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Correlation of hospital Magnet status with the quality of physicians performing neurosurgical procedures in New York State

Kimon Bekelis, M.D.^{1,2,3}, Symeon Missios, M.D.⁴, and Todd A. MacKenzie, M.D.^{3,5,6}

¹Department of Neurosurgery, Thomas Jefferson University Hospital, Philadelphia, PA

²The Dartmouth Institute for Health Policy and Clinical Practice, Lebanon, NH

³Geisel School of Medicine at Dartmouth, Hanover, NH

⁴Center for Neuro and Spine, Akron General Hospital-Cleveland Clinic, Akron, OH

⁵Department of Medicine, Dartmouth-Hitchcock Medical Center, Lebanon, NH

⁶Department of Community and Family Medicine, Dartmouth-Hitchcock Medical Center, Lebanon, NH

Abstract

Purpose—The quality of physicians practicing in hospitals recognized for nursing excellence by the American Nurses Credentialing Center has not been studied before. We investigated whether Magnet hospital recognition is associated with higher quality of physicians performing neurosurgical procedures.

Materials and Methods—We performed a cohort study of patients undergoing neurosurgical procedures from 2009–2013, who were registered in the New York Statewide Planning and Research Cooperative System (SPARCS) database. Propensity score adjusted multivariable regression models were used to adjust for known confounders, with mixed effects methods to control for clustering at the facility level. An instrumental variable analysis was used to control for unmeasured confounding and simulate the effect of a randomized trial.

Results—During the study period, 185,277 patients underwent neurosurgical procedures, and met the inclusion criteria. Of these, 66,607 (35.6%) were hospitalized in Magnet hospitals, and 118,670 (64.4%) in non-Magnet institutions. Instrumental variable analysis demonstrated that undergoing neurosurgical operations in Magnet hospitals was associated with a 13.6% higher chance of being treated by a physician with superior performance in terms of mortality (95% CI, 13.2% to 14.1%), and a 4.3% higher chance of being treated by a physician with superior performance in terms of length-of-stay (LOS) (95% CI, 3.8% to 4.7%) in comparison to non-Magnet institutions. The same associations were present in propensity score adjusted mixed effects models.

Conclusions—Using a comprehensive all-payer cohort of neurosurgical patients in New York State we identified an association of Magnet hospital recognition with superior physician performance.

Keywords

neurosurgery; physician quality; Magnet recognition; center of excellence; public reporting; SPARCS

INTRODUCTION

The Magnet Recognition Program of the American Nurses Credentialing Center (ANCC)(1) is an initiative designed to identify health care organizations committed to quality improvement, and superior nursing care delivery. This program focuses on nursing excellence and targets a series of benchmarks: “transformational leadership, a structure that empowers staff, an established professional nursing practice model, support for knowledge generation and application, and robust quality improvement mechanisms”.(1) These facilities have been found to have lower rates of nursing burnout and improved overall financial performance.(1–6) However, the quality of physicians practicing in these institutions has not been studied before.

Prior studies have investigated the association of Magnet recognition with outcomes for different patient groups. Some researchers have shown improved outcomes in Magnet hospitals for elderly Medicare medical and surgical patients.(7, 8) However, others failed to demonstrate a similar benefit of Magnet status.(9–11) It is unclear whether these outcomes are only the result of superior nursing care, or whether these centers of excellence additionally attract higher quality physicians. There has been no previous investigation attempting to answer this question in a comprehensive all-payer cohort, while controlling for unmeasured confounding.

We used the New York Statewide Planning and Research Cooperative System (SPARCS) (12) to study the association of Magnet hospital designation with the quality of physicians performing neurosurgical operations. We utilized a battery of approaches to control for measured confounding, including regression adjustment, and propensity score adjustment, whereas mixed effects methods were employed to control for clustering at the hospital level. An instrumental variable (IV) analysis was used to control for unmeasured confounding and simulate the effect of randomization.

METHODS

New York Statewide Planning and Research Cooperative System (SPARCS)

This study was approved by our institutional Committee for Protection of Human Subjects. Informed consent was waived because the study was based on de-identified data. All patients who underwent neurosurgical operations, and were registered in the SPARCS (New York State Department of Health, Albany, NY)(12) database between 2009 and 2013 were included in the analysis. For these years, SPARCS contains patient-level details for every hospital discharge, ambulatory surgery, and emergency department admission in New York

State as coded from admission and billing records. More information about SPARCS is available at <https://www.health.ny.gov/statistics/sparcs/>.

