The Impact of a Tiered Network on Hospital Choice

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Objective. To evaluate the effect of a tiered network on hospital choice for scheduled admissions.

Data. The 2009–2012 patient-level claims data from Blue Cross Blue Shield of Massachusetts (BCBSMA).

Study Design. BCBSMA's three-tiered hospital network employs large differential cost sharing to encourage patients to seek care at hospitals on the preferred tier. During the study period, 44 percent of hospitals were moved to a different tier based on changes in cost or quality performance. We relied on this longitudinal variation for identification and specified conditional logit models to estimate the effect of the tiered network (TN) on patients' hospital choices relative to a non-TN comparison group.

Principal Findings. The TN was associated with increased use of hospitals on the preferred and middle tiers relative to the nonpreferred tier for planned admissions. The results suggest that if all members were in a TN plan, relative to all members being in a non-TN plan, scheduled admissions to hospitals on the nonpreferred tier would drop by 7.6 percentage points, while those to middle and preferred tier hospitals would rise by 0.9 and 6.6 percentage points, respectively.

Conclusion. Differential cost sharing can steer patients toward preferred hospitals for planned admissions.

Key Words. Tiered network, cost sharing, hospital choice

Tiered network insurance plans (TNs) categorize physicians and/or hospitals into tiers based on criteria including cost and quality measures, and use cost sharing differences between tiers to encourage patients to seek care from preferred providers. By steering patients toward providers with lower costs and/or higher measured quality, TNs attempt to enhance the value of care delivered. Moreover, TNs allow patients who elect to receive care from preferred providers to pay less out of pocket while also preserving their ability to choose providers on nonpreferred tiers.

Over the past 5 years, TNs have become increasingly popular. The percentage of employers whose largest plan included a tiered or limited network increased from 16 percent in 2010 to 23 percent in 2013, and TN plans are even more prevalent among very large employers (Choudhry, Rosenthal, and Milstein 2010b; Kaiser Family Foundation 2013). This proliferation of TNs has been driven in part by employers seeking to constrain premiums, which can be significantly lower for TN plans, while preserving benefit generosity. For example, various insurers have reported charging 14–30 percent less for TN plans than for nontiered plans with otherwise comparable benefits (Ho 2004; Tufts Health Plan 2012). In addition, relative to limited or narrow networks that exclude selected providers from plan coverage, and because TNs preserve patients' ability to choose from a wide range of providers (albeit with differential cost sharing), they might be more palatable to plan members (Draپر, Liebhaber, and Ginsburg 2007).

While many TNs focus on physicians rather than hospitals, tiered hospital networks may be more effective in addressing high spending levels for several reasons. First, unit prices are larger and pricing variation potentially greater for hospital-based care than for outpatient visits (America's Health Insurance Plans 2010). For example, one study found that payments to the lowest versus highest priced hospitals in Massachusetts differed by over 300 percent for the same basket of services, with no evidence of quality differences (Office of Attorney General Martha Coakley 2010). Second, individuals may be more willing to switch hospitals than physicians because patients often value long-term, interpersonal relationships with their physicians, while hospital care tends to be more discrete and episodic. In some cases, switching hospitals will entail a switch in physician because not all physicians can admit to all hospitals. The effects may differ based on whether the admitting physician is a primary care physician (PCP) or specialist. Patients may be less tied to specialists than PCPs, but tendencies of PCPs to refer to specialists in their system may limit the ability of patients to choose preferred hospitals. Thus, hospital choices for certain types of procedures, for example, hip replacements, may be influenced by admitting privileges and existing referral patterns. Our results reflect these institutional details.

