**Association of Hospital Quality Star Ratings with Hospital’s Average Spending Levels During a Medicare Spending per Beneficiary Episode**

***Abstract***

Geographic variation in Medicare spending, and quality of care, has extensively been documented. One of the goals of health reform is to reduce such variation that many believe results from differences in providers’ behaviors and, hence, amenable to policy. However, to date, little is known about variation in resource use across clinical decision-making units, notably hospitals, within the context of a changing policy landscape. And, even much less is known about the implications for quality.

We conducted a cross sectional analysis using national data on over 3,000 hospitals, profiled on hospital’s average spending levels during a Medicare Spending Per Beneficiary (MSPB) episode and quality star ratings in 2015. We found substantial variation in hospital MSPB (crude mean and 95%CI). Furthermore, adjusted analyses show that hospitals with highest star ratings incurred (lower/higher?) MSPB compared with their counterparts. Targeting resource use at the level of clinical decision-making units may help improve Medicare spending trajectory.

**Keyword**: Medicare hospital spending. Hospital quality

***Health Affairs Manuscript***

**Multivariate Analyses**

We specified a multilevel model (a random intercept) describing hospital’s average spending levels during a Medicare Spending Per Beneficiary (MSPB) episode as follows:

*Yi = αj*[i] + Σ*βpXpi* + *εi*,for hospitals (*i* = 1 to *N*)

*αj = a* + Σ*bkWkj* + *uj*,for markets (*j* = 1 to *J*)

where *Xpi* (for *p* = 1 to *P*) and *Wkj* (for *k* = 1 to *K*) represent predictors at the hospital and market levels, respectively, and *εi* and *uj* are independent error terms at each of the two levels.

**NOTE:**

Outcome variable name in dataset: (**episode)**

Hospital unique identifier: (**provider\_id *N*= 3,132)**

Grouping variable is hospital referral region: (**hrr *J*= 304**)

(episode = preindex + index + postindex)

**Centering**

* All continuous predictors at the hospital level have been transformed to a four-category ranking of increasing value. This transformation makes all hospital-level predictors categorical, with the reference category indicated in table below.
* All market-level predictors are continuous and need to be **centered** on the overall market mean. This will facilitate interpretation of the results and improve model convergence. Thus, estimation and prediction will be with respect to a hospital with the reference categories indicated in level-1 and having values of the market predictors equal to the grand mean observed across the HRRs.
* *The market level predictors need to be centered on the grand mean to facilitate interpretation of the results. R has an option to handle centering.*

**Missing Data**

* Key predictor, *Star Ratings*, has missing value.
* *System membership* and *network membership* have a large number of missing observations. All quality improvement predictors have missingness to some degree (and some other level-1 ones).
* The dataset is complete with respect to market-level predictors. All variables are available in their raw scale in the dataset for treatment of missing data, if necessary.

**Exhibit 5.** Predictors of Hospitals’ Average Spending Levels during a Medicare Spending Per Beneficiary (MSPB) Episode, 2015