Magnet Recognition Program

The Magnet Recognition program of the ANCC was established in 1994 by a subsidiary of the American Nurses Association.(1) Magnet recognition lasts for four years. As of 2015, 402 facilities in the United States were recognized by the program. More information on this process can be found at <http://www.nursecredentialing.org/Magnet>. The program's website was used to identify hospitals in New York State that obtained Magnet recognition and the year this was achieved. Hospitals were classified as having Magnet recognition in the corresponding year of the analysis. Classifications were updated each year of the study period in case of mergers or closures.

Cohort Definition

In order to establish the cohort of patients, we used *International Classification of Disease-9-Clinical Modification* (ICD-9-CM) codes to identify patients in the database who underwent neurosurgical operations (Table S1) between 2009 and 2013. Patients who underwent procedures by physicians with fewer than 10 total procedures from 2009–2013, were excluded.

Outcome variables

The primary outcome variable was treatment by a physician belonging to the quartile with the lowest mortality for neurosurgical operations. Secondary outcome was treatment by a physician belonging to the quartile with the shortest LOS after neurosurgical operations. There was no restriction on how many hospitals the surgeon practiced in. However, their performance in terms of mortality, and LOS were calculated based on their outcomes from all the patients they treated.

Exposure variables

The primary exposure variable was undergoing neurosurgical operations in a Magnet hospital.

Covariates (Table S1) used for risk-adjustment were age, gender, race (African-American, Hispanic, Asian, Caucasian, other), insurance (private, Medicare, Medicaid, uninsured, other), and number of procedures per physician. The comorbidities used for risk adjustment were diabetes mellitus (DM), smoking, chronic lung disease, hypertension, hypercholesterolemia, peripheral vascular disease (PVD), congestive heart failure (CHF), coronary artery disease (CAD), history of transient ischemic attack (TIA), alcohol abuse, obesity, chronic renal failure (CRF), and coagulopathy. Only variables that were defined as “present on admission” were considered part of the patient's preadmission comorbidity profile.

Statistical analysis

The association of Magnet recognition with our outcome measures was examined in a multivariable setting. Patients admitted to a Magnet hospital or a non-Magnet institution

were non-randomly directed to either facility. In order to account for this unmeasured confounding, and to simulate the effect of randomization, we used an instrumental variable analysis, an econometric technique.(13) The differential distance of the patient to the closest Magnet hospital (distance to a Magnet hospital minus distance to a non-Magnet institution) was used as an instrument for the treatment facility. This was calculated based on real road network data, based on previously published methodology.(14) This advanced observational technique has been used before by clinical researchers, to answer comparative effectiveness questions for different interventions, including the value of primary stroke centers. The goal is to simulate randomization, especially when the baseline functional characteristics of the patients (including the functional status of stroke patients) are unknown (similar to our application).(15–17)

A good instrument is not associated with the outcome other than through the exposure variable of interest (a requirement known as the exclusion restriction criterion).(18) In our case it is unlikely that the differential distance to the closest Magnet hospital would be associated with mortality in any way other than the choice of treatment facility. A two stage least squares (2SLS) method was used for the calculation of the coefficients. The value of the F statistic in the first stage of the 2SLS approach was 112, which is consistent with a strong instrument ($F \text{ statistic} > 10$), based on a practical rule.(13)

A probit regression was used for the categorical outcomes.(19) The covariates used for risk adjustment in these models were: age, gender, race, insurance, type of procedures number of procedures per surgeon, and all the comorbidities and hospital characteristics mentioned previously. Since the coefficients produced by the probit function are not interpretable, we used the marginal effects of our independent variables instead. The marginal effects are the partial derivatives of the coefficients, and reflect the change in the probability of the dependent variable, for 1 unit change in the independent variable, at the average value of all other covariates.