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There is a large literature documenting the link between cost sharing and medical care use (Newhouse et al. 1981; Brook et al. 1983; Manning et al. 1984; Keeler et al. 1985; Lohr et al. 1986; Lurie et al. 1989; Newhouse 1993; Rice and Morrison 1994; Blustein 1995; Rubin and Mendelson 1995; Friedman et al. 2002; Liang et al. 2004; Busch et al. 2006; Wharam et al. 2007, 2011; Greene et al. 2008; Trivedi, Rakowski, and Ayanian 2008; Nair et al. 2009; Chen, Levin, and Gartner 2010). These studies, however, focus on cost sharing applied uniformly to all providers or services. While high across-the-board cost sharing can create financial barriers to access, TNs employ differential cost sharing to influence patient choices of care options. In this sense, TNs are more analogous to tiered pharmacy formularies that use differential cost sharing to encourage the use of medications on the preferred tier. Studies of such formularies have generally reported statistically significant though quantitatively modest effects (Mahoney 2005; Chernew et al. 2008; Choudhry et al. 2010a; Maciejewski et al. 2010; Gibson et al. 2011a,b; Frank et al. 2012). This literature, however, has primarily evaluated the impact of differential cost sharing on medication choice and adherence for chronic conditions, whereas our study considers the choice of providers for scheduled hospitalizations.

The literature specific to provider networks is sparse and somewhat mixed. Scanlon, Lindrooth, and Christianson (2008) conducted the only empirical evaluation of which we are aware of a tiered hospital network. They found the probability of receiving care at a preferred hospital increased among nonunion-affiliated TN patients with medical diagnoses but not with surgical diagnoses, and no effect was found among union-affiliated TN patients. Sinaiko and Rosenthal (2014) recently evaluated plans that tiered physicians and found no effect on care patterns among patients with existing physician relationships, though nonpreferred physicians received fewer new patient visits. Two other studies of a reference-pricing benefit design (Robinson and Brown 2013) and a limited network (Rosenthal, Li, and Milstein 2009) suggest that cost-sharing differences influence patient-provider choices.

Most TN plans, to date, have been structured with modest cost sharing overall and small differences between tiers. TNs with greater intertier cost-sharing differences may exert more influence on patients' hospital choices.

In this study, we examined the tiered hospital network of Blue Cross Blue Shield of Massachusetts (BCBSMA), the largest insurer in Massachusetts (covering 45 percent of commercial market enrollees) and an early adopter of a TN with large intertier cost-sharing differences. Our overall objective was to evaluate the extent to which the TN altered hospital choices for admissions.

DATA AND SETTING

In 2007, Blue Cross Blue Shield of Massachusetts implemented its tiered hospital network, which assigns hospitals in Massachusetts to one of three tiers: the preferred, middle, or nonpreferred tier. While TN plan members may receive care at any of these hospitals, they face financial incentives to choose a preferred hospital. In the small-group market, tiered copays were set at the start of the study period at \$150, \$500, and \$1,000 for inpatient admissions to preferred, middle, and nonpreferred hospitals, respectively. In October 2009, BCBSMA introduced an additional benefit design with even greater cost-sharing differences between tiers, including a \$150 copay for preferred hospitals, a \$150 copay after a \$500 deductible for middle hospitals, and a \$1,000 copay after a \$2,000 deductible for nonpreferred hospitals. Patients admitted through the emergency department were exempt from the cost sharing. These same benefit designs were offered in the large-group market, although plans in the large-group market can customize cost-sharing levels when self-insured. Observed average cost-sharing per admission (including copays and deductibles) for TN and non-TN members averaged across the small- and large-group markets are presented in Figure 1.

To ensure that TN plan members receive the information they need to make informed choices, BCBSMA provides online and paper-based “engagement tools” that summarize hospital tierings and guide members toward selecting a preferred hospital. In addition, BCBSMA maintains a special unit of member service representatives with expertise on TN plans and requires that brokers undergo TN training and certification before selling the product.

Figure 1: Cost Sharing by Tier

Notes: Observed average cost sharing by hospital tier for TN and non-TN member admissions after sample exclusions.

BCBSMA re-tiers hospitals periodically based on a combination of cost (unit prices) and quality measures (including CMS Hospital Compare and AHRQ indicators).¹ During the study period (2009–2012), 66 percent of hospitals remained on the same tier, but 44 percent of hospitals (representing 58 percent of admissions) changed tiers because of either changes in cost and/or quality performance (Figure 2). Nearly all of the changes in hospital tierings derived from decreases in negotiated unit prices, as the large majority of hospitals consistently met the quality standards set by BCBSMA (during the study period, only 1.8 percent of admissions were to hospitals with a low-quality rating). Most tier changes involved the migration of hospitals from the middle to the preferred (low cost sharing) tier, though several large hospitals were switched to the nonpreferred tier such that the proportion of admissions to nonpreferred hospitals also increased (Figure 2). While hospital tierings can be challenging to create and value itself can be difficult to operationalize in practice, our analysis takes a demand-side perspective, accepting the tierings as defined by BCBSMA to estimate the TN’s impact on patient hospital choices.

