteristics. Standard errors clustered at SNF level. * indicates $p < .05$.

6 exhibited significantly lower hospital readmissions, but no significant difference in initial SNF length of stay (Figure 1, Panels c and f and Table 1 in Appendix SA2, column 4). Across outcomes, health systems 1 and 4 exhibited small differences between preferred and nonpreferred SNFs that were largely statistically insignificant (Figure 1, Panels c–g and Table 1 in Appendix SA2, column 4). Focusing on individual health systems, differences in episode spending were largely statistically insignificant except for health system 2, which exhibited \$2,734 lower episode Medicare payments, and health system 5, which exhibited \$1,621 higher episode Medicare payments (Figure 1, Panel d and Table 1 in Appendix SA2, column 4). Preferred SNFs exhibited lower rates of SNF readmission across all systems, although only the pooled estimate was statistically significant (Figure 1, Panel e and Table 1 in Appendix SA2, column 4). Mortality differences were mixed and statistically insignificant across systems except for health system 4, which exhibited significantly lower mortality at preferred SNFs (1.4 percentage points lower; Figure 1, Panel g and Table 1 in Appendix SA2, column 4).

In the first sensitivity analysis, we estimated differences between preferred and nonpreferred SNFs, pairing each preferred SNF with nonpreferred SNFs located within a four-mile radius (Table 1 in Appendix SA2, Column 5). On average, each preferred SNF was paired with 3.6 percent of nonpreferred SNFs in their respective market. The overall pattern of results was similar to the main estimates, except that preferred SNFs now exhibited lower mortality relative to nonpreferred SNFs. In the second sensitivity analysis, we adjusted for facility-level characteristics, which attenuated both overall and within-health system differences, reflecting that the institutional characteristics of preferred SNFs differed from nonpreferred SNFs, but did not alter the overall pattern of findings (Table 1 in Appendix SA2, Column 6).

Bound for Preferred SNF Coefficient Accounting for Omitted Variables Bias

As described above, we constructed bounds for the estimated differences in patient outcomes between preferred and nonpreferred SNFs that incorporated potential selection bias, based on the extent to which the preferred versus nonpreferred difference and the R^2 changed between a “base” unadjusted model relative to a model with patient-level control variables. We focused on outcomes that were statistically significant across health systems in the adjusted models: the initial SNF length of stay, readmission rates to SNFs, and Medicare episode spending. The base model only controlled for the MS-DRG from the hospitalization preceding the SNF stay, while the adjusted

models also adjusted for the patient characteristics described above and fixed effects for the discharging hospital. Patients admitted to preferred SNFs exhibited an initial SNF length of stay that was 4.8 days shorter than nonpreferred SNFs in the unadjusted model, but this fell in magnitude to 3.5 days shorter in the adjusted model (Table 4). The R^2 in the unadjusted model was 0.05, but increased to 0.11 in the adjusted model with patient characteristics. Using these results (based on Equation 1 in Appendix SA2) and assuming that selection into preferred SNFs based on unobserved and observed controls were equally important, we estimated that initial SNF stays in preferred SNFs would still be 2.8 days shorter than nonpreferred SNFs. Moreover, selection on unobserved patient characteristics would have to be 5.2 times more important than selection on observed characteristics to offset the overall preferred SNF estimate.

Table 4: Differences between Preferred and Nonpreferred SNFs Accounting for Omitted Variables Bias

	1. Unadjusted Model: Only Controls for Medicare Severity Diagnosis Related Group		2. Adjusted model: Adds Patient-level Controls		3. Estimates Incorporating Potential Omitted Variables Bias	
	Preferred versus Nonpreferred SNF Difference	R^2	Preferred versus Nonpreferred SNF Difference	R^2	Preferred versus Nonpreferred SNF Difference	Selection on Unobserved Relative to Observed Patient Characteristics Necessary to Offset Adjusted Difference (Ratio)
Initial SNF length of stay (days)	-4.8***	0.05	-3.5***	0.11	-2.8	5.2
SNF readmission (%)	-1.8**	0.04	-1.4**	0.06	-1.1	5.1
Medicare spending for postdischarge episode (\$)	-1,336**	0.06	-687*	0.13	-320	1.9

Notes. Panels 1 and 2 display coefficient estimates and R^2 from an “unadjusted” model just controlling for Medicare Severity Diagnosis Related group and an adjusted model controlling for other patient characteristics (described in text). Panel 3 displays (1) estimated difference assuming selection in preferred SNFs based on unobserved characteristics is equally important to selection in preferred SNFs based on observed characteristics and (2) the ratio of selection on unobserved characteristics relative to observed characteristics necessary to offset the difference in the adjusted model. * $p < .05$, ** $p < .01$, *** $p < .001$ for the unadjusted and the adjusted models.

