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## Observable Flaws in CMS's Dialysis Star-Rating System and a Proposed Alternative



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### Overview

In January 2015, CMS launched a star-rating system for U.S. dialysis facilities. This article analyzes nearly 6,000 U.S. dialysis facilities and explores trends and variations in star-rating scores based on facility characteristics and local demographic factors. Statistical tests show variation across states and by demographic factors.

For example, facilities serving communities with more black residents or communities with lower median incomes tend to score lower. Regression analysis indicates that communities with higher incomes have facilities that perform better overall and in particular better on certain underlying metrics.

This finding suggests that CMS's program, which seeks to measure facility quality, not patient characteristics, needs further revision.

A simpler star-rating system that relies only on standardized measures of hospitalization, mortality, and transfusion rates yields a more reliable metric and one in which over half of all facilities would be awarded a different rating.

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Nevertheless, to ensure that the star-rating system accurately informs patients about the quality of care they can expect from a given facility, star-rating scores should either be adjusted to account for underlying community characteristics or, as demonstrated below, rely only on inputs that are already adjusted to reflect differences in patients' traits and health.

### Background

In a June 2014 blog post, Patrick Conway, CMS's Chief Medical Officer and Deputy Administrator for Innovation and Quality and now also the acting Principal Deputy Administrator, explained the objective of CMS's star ratings, which also apply to nursing homes, hospitals, home health agencies, and some physician practices.

Conway said: "The star ratings empower consumers with information to make more informed health care decisions, encourage providers to strive for higher levels of quality, and drive overall health system improvement."

In its announcement of the dialysis star-rating program, CMS further explained, "These ratings summarize performance data, making it easier for consumers to use the information on the website. These ratings also spotlight excellence in health care quality."

However, the new dialysis star-rating program is not without controversy. MedPAC, the commission that advises Congress on Medicare reimbursement matters, expressed concern expressed concern last summer that CMS intended to establish the dialysis star-rating system without considering public comment and urged a delay, noting that "an open and transparent process will give beneficiaries, providers, and other members of the public the opportunity to submit comments to the agency's proposal."

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Many in the provider community objected, as well. Kidney Care Partners, an umbrella coalition, wrote to CMS about the lack of consultation, the risk that the new measure will create patient confusion, the validity of certain component factors used to generate the final scores, and the bell curve assumption that forces the facility rating into a preset distribution.

## How Star Ratings Are Constructed

The dialysis star-rating system is based on a composite score for seven facility-specific quality measures from the CMS Dialysis Facility Compare (DFC) Database:

1. Standardized hospitalization ratio (SHR)
2. Standardized mortality ratio (SMR)
3. Standardized transfusion ratio (STrR)
4. Share of adult patients who received treatment through arteriovenous fistula (Fistula)
5. Share of adult patients who had a catheter (tube) left in a vein longer than 90 days for regular hemodialysis treatment (Catheter)
6. Share of adult patients who had hypercalcemia (that is, an average calcium level greater than 10.2 mg/d over the past three months) (Calcium)
7. Share of patients who had adequate Kt/V levels (that is, enough wastes removed from their blood during dialysis)<sup>1</sup> (Kt/V).

CMS translates the raw data for each metric into percentile ranks. That means that each metric's value is converted first into 100 groups ranging from 0.5 to 99.5. Next, those percentile ranks are converted to values reflecting a normal distribution.

As CMS explains, "To further differentiate facilities that performed exceptionally well or poorly, these percentile ranks (pRanks) were 'normalized' or mapped from the uniform percentile rank distribution to a normal distribution (nRanks)."

As a result, the difference in the value of a facility with a percentile rank of 99 for a given metric and a facility with a rank of 98 is greater than the difference between a facility with a percentile rank of 51 and a facility with a rank of 50. The effort to differentiate scores in the tails of the distribution is an artificial distinction imposed on the data by CMS.

When the seven factors are combined into a star rating, each is not weighted equally. Instead, a statistical method known as factor analysis is used to ensure that individual factors that are correlated are not disproportionately weighted. (For example, the share of adult patients who received treatment through arteriovenous fistula is correlated with the share of patients who had a catheter for longer than 90 days;  $\hat{\rho} = 0.45$ .)