Figure 2: Hospital Admissions, 2009–2012

Notes: Four different tier schedules were in effect during the 2009–2012 period. The left chart shows the distribution of admissions by TN and non-TN members to nonpreferred, middle, and preferred hospitals under each tier schedule. The right chart shows the percentage of admissions to hospitals by tier switch direction for all years; “switch up” refers to admissions to hospitals that switched from the nonpreferred to the middle or preferred tier or from the middle to the preferred tier; “switch down” refers to admissions to hospitals that switched from the preferred to the middle or nonpreferred tier or from the middle to the nonpreferred tier.

Study Sample

We used BCBSMA claims data from 2009 to 2012. Enrollees in TN plans comprise our intervention group. We selected a comparison group of non-TN enrollees in plans with the same hospital choices and similar benefit design features as the TN enrollees but without differential cost-sharing tiers. All plans were health maintenance organization plans and none had contemporaneous nontraditional cost-sharing structures; for example, there are no high-deductible health plans in the sample.

Our unit of observation is the admission. During the study period, there were a total of 21,690 TN and control admissions among adult members (age 18–64) residing in Massachusetts. We excluded admissions for which a member was unlikely to have actively chosen the hospital or the member's choice was impaired; for example, hospital transfers (461 admissions; or 2.1 percent of the sample) and 30-day readmissions (975; 4.5 percent). In addition, we excluded admissions through an emergency department (ED), which are exempt from tiered cost sharing (3,094; 14.3 percent). To identify ED admissions, we first used an admission source variable provided by BCBSMA; however, this variable was discontinued in 2011, so we also imputed likely ED admissions, defined as admissions on the same or next day as an ED visit. We also excluded admissions based on the criteria used to define a member's hospital choice set (as discussed below), including admissions to hospitals located farther than 75 miles from a member's home ZIP code and admissions to hospitals that did not perform at least two procedures with the same diagnosis-related group (DRG) as the member's admission (819; 3.8 percent). To mitigate potential bias from out-of-state hospital use, we excluded members living in three hospital service areas (HSAs) near the Massachusetts border in which more than 20 percent of members received care at non-Massachusetts hospitals (374; 1.7 percent). We also excluded admissions with missing data (primarily DRG codes; 457; 2.1 percent). After adjustments, there were a total of 15,510 admissions in the sample, including 5,320 admissions by TN members (34.3 percent) and 10,190 by non-TN (comparison group) members (65.7 percent). Among members with admissions, 88.8 percent had a single admission during the study period, 9.1 percent had two admissions, and 2.1 percent had three or more admissions.

Statistical Analyses

We relied on BCBSMA's re-tiering of hospitals for identification in our analyses. Our basic research design compares how TN members' choices differ

when hospitals in their choice set change tiers, controlling for potential confounding variables and secular trends that affect demand by use of a non-TN comparison group. As noted above, 44 percent of hospitals representing 58 percent of admissions changed tiers during the 2009–2012 study period (Figure 2). Of these admissions to hospitals that switched tiers during the study, approximately three-quarters were to nine large hospitals (each representing at least 3 percent of TN or non-TN admissions), while the balance were to 19 smaller hospitals. The Institutional Review Boards of Harvard Medical School and the Massachusetts General Hospital approved this study.

Addressing Plan Choice Selection Bias

The major concern in our analysis is nonrandom selection into TN plans. This concern is mitigated by several aspects of our study design. First, we used longitudinal data and relied on BCBSMA's periodic re-tiering of hospitals (an arguably exogenous source of variation) for identification. Unlike cross-sectional studies, our approach compares the hospital choices of TN members during multiple periods when different tier schedules were in effect, thereby differencing out any potential time-invariant unmeasured factors. Second, individual members had limited ability to choose a TN versus non-TN plan because employers chose which plans to offer, and most chose full replacement; that is, only one type of plan was available (99.2 percent of the employers in our sample offered only TN or non-TN plans). Third, we propensity score-weighted the sample to balance TN and non-TN members on observed characteristics, as discussed below. Finally, we include a number of falsification and sensitivity analyses as described below.