In order to demonstrate the robustness of our data in a sensitivity analysis, we used standard techniques to account for measured confounding, while accounting for clustering at the hospital level. For categorical outcomes we used a probit regression model with patient county as a random effects variable, while controlling for all the covariates mentioned previously. In an alternative way to control for confounding, we used a propensity adjusted (with deciles of propensity score) probit regression model. We calculated the propensity score of admission to a Magnet hospital with a separate probit regression model, using all the covariates mentioned previously. In further sensitivity analysis we included the clinical diagnosis as a covariate in all analyses. The direction of the observed associations did not change and these results are not reported further. In a post-hoc analysis, we removed all hospitals that underwent a change in status during the years of the study (from non-Magnet to Magnet status), and repeated the above analyses. The direction of the observed associations did not change.

Regression diagnostics were used for all models. All results are based on two sided tests, and the level of statistical significance was set at 0.05. This study, based on 185,277 patients, has sufficient power (80%) at a 5% type I error rate to detect differences in mortality, as

small as 1.3%. Statistical analyses were performed using Stata version 13 (StataCorp, College Station, TX).

RESULTS

Patient characteristics

In the selected study period there were 185,277 patients hospitalized for neurosurgical procedures (mean age was 55.1 years, with 50.8% females) who were registered in SPARCS. 66,607 (35.6%) were hospitalized in Magnet hospitals, and 118,670 (64.4%) in non-Magnet institutions. The characteristics of the two cohorts at baseline can be seen in Table 1.

Inpatient mortality

Overall, 32,253 (48.4%) patients were treated by neurosurgeons, who belonged to the lowest quartile for inpatient mortality and practiced in Magnet hospitals, and 41,937 (35.3%) patients were treated by neurosurgeons who belonged to the lowest quartile for inpatient mortality and practiced in non-Magnet institutions. Hospitalization in a Magnet hospital for neurosurgical procedures was associated with superior physician performance in terms of mortality (Adjusted difference, 12.8%; 95% CI, 12.4% to 13.3%) in unadjusted analysis. Likewise, using a probit regression with instrumental variable analysis, we identified that undergoing neurosurgical operations in Magnet hospitals was associated with a 13.6% higher chance of being treated by a physician with superior performance in terms of mortality (95% CI, 13.2% to 14.1%), in comparison to non-Magnet institutions (Table 2). This persisted in a mixed effects probit regression model (Adjusted difference, 12.6%; 95% CI, 12.2% to 13.1%) and a propensity score adjusted probit model (Adjusted difference, 13.8%; 95% CI, 13.3% to 14.2%).

Length-of-stay

Overall, 27,653 (41.5%) patients were treated by neurosurgeons, who belonged to the lowest quartile for LOS and practiced in Magnet hospitals, and 42,811 (36.1%) patients were treated by neurosurgeons who belonged to the lowest quartile for inpatient mortality and practiced in non-Magnet institutions. Hospitalization in a Magnet hospital for neurosurgical procedures was associated with superior physician performance in terms of LOS (Adjusted difference, 5.4%; 95% CI, 4.9% to 5.9%) in unadjusted analysis. Likewise, using a probit regression with instrumental variable analysis, we identified that undergoing neurosurgical operations in Magnet hospitals were associated with a 4.3% higher chance of being treated by a physician with superior performance in terms of LOS (95% CI, 3.8% to 4.7%), in comparison to non-Magnet institutions (Table 2). This persisted in a mixed effects probit regression model (Adjusted difference, 5.1%; 95% CI, 4.6% to 5.6%) and a propensity score adjusted probit model (Adjusted difference, 4.2%; 95% CI, 3.7% to 4.6%).

DISCUSSION

Using a comprehensive all-payer cohort of neurosurgical patients in New York State we identified an association of Magnet hospital recognition with superior physician

performance in terms of mortality and LOS. These results were consistent across techniques to control for measured and unmeasured confounders. Public reporting and recognition of centers of excellence is a legislative mandate allowing increased patient participation in the decision making process.(20–25) In this setting Magnet status is heavily advertised by hospitals(1), while through recent inclusion in US News and World Report rating,(26) and endorsement by the Leapfrog Group(27) these initiatives are increasingly recognized by the public. Although the goal of the Magnet program is to “improve patient care”(1) the quality of physicians practicing in these institutions has not been studied before, preventing the public from making completely informed decisions in regards to their care.