The factor analysis creates three, equally weighted groups.

The first group, "Standardized Outcomes," comprises the variables for SHR, SMR, and STrR.

The second group, "Other Outcomes 1 (Fistula, Catheter)," comprises the variables for patients who re-

ceived treatment through arteriovenous fistula and those who had a catheter left in a vein longer than 90 days.

The final group, "Other Outcomes 2 (Kt/V, Calcium)," comprises the variables for hypercalcemia and Kt/V.

CMS averages the scores within each group and then averages across the three groups to arrive at a final score, which is then used to divide the facilities into five star-rating categories. Facilities with the top 10 percent of final scores are given a star rating of 5.

Facilities with the next 20 percent of scores are rated 4. Facilities within the middle 40 percent of final scores are given a star rating of 3. Facilities with the next 20 percent are rated 2, and facilities with the bottom 10 percent of final scores are rated 1.

## Data Review

The distribution of rated facilities is very close to CMS's stated objective: 9.8% are 1-star, 19.8% are 2-star, 40.1% are 3-star, 20.2% are 4-star, and 10.1% are 5-star.

The seven individual metrics are reported on different scales. STrR, SHR, and SMR have mean scores of 1.0. For these metrics, a lower score is better. Calcium and Catheter have mean scores of 2.3 and 10.5, respectively, and lower scores also reflect better outcomes. For Kt/V and Fistula, higher scores are better, and the average facility's results are 87.9 and 63.8, respectively.

Table 1 reports the average score for each metric within each of the five star-rating categories. While data similar to that presented in Tables 1, 2 and 3 below, was previously reported by CMS, the Agency report relied on data available as of January 2014. Here I present results from data available as of January 29, 2015. The new dataset bases all quality measures on calendar year 2013 except SMR, which is based on the previous four years of data (January 2010-December 2013).

**Table 1. Mean Values by Star Rating**

	1	2	3	4	5
STrR	1.5	1.2	<b>1.0</b>	0.8	0.6
SHR	1.3	1.1	<b>1.0</b>	0.9	0.8
SMR	1.3	1.1	<b>1.0</b>	0.9	0.8
Kt/V	79.2	85.0	<b>88.5</b>	91.3	93.0
Calcium	4.4	3.4	<b>2.3</b>	1.2	0.8
Fistula	51.1	58.7	<b>63.9</b>	69.3	74.7
Catheter	19.5	13.7	<b>9.9</b>	7.1	5.1

Source: January 2015 DFC data.

CMS reports quality metrics for 6,307 dialysis facilities, but some facilities are missing data for certain metrics. For the star-rating system, CMS excludes any facility that lacks data for all metrics in one of the three groups.

If a facility is not missing all values in a group, CMS assigns the median value, 50, to any missing measure. As Table 2 shows, 5,143 facilities (82%) have data for all seven measures, while 321 (5%) lack data for all seven. In total, 727 facilities (12%) are not rated due to insufficient reporting of quality metrics.

**Table 2. Facilities with Missing Measures**

# of Missing Measures	Facilities		%	
	Facilities	%	Facilities Unrated	%

<sup>1</sup> This variable is a weighted average derived from three separate measures for each of three patient types: adult hemodialysis, pediatric hemodialysis, and adult peritoneal dialysis.

**Table 2. Facilities with Missing Measures**

0	5,143	82	27	4
1	334	5	40	6
2	180	3	59	8
3	135	2	109	15
4	75	1	60	8
5	53	1	46	6
6	66	1	65	9
7	321	5	321	44
Total	6,307	100	727	12

Source: January 2015 DFC data.

The most common missing measure is STrR, with 952 facilities (16%) not reporting this metric (see Table 3). For the other measures, non-reporting rates ranged from 8% to 10%.

**Table 3. Missing Data by Measure**

Measures	Facilities with Missing Data	%
STrR	952	16
SHR	551	9
SMR	599	10
Kt/V	511	8
Calcium	524	9
Fistula	585	10
Catheter	585	10

Source: January 2015 DFC data.

## Analysis

### Distribution Analysis

To understand better the relationship between the star ratings associated with different types of facilities, I matched census tract-level demographic data from the U.S. Census Bureau with the CMS star-rating data using facility zip codes.