Propensity Score Weights

To derive propensity scores, we specified logistic regression models at the admission level for the probability of being in the TN group during each tier schedule period (Rubin 2001). The covariates included age, sex, health status (as measured by Verisk Health's diagnostic-cost-group scoring system, which is similar to the risk adjustment method used for Medicare Advantage plan payments [Pope et al. 2004]), individual versus family plan, employer size (<50, 51–499, 500+), employer type (commercial insured, commercial self-insured, small group, or municipal), whether a member's PCP was on a global budget (i.e., BCBSMA's Alternative Quality Contract [Song et al. 2011]) at the time of admission, admission source (physician vs. clinic referral), length

of stay, and ZIP-level variables for percent black, percent white, the log of household income, the log of population density per square mile, the number of hospitals within 10 miles, and the log of the population density to hospital ratio. We then calculated propensity-score overlap weights as follows: For admissions by TN members, the propensity score weight is one minus the predicted probability of being in the TN group; for admissions by non-TN members, it is the predicted probability. These weights were used in estimation.

Hospital Choice Model

We assessed the effect of TN plans on patient choices of preferred, middle, and nonpreferred hospitals using conditional-logit, discrete-choice models (McFadden 1973, 1974; Train 2009). Our estimation approach is based on a utility maximizing model of hospital choice that assumes the utility associated with a given hospital derives from observed and unobserved hospital and patient characteristics. Thus, we posited a model where the utility patient i gains from receiving care at hospital j during time t is $U_{ijt} = f(X_{ijt}, Z_{it}, hospital_j, tier_{jt}, TN_i, \varepsilon_{ijt})$. X_{ijt} is a vector of patient/hospital-level covariates, including $distance_{ij}$ from member i 's home ZIP code to hospital j (including $\ln(1 + distance)$ and $[\ln(1 + distance)]^2$), which has been shown to be associated with hospital choice (McGuirk and Porell 1984; Luft et al. 1990; Adams et al. 1991; Burns and Wholey 1992; Chernew, Scanlon, and Hayward 1998), and indicator variables for whether member i 's PCP was mainly affiliated with hospital j ($pcp_hosp_aff_{ijt}$). $pcp_hosp_aff_{ijt}$ may not include all hospitals where a PCP has admitting privileges. Also, it does not directly adjust for the admitting physician (which may be the PCP or a specialist), though it should capture much of the effect of specialist affiliations, given that patients often rely on their PCP for specialist referrals, and PCPs often recommend specialists within their own hospital system. Z_{it} is a vector of patient-level covariates including whether member i 's PCP was on a global budget ($pcp_glob_budget_{it}$) during time t , and a vector of $time_{it}$ indicator variables for the periods when each tier schedule was in effect, which correspond roughly with calendar years and vary slightly between members based on plan sponsor (i.e., employer) contract renewal dates. $Hospital_j$ is a vector of hospital fixed effects for each of the hospitals in member i 's choice set. These fixed effects capture time-invariant hospital traits, such as size (number of beds), ownership status (public, private, nonprofit), teaching status, location, availability of services, the average patient's valuation of reputation and amenities, and physician referral patterns that are stable over time. $Tier_{jt}$ is a vector of indicator variables for the tier (preferred and middle; nonpreferred is the refer-

ence category) of hospital j during time t . TN_i is an indicator variable equal to 1 if member i was enrolled in a TN plan at the time of admission. ε_{ijt} captures heterogeneity in patient i 's preferences for unobserved time-variant characteristics of hospital j during time t .

