Results of Statistical Analysis

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## RESULTS

In 2011, there were 239,950 TKA among 28,808,011 beneficiaries in the study, while in 2015, there were 262,013 TKA among 30,177,710 beneficiaries. When the expected rate of TKA was based on adjustment for age, sex, and race/ethnicity, the OER varied widely among HRRs (Supplemental figure 1-map). The highest OER of 1.72 was in Idaho Falls, ID, while the lowest OER of 0.52 was in Bronx, NY. HRRs with the highest OER were predominantly white, while HRRs with the lowest OERs had large proportions of ethnic minorities (Supplemental table 1). Despite adjustment of the expected rates for race/ethnicity, significant correlations remained between the OER and the racial composition of the HRR, indicating residual confounding (Supplemental figure 2). Therefore, subsequent analyses used race-specific models to generate the expected number of TKA. Because whites comprised 84.64% of the sample, our analyses focused on associations among whites.

Among whites, the clinical characteristics of beneficiaries varied widely among HRR, with for example, the percent of poor beneficiaries ranging from 0.83% to 3.33%, and those with dementia ranging from 0.63% to 2.63%. (Supplemental table 2). Adjustment for indicators of knee osteoarthritis, comorbidities, and socioeconomic status resulted in OERs that were somewhat less divergent, with 10th and 90th percentiles of X and X, compared to X and X for OERs based on age and sex-adjustment (Supplemental figure 3 and Supplemental table 3). However, substantial regional variation in OERs remained after adjustment for patient characteristics, with high OER in several HRR in the upper Midwest and mountain west, and low OER in the New York City region and south Florida (Figure 1 and Supplemental table 4).

HRRs that included more rural residents had generally higher OER than those that were less rural (Figure 2). HRRs whose residents had fewer outpatient visits for knee complaints also had higher OER than those whose residents had more such visits. There was no association between the OER and the proportion of Medicare Advantage beneficiaries in an HRR. In contrast, HRRs with more TKA surgeons per capita had higher OERs than those with fewer surgeons per capita.

HRRs with high OERs tended to have high OERs among patients with very low estimated probabilities of TKA as well as those with higher estimated probabilities of TKA, while HRRs with low OERs tended to have low OERs across quartiles of estimated probability of TKA (Figure 3). This pattern suggests that HRRs with high OERs were less discriminating in performing TKA across a spectrum of beneficiaries with varying likelihood of TKA, and that HRRs with low OERs were universally more discriminating. Consistent with this interpretation, rates of TKA among beneficiaries with dementia, peripheral vascular disease, and leg ulcers were higher in HRRs with high OERs, as were rates among healthy 65 to 69 year-olds (Figure 4).

The number of TKA surgeons per HRR ranged from 48 to 1047. The annual number of TKA performed varied widely, but the number and range of TKAs per surgeon was similar in high OER regions as in other regions (Supplemental figure 4).

Analyses in blacks, Hispanics, and Asians was limited by low representation across HRRs. Only six HRR included at least 15,000 Hispanic beneficiaries, which corresponded to the lowest white HRR population in our study. Forty-two HRRs included at least 15,000 black beneficiaries. OERs among blacks in these HRRs ranged from 0.59 to r round(max(smr\_black\_filt$smr1),2)` (Supplemental table 5). OERs in blacks and whites in these regions were positively correlated, and generally higher among blacks (Figure 5).

## Hawaii

The Hawaii HRR information

| **HRR** | **City** | **State** | **OER (Model 1)** | **OER (Model 3)** |
| --- | --- | --- | --- | --- |
| 150 | Honolulu | HI | 0.703 | 0.865 |

#### Table 1. Observed/expected ratios (OER) for primary total knee arthroplasty rates among white Medicare beneficiaries in the urban centers or outlying areas of selected Health Referral Regions. Regions selected were those with a large geographic area, an urban center with a population of 100,000 or more, and an OER at the low, middle, or high end of the distribution.

| Heath Referral  Region | Percent of  beneficiaries living in  the urban center | Overall OER | OER urban center | OER outlying area | OER difference |
| --- | --- | --- | --- | --- | --- |
| Lexington, KY | 14.7 | 0.81 | 0.81 | 0.81 | 0.00 |
| Syracuse, NY | 12.0 | 0.84 | 0.72 | 0.85 | 0.13 |
| San Antonio, TX | 48.6 | 0.86 | 0.72 | 1.00 | 0.28 |
| Albuquerque, NM | 38.3 | 0.97 | 0.87 | 1.04 | 0.17 |
| Bakersfield, CA | 35.8 | 1.01 | 0.93 | 1.06 | 0.13 |
| Phoenix, AZ | 55.1 | 1.04 | 0.95 | 1.15 | 0.20 |
| Wichita, KS | 25.3 | 1.43 | 1.13 | 1.55 | 0.41 |
| Lincoln, NE | 35.2 | 1.57 | 1.35 | 1.70 | 0.35 |
| Salt Lake City, UT | 12.7 | 1.64 | 1.28 | 1.69 | 0.41 |