Prior investigations have demonstrated conflicting results regarding the association of Magnet recognition and patient outcomes. Some researchers failed to identify a benefit of Magnet status in regards to objective outcomes.(9–11) On the contrary others have shown superior outcomes for several conditions including falls,(28) mortality after trauma,(29) and outcomes of very low birth weight infants.(30) Friese et al(7) using a cohort of elderly surgical Medicare patients demonstrated that hospitalization in a Magnet hospital was associated with lower 30-day mortality and rates of failure-to-rescue. Similar results were demonstrated in an earlier national study,(31) and a regional analysis in Pennsylvania.(8) The lack of adjustment for clustering, and rigorous control for measured and unmeasured confounders (especially the fact that patients were non-randomly selected for either treatment center), significantly limit the interpretation of the results of these investigations. A meta-analysis by Petit Dit Driel and Regnaud reached the same conclusions.(32) Prior studies have not established whether these outcomes are only the result of superior nursing care, or whether these centers of excellence additionally attract higher quality physicians.

Our study purposefully addresses many of the methodologic limitations of previous investigations. First, we created a cohort of all patients in a major state, giving a true picture of practice in the community. Second, we used advanced observational techniques to control for confounding. Propensity score stratification was used to adjust our analyses for known confounders. The possibility of clustering, which can bias the results of multi-center studies, was accounted for by using mixed effects methods. Most importantly, an instrumental variable analysis was used to control for unmeasured confounders (mainly the a priori selection of treatment facility), and simulate the effects of randomization. The instrumental variable analysis is expected to control for such factors and report results for patients of similar functional status. Results were consistent across techniques, supporting the validity of the observed associations.

It is unclear whether centers of excellence attract physicians of higher quality, or if the opposite is true. It is likely that the presence of highly performing physicians in these institutions is multifactorial. Previous work has demonstrated that Magnet hospitals have less organizational hierarchy and increased nursing autonomy, invest in quality benchmarking and reporting, and have higher nursing satisfaction.(1–6, 33–35) Such institutional commitment to quality improvement empowers nurses and physicians to deliver evidence-based care, establish effective communication, and identify patient problems quicker,(33–35) From a policy perspective, it is important to recognize that Magnet hospitals not only demonstrate better nursing care but also employ physicians with superior

performance. This can help the public make decisions about their care especially since other reporting initiatives such as Hospital Compare, and the ProPublica Surgeon Scorecard have been criticized for their accuracy.(36–38)

Our study has several limitations. Residual confounding could account for some of the observed associations. However, this is minimized to the extent that we are using a good instrument for treatment facility. The F statistic in our analysis suggests a strong instrument. In addition, coding inaccuracies will undoubtedly occur and can affect our estimates. Although SPARCS includes all hospitals from the entire New York State, the generalization of this analysis to the entire US population is uncertain. SPARCS does not provide any clinical information on the functional status of the patients (National Institutes of Health Stroke Scale), which can affect the choice of institution. However, the use of the instrumental variable analysis is attempting to control for unknown confounders such as these, and has been used before in stroke patients from this database.(15–17)

Additionally, we were lacking post-hospitalization, and long-term data on our patients. Quality metrics (i.e. modified Rankin score) are also not available through SPARCS, and therefore we cannot compare the two hospital settings on these outcomes. The definitive comparison of the two hospital settings on functional outcomes can only be done in prospective registries. In this direction, the NeuroPoint Alliance has created the first neurosurgery registry, with results expected in the near future.(39) Finally, in order to control for the possibility that the observed associations reflect the impact of the socioeconomic status of the community (which in turn can affect the quality of physicians), we rigorously controlled our analyses for the socioeconomic status of the treated patients. Additionally, we used an instrumental variable analysis, which is expected to control for unmeasured confounding, and is the best available method for causal inference in retrospective data. Therefore the observed associations are not the result of the socioeconomic status of the community.