When a patient chooses to receive care at hospital j , the conditional-logit model assumes the utility associated with hospital j is greater than that of all other k alternatives in the patient's hospital choice set. For tractability, the conditional-logit model assumes that the ε_{ijt} 's are independent and identically distributed (i.i.d.). The logit-choice probability that individual i will choose hospital j during time t takes the form:

$$p(Y_{ijt} = 1) = \frac{\exp(\beta_1 X_{ijt} + \beta_2 Z_{it} * tier_{jt} + \beta_3 hospital_j + \beta_4 TN_i * hospital_j + \beta_5 tier_{jt} + \beta_6 TN_i * tier_{jt})}{\sum_{k \in C_{it}} \exp(\beta_1 X_{ikt} + \beta_2 Z_{it} * tier_{kt} + \beta_3 hospital_k + \beta_4 TN_i * hospital_k + \beta_5 tier_{kt} + \beta_6 TN_i * tier_{kt})}$$

where $Y_{ijt} = 1$ when individual i is treated at hospital j during time t . The denominator includes the k alternatives in member i 's choice set of hospitals (C_{it}). As noted above, a hospital was included in a member's choice set if the hospital is located within 75 miles of the member's home ZIP code and the hospital performed at least two procedures with the same DRG as the member's admission. Note that the patient-level covariates (Z_{it}), including $pcp_glob_budget_{it}$ and $time_{it}$, were included only as interactions with $tier_{jt}$ because uninteracted patient-level variables in conditional-logit models are absorbed in the patient fixed effect. The $pcp_glob_budget_{it} * tier_{jt}$ interactions control for the impact of a member's PCP being on a global budget on the tier of the member's hospital choice (we included these covariates because PCPs on a global budget may be more likely to refer patients to preferred hospitals), while the $time_{it} * tier_{jt}$ interactions capture time trends correlated with hospital tiers.

Our primary explanatory variable of interest is $TN_i * tier_{jt}$, the interaction between enrollment in a TN plan and hospital tier. The $hospital_j$ and $TN_i * hospital_j$ fixed effects control for time-invariant factors influencing the hospital choices of non-TN and TN plan members, respectively. $Tier_{jt}$ therefore controls for secular trends associated with changes in hospital tiers as reflected by non-TN plan member hospital choices, and the coefficient on $TN_i * tier_{jt}$ (β_4) captures the impact of tier switches on TN plan member hospital choices.

We exponentiated the $TN_i * tier_{jt}$ coefficients to generate odds ratios that compare the likelihood of care at middle and preferred hospitals relative to nonpreferred hospitals among TN versus non-TN plan members. We also computed the predicted probabilities that TN and non-TN plan members will receive care at nonpreferred, middle, and preferred hospitals. These predicted

probabilities, unlike the odds ratios, are based on simulations that use individual characteristics averaged across the full sample. To calculate the TN plan member probabilities, we set TN_i equal to 1 for the full sample, derived the predicted probabilities of member i receiving care at each hospital j in his or her choice set, summed these predicted probabilities for nonpreferred, middle, and preferred hospitals, and then averaged the predicted probabilities by tier across members. To calculate the probabilities for non-TN plan members, we repeated these steps with TN_i set equal to 0 for the full sample. The differences between the TN and non-TN predicted probabilities provide an estimate of how the TN would affect hospital choice if everyone were in the TN versus no one being in the TN. As a sensitivity analysis, we also simulated effect size estimates using only TN plan members in the sample. We then bootstrapped 95 percent confidence intervals around our effect size estimates. To calculate the confidence intervals, we drew 500 bootstrap samples (random with replacement) with 15,510 admissions (the number of admissions in our analytic sample) and propensity score-weighted the samples separately. With each sample, we then specified our conditional-logit model and computed predicted probabilities and effect sizes, as described above. From these bootstrapped effect size estimates, we derived standard errors and generated the confidence intervals.

Falsification Test

As a falsification test, we assessed the TN's impact on the hospital choices of patients admitted through an ED, as ED admissions are exempt from tiered cost sharing. In defining the ED admissions sample, we used the admission source variable provided by BCBSMA, which most cleanly identifies admissions through an ED.² To define ED choice sets, we included all hospitals within 25 miles of a member's home ZIP code because most patients would not travel farther for emergent care. Given the smaller sample size for this subanalysis, we combined the fixed effects of hospitals with fewer than 10 ED admissions in order for the model to converge.

Robustness Tests

To test the robustness of our results, we conducted several sensitivity analyses examining the effects of different potential sources of identification. Thus, we specified a model without $TN_i \times hospital_j$ interactions, which allows for identification from cross-sectional variation in TN and non-TN hospital

choices in addition to the longitudinal variation from hospital tier changes over time. We also specified a model without $pcp_hosp_aff_{ijt}$ because choice of PCP could be endogenous, and to test the sensitivity of our results to affiliation. Finally, we estimated separate models for the four tier-schedule periods, which rely solely on the cross-sectional variation between TN and non-TN hospital choices during each period.