Performing the same procedure for SNF readmissions, we found that preferred SNF patients were 1.1 percentage points less likely to be readmitted to a SNF and that selection into preferred SNFs based on unobserved characteristics would have to be 5.1 times more important than selection on observed characteristics to negate this effect. Finally, accounting for potential omitted variables bias, we estimated that episode Medicare payments were \$320 lower at preferred SNFs and that selection into preferred SNFs based on unobserved characteristics would have to be 1.9 times more important than selection on observed characteristics to offset the preferred SNF estimate.

DISCUSSION

Medicare payment models such as ACOs and bundled payment have increased hospitals' responsibility for health care utilization and patient outcomes following discharge among fee-for-service Medicare patients. In response, hospitals have created networks of preferred postacute care providers (such as SNFs), where facilities are chosen on the basis of prior utilization and quality. To the extent that hospitals are able to accurately identify higher quality and lower cost SNFs for preferred provider networks, this could more broadly improve postacute care and postdischarge outcomes.

We investigated publicly reported quality, health care utilization, Medicare spending, and patient outcomes for SNFs selected to join in preferred networks with six large health systems as a part of ACO participation. We found that preferred SNFs exhibited higher performance on publicly reported nursing home quality relative to other SNFs in the same markets, suggesting that this was one criterion for preferred network inclusion. We found that patients admitted to preferred SNFs exhibited lower unadjusted length of stay, fewer hospital or SNF readmissions, lower Medicare postdischarge spending, and lower mortality rates. However, patients admitted to preferred SNFs were substantially less likely to be eligible for Medicaid or the Part D low-income subsidy (implying higher socioeconomic status) and were more likely to be admitted for lower extremity joint replacement (which is often performed for patients with lower comorbidity). These findings are consistent with previous work, which found that Medicare dual-eligible beneficiaries were more likely to be admitted to SNFs with lower nurse staffing and transition to long nursing home stays (Rahman et al. 2014).

Adjusting for patient characteristics, we found that patients admitted to preferred SNFs still exhibited lower length of stay, lower episode Medicare

payments, and fewer SNF readmissions, although differences were attenuated. Differences in preferred versus nonpreferred SNFs varied across health care systems, with preferred SNFs exhibiting lower length of stay relative to nonpreferred SNFs in some health systems and lower hospital readmission rates in others. This finding motivates future work to investigate whether selection criteria for preferred provider status vary across health systems.

Our study had a number of limitations. First, we were not able to estimate the causal effects of being admitted to a preferred SNF on episode outcomes. We calculated bounds for the estimated differences between preferred and nonpreferred SNFs that accounted for potential omitted variables bias and continued to find that, across the health systems in our sample, preferred SNFs had shorter stays, lower episode Medicare payments, and SNF readmissions. However, these bounds were subject to strong assumptions on the relationship between selection into preferred SNFs based on unobserved versus observed patient characteristics. Thus, while the estimated bounds were suggestive, they were not conclusive. Second, we examined six ACOs that publicly posted information on preferred networks; our results might not be representative of other preferred networks. Third, we were unable to examine patient outcomes after SNFs entered preferred networks. Finally, the move toward narrow networks might have an important effect on competition between SNFs in a given health care market. We hope to investigate these issues in future research.

In summary, our results suggest that while adjusted differences in costs and patient outcomes between preferred and nonpreferred SNFs were driven partially by differences in patient composition, increasing reliance on preferred SNFs may still improve overall costs and patient outcomes. However, one caveat is that preferred SNFs might have limited capacity to absorb new admissions. For example, we found that preferred SNFs already had an occupancy rate of 82 percent prior to the establishment of preferred networks.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: This research was supported by the National Institute on Aging (R01AG046838). Pinar Karaca-Mandic provides consulting services to Tactile Medical and Precision Health Economics. Those activities are not related to this manuscript. Lianna Weissblum is employed by Medtronic. Her activities at Medtronic are not related to this manuscript.

Disclosures: None.

Disclaimer: None.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix SA1: Author Matrix.

Appendix SA2: Calculation of Bounds for Coefficient Estimates Accounting for Selection Bias.