The Census Bureau data include information about median incomes, educational attainment, race, and age. These data are also matched with facility-level data from the 2011 Dialysis Facility Report (DFR) dataset, which reflects data from calendar year 2010 and allows for the incorporation of information about facility staffing levels.

Table 4 details the distribution of star ratings for various subgroups. After reporting the share of facilities in each star-rating category, the table reports the total number of facilities within the given subgroup, the average score, and the results of a t-test and Pearson's chi-squared test.

The t-test determines if the average score for that subgroup is statistically different from the mean of the rest of the dialysis facilities. Pearson's chi-squared test assesses whether the distribution of scores in a subpopulation is statistically independent from the star rating. P-values of less than 0.05 indicate statistically significant differences in the mean (t-test) and the distribution (chi-squared test).

Facilities in census tracts with a black population above the national median tend to have lower star ratings—just 6.6% are 5-star, and the average score is 2.87. Conversely, census tracts with a white population above the national median have an average score of 3.05, and 11.6% are 5-star.

Facilities in low-income communities clearly perform poorly. Facilities located in census tracts where the median income is in the bottom 20% average 2.8 stars and are twice as likely to have 1 star (18.4%) compared to facilities with median incomes near the national average (9.1%).

There is considerable variation in star ratings across states. The three states with the most facilities (Texas, California, and Florida) have mean scores of 3.19, 3.29, and 2.60, respectively. New York, Ohio, and Washington, three states in distinct regions of the country, have mean scores of 2.82, 2.60, and 3.57, respectively. (See Figure 1.) Dialysis Patient Citizens, a patient advocacy group, reports that healthier states tend to have higher-rated facilities.

**Table 4. Distribution of Star Ratings for a Range of Facility Subpopulations**

	Star Rating (%)					No. of facilities	Avg. score	T-test (p-value)	Chi-squared test (p-value)
	1	2	3	4	5				
All facilities	9.8	19.8	40.1	20.2	10.1	5,580	3.0	N/A	N/A
All nonprofit	10.4	18.7	39.3	18.1	13.5	758	3.1	0.24	0.01
Black % above national median	11.3	21.0	43.4	17.7	6.6	2,060	2.9	0.00	0.00
White % above national median	9.0	20.9	38.1	20.4	11.6	3,104	3.0	0.01	0.00
Median income in bottom 20%, by census tract	18.4	19.7	35.0	19.7	7.2	223	2.8	0.00	0.00
Median income in middle 20%, by census tract	9.1	19.8	40.3	19.8	10.9	2,383	3.0	0.16	0.35
Median income in top 20%, by census tract	7.1	17.7	39.0	24.8	11.3	141	3.2	0.11	0.54

Source: January 2015 DFC data and U.S. Census Bureau.

Figure 1. State Variation in Star Ratings



### Regression Analysis

The distribution analysis above suggests that community demographics and geography impact a facility's star rating. Given that the objective of the star-rating program is to measure facility quality, systemic geographic and demographic variation in scores is suggestive of potential measurement bias.

Specifically, if patient and community demographic data can predict a facility's star rating, this may indicate that patient characteristics influence a system intended to measure facility quality. Regression analysis can further examine this question by estimating the impact of various explanatory variables on star ratings.

### Predicting Star Ratings

Table 5 reports ordinary least squares (OLS) regression results. I regress star ratings on facility traits (column 1), add patient and community demographics (col-

umn 2), and add state dummy variables (column 3). Independent variables include dummy variables to indicate if a facility is owned by one of the three large dialysis organizations (LDOs) or by another chain (compared to independent facilities); patient-to-staff ratios; the share of patients on Medicare; average patient age; percent of white population by facility; and, by census tract, the log of the median income and the percent of the population with a college degree or above.<sup>2</sup>

<sup>2</sup> Determining if a facility is owned by an LDO involved multiple steps. The star-rating dataset includes a variable identifying the chain that owns a facility if it is not independent, but it was necessary to correct for a number of observed errors. In particular, some smaller chains have been acquired in recent years by an LDO, but the new ownership was not necessarily reflected in the data. In other instances, facilities had DaVita or Fresenius in their name but were not listed as a DaVita or Fresenius facility.