To evaluate potential selection bias, we conducted two additional sensitivity analyses. First, we defined a panel of members who were enrolled in a TN or non-TN plan for at least four quarters prior to receiving care. Second, we defined a panel of members who were continuously enrolled in a TN or non-TN plan for at least eight quarters. Similar results between the full sample and these subsamples would moderate concerns over selection bias.

RESULTS

Descriptive Statistics

Patient characteristics for the unweighted and propensity score-weighted samples with standardized differences are presented in Table 1. Prior to weighting, TN and non-TN members shared similar patient (age, sex, risk score) and area (race, income, population density) characteristics, but TN members were more likely to be employed by larger, self-insured, and municipal employers. The propensity score-weighted sample is well-balanced with standardized differences near zero across all observed patient, employer, and area characteristics.

Hospital Choice Conditional-Logit Regression Results

For the main analysis (Table 2, column I), the $TN_i * tier_{jt}$ interactions indicate that TN members were more likely than non-TN members to receive care at preferred (odds ratio = 1.80; $p \leq .05$) and middle-tier (1.63; $p \leq .05$) hospitals relative to nonpreferred hospitals. In addition, patients were significantly more likely to receive care at the hospital with which their PCP was affiliated, and distance significantly affected hospital choice, as expected. Results from the falsification test examining admissions through an ED are shown in Table 2, column II.

In Figure 3, we display the predicted probabilities that the TN steered patients from nonpreferred to middle and preferred hospitals for the main analysis and falsification test. The simulated shares if all members were in a

Table 1: Patient Characteristics

	Unweighted Sample			Weighted Sample		
	TN	Non-TN	Standardized Difference	TN	Non-TN	Standardized Difference
Admissions	5,320	10,190		5,320	10,190	
Patient characteristics						
Age (years)	42.9	41.8	0.000	42.8	42.8	0.000
Female (%)	69.5	73.6	0.000	69.6	69.6	0.000
Risk score	8.5	7.7	0.000	8.4	8.4	0.000
Nonfamily plan (%)	22.5	21.7	-0.033	24.1	24.1	0.000
Employer size (%)						
<50 employees	21.4	48.4	-0.683	33.1	33.1	0.000
50-499 employees	37.7	39.0	-0.167	46.1	46.1	0.000
500+ employees	40.9	12.6	0.929	20.8	20.8	0.000
Market segment (%)						
Commercial insured	34.4	57.0	-0.652	52.7	52.7	0.000
Commercial self-insured	24.1	3.1	0.878	8.9	8.9	0.000
Small group	14.9	32.6	-0.462	22.3	22.3	0.000
Municipal	26.7	7.3	0.498	16.1	16.0	0.002
PCP on global budget (%)	63.0	46.4	0.092	57.4	57.4	0.000
Admission characteristics						
Physician referral (%)	81.6	87.5	-0.038	82.3	82.3	0.000
Length of stay (days)	3.4	3.3	0.000	3.3	3.3	0.000
Area characteristics (ZIP)						
Percent black	5.69	5.45	0.002	6.09	6.09	0.000
Percent white	82.93	82.99	0.000	82.01	82.01	0.000
Ln household income	11.18	11.19	0.000	11.16	11.16	0.000
Ln population per sq mile	7.29	7.24	0.001	7.27	7.27	0.000

TN plan, relative to all members being in a non-TN plan, indicate a 7.6 percentage point shift from nonpreferred (95 percent confidence interval, -9.17 to -5.94 percentage points) to middle (+0.9 percentage points, -0.9 to 2.79 percentage points) and preferred (+6.6 percentage points, 4.89 to 8.22 percentage points) hospitals. The simulations that estimate effect sizes using only TN plan members shows similar share changes. With these effects, and given the average difference in TN and non-TN member cost-sharing for admissions to nonpreferred relative to preferred/middle hospitals, the choice

Table 2: Odds Ratios from Hospital Choice Analyses

	I	II	III	IV	V	VI	VII	VIII	IX	X
	Main Analysis	ED Admits	Without TN Hospital Interactions	Without pcp_aff	2009 Tier Schedule	2010 Tier Schedule	2011 Tier Schedule	2012 Tier Schedule	Continuing Members	Continuously Enrolled Members
pcp_hosp_aff	7.65*** (0.726)	9.75*** (1.452)	7.62*** (0.723)	—	8.31*** (1.394)	8.46*** (0.857)	7.73*** (0.809)	7.28*** (0.764)	7.65*** (0.815)	7.98*** (0.827)
ln_dist	1.51*** (0.188)	1.45 (0.560)	1.51*** (0.194)	1.49** (0.200)	1.71** (0.539)	1.46* (0.258)	1.48** (0.194)	1.55* (0.309)	1.45* (0.222)	1.46** (0.211)
ln_dist_sq	0.58*** (0.024)	0.47*** (0.063)	0.58*** (0.024)	0.52*** (0.025)	0.58*** (0.049)	0.60*** (0.029)	0.58*** (0.024)	0.56*** (0.037)	0.58*** (0.029)	0.58*** (0.025)
tn_preferred	1.80* (0.504)	0.87 (0.455)	1.88*** (0.158)	1.82* (0.548)	1.66 (0.602)	2.03*** (0.301)	1.72*** (0.197)	1.96*** (0.284)	1.70 (0.673)	1.70 (0.550)
tn_middle	1.63* (0.360)	1.75 (1.010)	1.57*** (0.186)	1.57* (0.340)	1.31 (0.504)	1.61† (0.412)	1.72** (0.298)	1.47 (0.376)	1.76† (0.578)	1.92** (0.446)
Admissions	15,510	1,960	15,510	15,510	3,849	3,070	4,515	4,076	9,446	9,539
Choices	528,614	41,198	528,614	528,614	128,351	107,203	154,965	138,095	319,735	323,429
Choices/ Admission	34.1	21.0	34.1	34.1	33.3	34.9	34.3	33.9	33.8	33.9

Standard errors reported in parentheses.
†, $p \leq .10$, * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

elasticity was -0.13 .³ This implies that a 10 percent increase in cost-sharing difference causes a 1.3 percent shift in scheduled admissions from nonpreferred to preferred/middle hospitals.

In contrast, relatively small and statistically nonsignificant changes in simulated shares are predicted for ED admissions to nonpreferred (+1.0 percentage point), middle (-1.4 percentage points), and preferred (+0.5 percentage points) hospitals, although the confidence intervals are wider in this subset.

The results of our robustness tests are presented in Table 2, columns III–X. Column III contains results for the model that relies on both cross-sectional and longitudinal variation from hospital tier switches. These results are similar to the main results, but with smaller standard errors. Column IV presents results for the model without $pcp_hosp_aff_{ijt}$ which again are very similar to the main results. In columns V through VIII, results are provided from the cross-sectional models that compare TN and non-TN hospital choices for the four periods when different tier schedules were in effect (with no identification from hospital tier switches). While some variation in results might be expected given the changing mix of hospitals on different tiers during each period, the results were largely stable across periods.

Results from the selection-bias tests examining continuing members and continuously enrolled members are shown in columns IX and X, respectively. The $TN_i * tier_{jt}$ odds ratios for these samples are fairly similar to those of the

Figure 3: Predicted Probabilities That the TN Steered Patients from Nonpreferred to Middle and Preferred Hospitals

Notes: The main analysis includes all admissions after sample exclusions. The falsification test includes ED admissions identified by the admission source variable provided by BCBSMA. Figures are presented with 95 percent confidence intervals generated through bootstrap analyses.

main analysis, implying that our results were insensitive to individuals differentially selecting into or out of TN plans over time.

Overall, the results are robust across sensitivity analyses: In all models, the $TN_i * tier_{jt}$ odds ratios indicate effects with relatively similar magnitudes. Moreover, the falsification test suggests that the TN had little or no impact on hospitalizations through the ED; that is, being in a TN plan was only associated with hospital choice for planned admissions with differential cost sharing, not with hospital choice for ED admissions without differential cost sharing.

