S1 File: Supplementary Materials

Precision hospital performance: describing phenotypes by applying big data analytics

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**Fig A. Instructions provided to experts in quality measurement.**

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| **Objective: To characterize similarities and differences in the profiles of performance of 32 performance profiles that synthesize the full spectrum of hospital performance on the Hospital Compare measures****Approach: Please follow this two-step process to define the anchors that supervise our model (see key principles for each step below)**1. Review the profile of performance for each illustrative hospital and classify performance in each domain of quality
2. Assign an integer from 1 (lowest) to 10 (highest) that summarizes the overall performance of each illustrative hospitals across domains

**Step 1: Principles to inform the classification of performance by domain*** Five categories of performance:
	+ ↑↑: Best performance in the domain across all illustrative hospitals (most measures in the domain, on average, are approximately 1 S.D. greater than the mean)
	+ ↑: Better performance in the domain (most measures in the domain, on average, fall between the mean and mean + 1 S.D.)
	+ Par: Average performance in the domain (most measures close to the mean, or similar proportions of measures above/below the mean)
	+ ↓: Worse performance in the domain (most measures in the domain, on average, fall between the mean and mean - 1 S.D.)
	+ ↓↓: Worst performance in the domain across all illustrative hospitals (most measures in the domain, on average, are approximately 1 S.D. less than the mean)
* Classification should reflect the aggregate performance across the entire domain, favoring consistent performance over outliers
* It is acceptable (and expected) that several performance profiles will have the same (or very similar) classifications across domains, and these hospitals can be grouped in the subsequent ranking step

**Step 2: Principles to inform the assignment of an integer summarizing overall performance*** Relative hierarchy of domains is consistent with CMS’ FY17 Value-Based Purchasing weightings
	+ Mortality
	+ Experience//Readmission
	+ Surgical//Safety (HAI)//Value
	+ Process
* It is acceptable for multiple illustrative hospitals to receive the same ranking, even if profiles of performance differ
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Fig B. Materials provided to experts in quality measurement, including all 32 performance profiles generated from the coupled diffusion process and partition trees.











Table A. Excluded measures.

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| *Structural measures* |
| * OP\_12: Ability of patients to check labs online
 |
| * OP\_17: Ability of providers to track patients’ lab results, tests and referrals electronically between visits
 |
| * OP\_25: Ability of providers to receive lab results electronically
 |
| * SM\_PART\_CARD: Presence of a cardiac surgery registry
 |
| * SM\_PART\_GEN\_SURG: Presence of a general surgery registry
 |
| * SM\_PART\_STROKE: Presence of a stroke registry
 |
| * ACS\_REGISTRY: Acute coronary syndrome registry
 |
| *Volume of selected outpatient procedures (OP\_26\_xx measures)* |
| * Gastrointestinal
 |
| * Eye
 |
| * Nervous system (i.e., CNS injections)
 |
| * Musculoskeletal
 |
| * Skin
 |
| * Genitourinary
 |
| * Cardiovascular
 |
| * Respiratory
 |
| *Reported at fewer than 5% of all Medicare hospitals* |
| * AMI\_7a: Heart attack patients who got drugs to break up blood clots within 30 minutes of arrival
 |
| * OP\_1: Median time to fibrinolysis
 |
| * OP\_2: Outpatients with chest pain or possible heart attack who got fibrinolytic therapy within 30 minutes of arrival
 |
| * CAC\_1: Children who received reliever medication while hospitalized for asthma
 |
| * CAC\_2: Children who received systemic corticosteroid medication (oral and IV medication that reduces inflammation and controls symptoms) while hospitalized for asthma
 |
| * CAC\_3: Children and their caregivers who received a home management plan of care document while hospitalized for asthma
 |

**Table B. Characteristics of hospitals, the demographics of their hospital services areas and high performers in existing rating systems.**

|  |  |  |
| --- | --- | --- |
|  | **U.S. Hospitals****(N=4665)** | **Sample****(N=1609)\*** |
| **Hospital characteristics – no (%)** |  |  |
| Region |  |  |
| Northeast | 577 (12.4%) | 313 (19.5%) |
| South | 1378 (29.5%) | 406 (25.2%) |
| Midwest | 1745 (37.4%) | 594 (36.9%) |
| West | 914 (19.6%) | 296 (18.4%) |
| Other† | 51 (1.1%) | 0 (0.0%) |
| Location |  |  |
| Urban | 3536 (75.8%) | 1600 (99.4%) |
| Rural | 1129 (24.2%) | 9 (0.6%) |
| Critical Access Hospital |  |  |
| Yes | 1251 (26.8%) | 0 (0.0%) |
| No | 3414 (73.2%) | 1609 (100.0%) |
| Size |  |  |
| <100 beds | 2351 (50.4 %) | 58 (3.6%) |
| 100-200 beds | 974 (20.9 %) | 424 (26.4%) |
| 200-300 beds | 552 (11.8%) | 421 (26.2%) |
| 300-400 beds | 332 (7.1%) | 283 (17.6%) |
| ≥400 beds | 456 (9.8%) | 423 (26.3%) |
| Teaching hospital |  |  |
| Yes | 1231 (26.4%) | 792 (49.2%) |
| No | 3434 (73.6%) | 817 (50.8%) |

|  |
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| **Hospital service areas characteristics** |
| Proportion of population that is racial minority – median (IQR) | 15.8% (6.8%-30.2%) | 21.1% (11.5%-33.5%) |
| Average household income – median (IQR) | $48,954 ($41,724 -$57,926) | $54,219 ($46,012-$64,233) |
| **High performers in existing hospital rating systems – no (%)** |
| U.S. News and World Report Honor Roll | 17 (0.4%) | 16 (1.0%) |
| HealthGrades Top 100 | 100 (2.1%) | 93 (5.8%) |
| Consumer Reports | 116 (2.5%) | 36 (2.2%) |
| Leapfrog “A” Grade | 83 (1.8%) | 31 (1.9%) |

\*5 hospitals included in our sample were not listed in the 2013 American Hospital Association Annual Survey and could not be included in this table.

† Puerto Rico, Guam, Virgin Islands, and American Samoa

**Table C. Definition of top ranked hospitals under four existing rating systems.**

|  |  |
| --- | --- |
| **Rating system** | **Definition of “high performer”** |
| Leapfrog | Recipient of Leapfrog Top Hospital award in 2014 (http://www.leapfroggroup.org/TopHospitals) |
| U.S. News and World Report | Listed on the U.S. News Honor Roll 2014-2015 (http://health.usnews.com/health-news/best-hospitals/articles/2014/07/15/best-hospitals-2014-15-overview-and-honor-roll) |
| Consumer Reports | Hospitals achieving a safety score of > 65, which corresponds to 2 standard deviations above the mean (http://www.consumerreports.org/health/doctors-hospitals/hospital-ratings.htm) |
| HealthGrades | America’s 100 Best Hospitals in 2014 (http://www.healthgrades.com/quality/2014-healthgrades-americas-best-hospitals-report) |

Adapted from definition presented by Austin MJ et al. *Health Affairs* 2015;34(3):423-430.

**Captions for 2 Movies:**

Two movies of the diffusion map have been produced. In these, each point represents an individual hospital. The distance between points reflects the similarity of their underlying performance profiles.

**Movie A.** Overall diffusion map.

**Movie B.** Diffusion map in which each hospital is shaded according to its assigned neighborhood and the central hospital in each neighborhood is circled.