Table 5. Effect of Facility and Demographic Factors on Star Rating

	(1)	(2)	(3)
LDO: Davita	<b>0.773**</b> (0.048)	<b>0.780**</b> (0.048)	<b>0.831**</b> (0.049)
LDO: Fresenius	<b>-0.214**</b>	<b>-0.210**</b>	<b>-0.154**</b>

**Table 5. Effect of Facility and Demographic Factors on Star Rating**

	(1)	(2)	(3)
	(0.047)	(0.048)	(0.050)
<b>LDO: DCI</b>	<b>0.354**</b>	<b>0.387**</b>	<b>0.474**</b>
	(0.080)	(0.080)	(0.081)
<b>Non-LDO chains</b>	<b>0.108*</b>	<b>0.114*</b>	<b>0.093+</b>
	(0.054)	(0.055)	(0.057)
<b>Number of stations</b>	<b>-0.007**</b>	<b>-0.003+</b>	<b>-0.005**</b>
	(0.002)	(0.002)	(0.002)
<b>Patient/staff ratio, 2010</b>	<b>-0.038**</b>	<b>-0.029**</b>	<b>-0.015+</b>
	(0.009)	(0.009)	(0.008)
<b>% not on Medicare, 2010</b>		<b>-0.002</b>	<b>0.001</b>
		(0.003)	(0.003)
<b>Average patient age, 2010</b>		<b>0.010**</b>	<b>0.018**</b>
		(0.004)	(0.004)
<b>% white patients, 2010</b>		<b>0.002**</b>	<b>0.002*</b>
		(0.001)	(0.001)
<b>Log median income</b>		<b>0.207**</b>	<b>0.102*</b>
		(0.041)	(0.042)
<b>% bachelors degree or above</b>		<b>-0.006**</b>	<b>-0.004**</b>
		(0.001)	(0.001)
Observations	4,978	4,946	4,946
R-squared	0.161	0.174	0.250
State dummies	No	No	Yes

Standard errors in parentheses. \*\* p<0.01, \* p<0.05, + p<0.1

Regression results indicate the following:

- Census tract-level median income is a statistically significant factor in predicting star rating, after controlling for other observable factors. For example, a 10% increase in median wage in the census tract increases the star rating by at least 0.1 (depending on the particular regression specification). A more significant change in median income—from \$40,000 to \$60,000—would result in a 0.5 or more increase in the rating.
- Relative to independent facilities, the marginal impact of being DaVita-owned is 0.8 stars; DCI-owned, 0.4–0.5 stars; and another chain, 0.2 stars. The marginal effect of being a Fresenius facility is negative.

### Predicting Score Components

Three of the seven score components (STrR, SHR, and SMR) are risk-adjusted factors that reflect variations in patient population; the other four are not. Table 6 reports regression results for each factor under the specifications in the third column of Table 5.

- SHRs and SMRs are largely independent of the observable factors.
- LDOs and other chains achieve significantly better STrRs than independent facilities.
- For Kt/V, Calcium, Fistula, and Catheter, ownership has a significant effect. For Catheter and Fistula, census tract-level median income has a powerful positive effect.

**Table 6. Effect of Facility and Demographic Factors on Quality Measures**

	SHR	SMR	STrR	Kt/V	Calcium	Catheter	Fistula
<b>LDO: Davita</b>	<b>0.038**</b>	<b>-0.005</b>	<b>-0.220**</b>	<b>5.540**</b>	<b>-1.644**</b>	<b>-5.702**</b>	<b>4.790**</b>
	(0.014)	(0.013)	(0.027)	(0.445)	(0.134)	(0.311)	(0.529)
<b>LDO: Fresenius</b>	<b>0.047**</b>	<b>-0.024+</b>	<b>-0.210**</b>	<b>-0.913*</b>	<b>1.596**</b>	<b>-3.387**</b>	<b>2.798**</b>
	(0.014)	(0.013)	(0.027)	(0.447)	(0.134)	(0.313)	(0.531)
<b>LDO: DCI</b>	<b>-0.039+</b>	<b>-0.092**</b>	<b>-0.305**</b>	<b>3.816**</b>	<b>0.039</b>	<b>-3.191**</b>	<b>3.209**</b>
	(0.023)	(0.021)	(0.044)	(0.725)	(0.215)	(0.506)	(0.859)
<b>Non-LDO chains</b>	<b>0.044**</b>	<b>0.004</b>	<b>-0.112**</b>	<b>2.207**</b>	<b>0.424**</b>	<b>-1.577**</b>	<b>1.364*</b>
	(0.016)	(0.015)	(0.031)	(0.511)	(0.153)	(0.357)	(0.607)

**Table 6. Effect of Facility and Demographic Factors on Quality Measures**

	<b>SHR</b>	<b>SMR</b>	<b>STrR</b>	<b>Kt/V</b>	<b>Calcium</b>	<b>Catheter</b>	<b>Fistula</b>
<b>Number of stations</b>	<b>0.000</b> (0.001)	<b>-0.002**</b> (0.000)	<b>-0.002*</b> (0.001)	<b>0.123**</b> (0.017)	<b>-0.006</b> (0.005)	<b>0.011</b> (0.012)	<b>-0.048*</b> (0.020)
<b>Patient/staff ratio, 2010</b>	<b>0.012**</b> (0.002)	<b>-0.008**</b> (0.002)	<b>0.009+</b> (0.005)	<b>0.109</b> (0.077)	<b>-0.019</b> (0.023)	<b>-0.103+</b> (0.055)	<b>0.113</b> (0.093)
<b>% not on Medicare, 2010</b>	<b>0.004**</b> (0.001)	<b>-0.000</b> (0.001)	<b>-0.005**</b> (0.002)	<b>-0.143**</b> (0.029)	<b>-0.004</b> (0.009)	<b>-0.040+</b> (0.020)	<b>0.078*</b> (0.035)
<b>Avg. patient age, 2010</b>	<b>-0.003**</b> (0.001)	<b>-0.005**</b> (0.001)	<b>0.000</b> (0.002)	<b>0.418**</b> (0.035)	<b>-0.024*</b> (0.011)	<b>0.009</b> (0.025)	<b>-0.088*</b> (0.042)
<b>% white patients, 2010</b>	<b>-0.001**</b> (0.000)	<b>0.000</b> (0.000)	<b>0.001*</b> (0.000)	<b>-0.044**</b> (0.006)	<b>-0.007**</b> (0.002)	<b>0.005</b> (0.004)	<b>0.090**</b> (0.007)
<b>Log median income</b>	<b>0.029*</b> (0.012)	<b>-0.015</b> (0.011)	<b>-0.045*</b> (0.023)	<b>0.565</b> (0.380)	<b>-0.145</b> (0.113)	<b>-0.928**</b> (0.265)	<b>1.412**</b> (0.450)
<b>% bachelors or above</b>	<b>-0.000</b> (0.000)	<b>-0.000</b> (0.000)	<b>-0.000</b> (0.001)	<b>-0.071**</b> (0.009)	<b>0.006*</b> (0.003)	<b>0.032**</b> (0.007)	<b>-0.029**</b> (0.011)
Observations	4,938	4,946	4,765	4,917	4,882	4,894	4,894
R-squared	0.183	0.098	0.126	0.172	0.274	0.182	0.178
State dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Metric mean	1.0	1.0	1.0	87.9	2.3	10.5	63.8
Metric standard deviation	0.3	0.3	0.5	9.9	2.8	6.7	11.2

Standard errors in parentheses. \*\* p<0.01, \* p<0.05, + p<0.1.

## Alternative Star-Rating

One approach to measure the appropriateness of the current star-rating system is to construct an alternative set of criteria that also hold clinical validity and compare the results.

Here, I present an alternative to the current system a star-rating system based solely on the three standardized metrics: SMR, SHR and STrR. I then analyze the results to determine how many facilities would be assigned a different star-rating and the magnitude of the change for those facilities that are affected.

As Table 6 shows, the three standardized metrics are generally less susceptible to variations in patient age, race, income, and education than Kt/V, Calcium, Catheter, and Fistula. This result is intuitive as these metrics are standardized through a model that adjusts each result based on patient age, gender, diabetes, duration of ESRD, cause of ESRD, nursing home status, body mass index, and ethnicity. As such, there is an inherent advantage in the standardized metrics relative to the other quality metrics.

Furthermore, Kt/V, Calcium, and the type of vascular access used during dialysis are all “process” measures as opposed to outcome measures; only a *means* to lower hospitalization rates and lower mortality rates for a facility’s patient population. And a lower standardized transfusion rate raises the probability that a patient will be eligible for transplantation, the ideal modality for ESRD.

In my alternative star-rating system, each of the three standardized metrics is equally weighted. I otherwise follow the same steps that CMS follows in constructing ratings. Table 7 describes the number of facilities that change star ratings. 42% of facilities maintain the same score, 47% change by +/- 1, and 11% change by more than +/- 1.

For example, among the 2,338 facilities that are currently 3-star, 1,056 facilities remain so under the alternative system, while 568 receive a lower star rating (93 1-star, and 475 2-star) and 608 receive a higher star rating (497 4-star, and 111 5-star). Just 1 facility would change from 1 star to 5 stars, and 1 would change from 5 stars to 1 star.

**Table 7. Facility Score Changes Between Alternative Star-Rating and Original Star-Rating**

<b>Original Star Rating</b>	<b>New Star Rating</b>					<b>Total</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	
<b>1</b>	<b>258</b>	190	93	3	1	545
<b>2</b>	172	<b>381</b>	475	74	4	1,106
<b>3</b>	119	458	<b>1,056</b>	474	131	2,238
<b>4</b>	8	78	497	<b>371</b>	172	1,126

**Table 7. Facility Score Changes Between Alternative Star-Rating and Original Star-Rating**

	New Star Rating					
	5	4	3	2	1	Total
Total	558	1,116	2,232	1,116	558	5,580

Table 8, which replicates the regression in Table 5, column 3 but substitutes the alternative star-rating measure as the dependent variable, demonstrates that the effects of demographic characteristics on the star rating are greatly reduced when only the three standardized measures are used to compute the star rating. The impact of ethnicity becomes insignificant, as does census tract-level income, when controlling for state effects. The effect of education is near zero.

**Table 8. Effect of Facility and Demographic Factors on Alternative Star Rating**

	Alternative Star-Rating
LDO: Davita	<b>0.088+</b> (0.054)
LDO: Fresenius	<b>0.111*</b> (0.054)
LDO: DCI	<b>0.481**</b> (0.087)
Non-LDO chains	<b>0.030</b> (0.061)
Number of stations	<b>-0.002</b> (0.002)
Patient/staff ratio, 2010	<b>-0.026**</b> (0.009)
% not on Medicare, 2010	<b>0.000</b> (0.004)
Average patient age, 2010	<b>0.016**</b> (0.004)
% white patients, 2010	<b>-0.001</b> (0.001)
Log median income	<b>-0.006</b> (0.046)
% bachelors degree or above	<b>0.002*</b> (0.001)
Observations	4,946
R-squared	0.138
State dummies	Yes

Standard errors in parentheses. \*\* p<0.01, \* p<0.05, + p<0.1.

## Conclusion

CMS created the dialysis facility star-rating system to help patients find the best quality of care in the vital area of in-center dialysis treatment. Improving consumer awareness and promoting health care quality are worthy goals, but the star-rating system as currently constructed is not appropriately directed toward those ends.

This analysis indicates that the current system may be predicting local demographic factors in addition to facility quality metrics.

In addition to legitimate concerns raised by other stakeholders and given the importance of patient demographics in predicting patient outcomes and health status, it is necessary to consider refinements to the star-rating system.

Specifically, there are statistically significant differences in the average star rating for facilities located in lower-income census tracts and facilities in census tracts with higher-than-average black populations. Regression analysis results indicate that patient age and median income are significant predictors of some of the seven individual underlying metrics even after controlling for facility ownership, facility size, patient/staff ratios, and state.

CMS has the opportunity to make reforms to the Dialysis star rating system through its Technical Experts Panel. Experts with clinical knowledge of ESRD, statistics and biostatistics, and patients' perspectives will advise CMS on changes to improve the star-rating system.

With luck, they will consider the unintended influence of community demographics and the benefit of relying on a system devoid of the bias identified in this article.

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