DISCUSSION AND CONCLUSION

Tiered networks seek to influence care-seeking choices by patients primarily through imposing differential cost-sharing amounts. While most TNs have been structured with relatively small differences in cost sharing, BCBSMA was an early adopter of a TN with large intertier cost-sharing differences.

These findings help quantify the impact of tiered networks. As provider network benefit designs become an increasingly common mechanism to reduce spending growth, health plans will compare the costs and benefits of implementing tiered versus narrow networks. A narrow network is an extreme type of provider network that does not cover the services of nonpreferred providers; that is, patients receiving care from these providers face full out-of-network cost sharing (Pear 2013; Kingsdale 2014). The TN we assessed was able to steer patients toward preferred hospitals while preserving a greater degree of provider choice (TN plan members still could receive care from any hospital in Massachusetts).

Yet provider tiering is but one tool to address concerns about higher spending. Despite the evidence that TNs can affect hospital choice, they have a number of potential drawbacks: TNs may transfer risk to patients, disrupt patient–provider relationships, and/or induce patients to make choices that are not appropriate in specific situations. Other strategies which we did not examine, for example, global provider budgets, may offer an alternative, perhaps more flexible, and in some cases, complimentary strategy to direct referrals.

Limitations

Our estimation approach has the following limitations. First, as with all quasi-experimental designs, unobserved factors may influence results. For example,

in our case, we do not observe risk tolerance, provider reputation, transportation options, or familiarity with and trust in the health care system. Yet our design addresses these concerns. For example, most of these factors are likely to be time-stable and thus addressed by the fixed effects we included in the models. We also exploited changes in tier schedules over time and propensity score-weighted our sample; these study design features mitigate selection bias. Finally, we have queried health plan executives about potential contemporaneous, unmeasured time-variant factors and found none.

Second, like many sentinel studies that examine a single health plan or even a single self-insured employer, we assessed a single tiered network, which could limit the generalizability of our findings. Our results, for example, reflect the existing physician–patient relationships, referral patterns, and admitting privileges. While our results are largely insensitive to controlling for PCP affiliation, it is important to note that results may differ in other settings.

Third, we cannot assess the mechanisms driving the finding. For example, while we take a demand-side perspective, it is possible that physicians aware of the TN changed referral patterns on their patients' behalf. This would require physicians not only to be aware of the program but also the details of the patients' insurance plans and to act only for those in the TN. It is likely, therefore, that the observed effects reflect a combination of patient demand conveyed to physicians, and physicians responding by changing referrals.

Fourth, like much of the choice literature, we do not assess the impact of the TN on rates of service use. In addition to steering patients toward preferred hospitals, the TN might dampen the use of discretionary services among members who would typically receive care at a nonpreferred hospital and thus face higher cost sharing at their routine provider. To the extent this is the case, our estimates of hospital switching could reflect nonrandom decisions not to seek care.

Fifth, we do not evaluate whether hospitals responded to the TN. We recognize that tiering implicitly creates incentives for hospitals as well as patients. We do not capture longer term effects that would arise if tiering encourages hospitals to better control costs and/or lower prices.

In short, this paper provides a robust estimate of the impact of a TN on hospital choice and suggests that tiering with large cost-sharing differentials represents an effective tool for impacting patient behavior. Despite our reasonably positive findings, we do not compare TNs to other approaches to steer patients or control spending. Future research should assess TN's effects on rates of service use, quality, and spending, as well as hospital responses to tiering.

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NOTES

1. The CMS Hospital Compare measures used for tiering included process measures related to care for acute myocardial infarction, heart failure, community-acquired pneumonia, and surgical infections. The AHRQ measures used for tiering included outcome measures related to hospital-acquired infections and obstetrics care.
2. The falsification test relies on the admission source variable created by BCBSMA, as this variable most cleanly identifies admissions through an emergency department. Since this variable was discontinued in 2011, the falsification test only covers 2009 and 2010. The effects of the TN over the 2009-2010 period were similar to our main results.
3. Choice elasticity was calculated as the percent difference in the probability of receiving care at a nonpreferred hospital between TN and non-TN plan members divided by the percent difference in the relative cost sharing (i.e., the difference in the average nonpreferred cost sharing less the difference in the average preferred/ middle cost sharing) faced by TN and non-TN plan members.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.