Conclusions

The quality of physicians practicing in hospitals recognized for nursing excellence by the American Nurses Credentialing Center has not been studied before. We investigated whether Magnet hospital recognition is associated with higher quality of physicians performing neurosurgical procedures. An instrumental variable analysis was used to control for unmeasured confounding and simulate the effect of a randomized trial. Using a comprehensive all-payer cohort of neurosurgical patients in New York State we identified an association of Magnet hospital recognition with superior physician performance.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Patient characteristics

Table 1

	All Patients N= 185,277			Patients treated in Magnet hospitals 28 institutions			Patients treated in non-Magnet hospitals 148 institutions			P-Value
	Mean	SD		Mean	SD		Mean	SD		
	N	%		N	%		N	%		
Age	55.08	14.76		55.95	14.77		54.58	14.73		<0.0001
Female gender	94074	50.78		33461	50.24		60613	51.08		0.0005
Race	131429	71.12	Caucasian	50182	75.53		81247	68.65		<0.0001
	17836	9.65	African-American	4865	7.32		12971	10.96		<0.0001
	13628	7.37	Hispanic	3368	5.07		10260	8.67		<0.0001
	3649	1.97	Asian	1623	2.44		2026	1.71		<0.0001
	18252	9.88	Other	6404	9.64		11848	10.01		0.011
Insurance	49029	26.51	Medicare	18799	28.25		30230	25.53		<0.0001
	7799	4.22	Medicaid	1995	3.00		5804	4.90		<0.0001
	97516	52.72	Private	36853	55.39		60663	51.23		<0.0001
	4349	2.35	Uninsured	1070	1.61		3279	2.77		<0.0001
	26270	14.20	Other	7822	11.76		18448	15.58		<0.0001
Transient Ischemic Attack	208	0.11		31	0.05		177	0.15		<0.0001
Ischemic Stroke	224	0.12		42	0.06		182	0.15		<0.0001
Coronary Artery Disease	17765	9.59		6573	9.87		11192	9.43		0.022
Chronic Obstructive Pulmonary Disease	27899	15.06		9510	14.28		18389	15.50		<0.0001
Congestive Heart Failure	3764	2.03		1211	1.82		2553	2.15		<0.0001
Diabetes Mellitus	28172	15.21		9511	14.28		18661	15.73		<0.0001
Coagulopathy	2116	1.14		730	1.10		1386	1.17		0.162
Chronic Renal Failure	4348	2.35		1565	2.35		2783	2.35		0.952
Hypertension	83309	44.96		29607	44.45		53702	45.25		0.001
Smoking	27294	14.73		7859	11.80		19435	16.38		<0.0001

	All Patients		Patients treated in Magnet hospitals 28 institutions		Patients treated in non-Magnet hospitals 148 institutions		P-Value
	Mean	SD	Mean	SD	Mean	SD	
	N= 185,277		N= 66,607		N= 118,670		
	54278	29.30	21433	32.18	32845	27.68	<0.0001
Hypercholesterolemia	19565	10.56	7072	10.62	12493	10.53	0.545
Obesity	2988	1.61	710	1.07	2278	1.92	<0.0001
Alcohol	3811	2.06	1357	2.04	2454	2.07	0.656
Peripheral Vascular Disease	74190	40.04	32253	48.42	41937	35.34	<0.0001
Top quartile of physicians (Mortality) *	70464	38.03	27653	41.52	42811	36.08	<0.0001
Top quartile of physicians (LOS) §							

SD: Standard Deviation

* Includes the quartile of physicians with the lowest inpatient mortality while performing neurosurgical procedures

§ Includes the quartile of physicians with the shortest length-of-stay while performing neurosurgical procedures

Table 2

Multivariable models examining the association of Magnet status with outcomes

	Inpatient Mortality[¶]		Length-of-stay[§]	
	Adjusted Difference (95% CI)	P-value	Adjusted difference (95% CI)	P-value
Instrumental variable analysis [*]	13.6 (13.2% to 14.1%)	<0.001	4.3% (3.8% to 4.7%)	<0.001
Mixed effects regression [‡]	12.6% (12.2% to 13.1%)	<0.001	5.1% (4.6% to 5.6%)	<0.001
Propensity score adjusted regression [‡]	13.8% (13.3% to 14.2%)	<0.001	4.2% (3.7% to 4.6%)	<0.001

CI: confidence intervals

^{*} Differential distance to Magnet hospital was used as an instrument of treatment hospital[‡] Hospital ID was used as a random effects variable[¶] Regressions based on probit models