| *Outcome variable =* ***episode*** |  |  | ***M1****: Null model* | | ***M2****: M1 + Hospital*  *Characteristics* | | ***M3****: M2 + Market*  *Characteristics* | | ***M4****: Best Fitted Model*  *(Most parsimonious)* | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Fixed Effects*** | *Parameter* | ***Variables Name in dataset*** | *Estimate* | *Std. Error\** | *Estimate* | *Std. Error\** | *Estimate* | *Std. Error\** | *Estimate* | *Std. Error\** |
| *Intercept* | a |  |  |  |  |  |  |  |  |  |
| ***Hospital-level*** |  |  |  |  |  |  |  |  |  |  |
| ***Quality star ratings (Key Predictor)*** | β1 | starrating |  |  |  |  |  |  |  |  |
| *Organizational Characteristics* |  |  |  |  |  |  |  |  |  |  |
| Urban location | β2 | urban |  |  |  |  |  |  |  |  |
| Medical school affiliation | β3 | mdschool |  |  |  |  |  |  |  |  |
| No affiliation |  |  |  |  |  |  |  |  |  |  |
| Limited/Graduate education |  |  |  |  |  |  |  |  |  |  |
| Major teaching |  |  |  |  | *Reference* |  | *Reference* |  | *Reference* |  |
| Ownership status | β4 | ownership |  |  |  |  |  |  |  |  |
| Public |  |  |  |  |  |  |  |  |  |  |
| Private not-for-profit |  |  |  |  |  |  |  |  |  |  |
| Private for-profit |  |  |  |  | *Reference* |  | *Reference* |  | *Reference* |  |
| Bed size | β5 | bedsize |  |  |  |  |  |  |  |  |
| Small (< 100 beds) |  |  |  |  |  |  |  |  |  |  |
| Medium (100 – 399 beds) |  |  |  |  |  |  |  |  |  |  |
| Large (400+ beds) |  |  |  |  | *Reference* |  | *Reference* |  | *Reference* |  |
| Network membership | β6 | network |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| ***Hospital-level*** |  |  |  |  |  |  |  |  |  |  |
| *Participation in Reform Initiative* |  |  |  |  |  |  |  |  |  |  |
| Patient-centered medical home (PCMH) | β7 | pcmh |  |  |  |  |  |  |  |  |
| Bundled payments | β8 | bundledpayment |  |  |  |  |  |  |  |  |
| Both (Bundled\*PCMH) | β9 | **Interaction effect** |  |  |  |  |  |  |  |  |
| *Patient Population Profile* |  |  |  |  |  |  |  |  |  |  |
| Case mix index | β10 | cmirank |  |  |  |  |  |  |  |  |
| Quartile 1 |  |  |  |  |  |  |  |  |  |  |
| Quartile 2 |  |  |  |  |  |  |  |  |  |  |
| Quartile 3 |  |  |  |  |  |  |  |  |  |  |
| Quartile 4 (Highest) |  |  |  |  | *Reference* |  | *Reference* |  | *Reference* |  |
| DSH percentile index | β11 | dshpctrank |  |  |  |  |  |  |  |  |
| Quartile 1 |  |  |  |  |  |  |  |  |  |  |
| Quartile 2 |  |  |  |  |  |  |  |  |  |  |
| Quartile 3 |  |  |  |  |  |  |  |  |  | . |
| Quartile 4 (Highest) |  |  |  |  | *Reference* |  | *Reference* |  | *Reference* |  |
| *Physicians per adjusted admission* | β12 | mdadjadmitrank |  |  |  |  |  |  |  |  |
| Quartile 1 |  |  |  |  |  |  |  |  |  |  |
| Quartile 2 |  |  |  |  |  |  |  |  |  |  |
| Quartile 3 |  |  |  |  |  |  |  |  |  |  |
| Quartile 4 (Highest) |  |  |  |  | *Reference* |  | *Reference* |  | *Reference* |  |
| ***Hospital-level*** |  |  |  |  |  |  |  |  |  |  |
| *Quality Improvement (QI) Efforts* |  |  |  |  |  |  |  |  |  |  |
| Participation in nursing care registry | β13 | nursingregistry |  |  |  |  |  |  |  |  |
| Participation in general care surgery registry | β14 | surgeryregistry |  |  |  |  |  |  |  |  |
| Tracking patient lab/test electronically | β15 | tracklab |  |  |  |  |  |  |  |  |
| Joint Commission Accreditation | β16 | jchao |  |  |  |  |  |  |  |  |
| ***Market-level*** |  |  |  |  |  |  |  |  |  |  |
| *Sociodemographic & Health Profile* |  |  |  |  |  |  |  |  |  |  |
| Average HCC score | b1 | avghcchrr |  |  |  |  |  |  |  |  |
| Percent eligible for Medicaid | b2 | pctmdcaidhrr |  |  |  |  |  |  |  |  |
| Percent male beneficiaries | b3 | pctmalehrr |  |  |  |  |  |  |  |  |
| Percent Black beneficiaries | b4 | pctblackhrr |  |  |  |  |  |  |  |  |
| Percent Hispanic beneficiaries | b5 | pcthispanichrr |  |  |  |  |  |  |  |  |
| Average age of beneficiaries | b6 | avgagehrr |  |  |  |  |  |  |  |  |
| Medicare Advantage enrollment | b7 | maadvantage |  |  |  |  |  |  |  |  |
| *Health Services Utilization* |  |  |  |  |  |  |  |  |  |  |
| Percent beneficiaries using inpatient | b8 | pctbenesusip |  |  |  |  |  |  |  |  |
| Percent beneficiaries using outpatient | b9 | pctbenesuop |  |  |  |  |  |  |  |  |
| Percent beneficiaries using PAC-SNF | b10 | pctbenesusnf |  |  |  |  |  |  |  |  |
| Percent beneficiaries using PAC-HHV | b11 | pctbenesuhh |  |  |  |  |  |  |  |  |
| Percent beneficiaries with ASC | b12 | pctbenesuasc |  |  |  |  |  |  |  |  |
| ***Market-level*** |  |  |  |  |  |  |  |  |  |  |
| *Health System Capacity* |  |  |  |  |  |  |  |  |  |  |
| Specialists per 100,000 residents | b13 | spcialisthrr |  |  |  |  |  |  |  |  |
| Primary care physicians (PCP)  per 100,000 residents | b14 | pcphrr |  |  |  |  |  |  |  |  |
| Acute care hospital beds  per 1,000 residents | b15 | hospbedshrr |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| ***Variance Components*** |  |  |  |  |  |  |  |  |  |  |
| Hospital level, *εi,* | σε2 |  |  |  |  |  |  |  |  |  |
| Market level (HRR) |  |  |  |  |  |  |  |  |  |  |
| Intercept, *ui* | σu2 |  |  |  |  |  |  |  |  |  |
| Covariance Hospital-Market | σεu |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| ***Model Fit Statistics*** |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| Sample size, *N* |  |  |  |  |  |  |  |  |  |  |

Note: