

Quality of Care and Relative Resource Use for Patients With Diabetes

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For most goods, quality and cost are assumed to be positively related in that higher quality is associated with higher cost. However, efficient health plans may be able to achieve both high quality and low cost by implementing effective procedures and utilizing highly trained providers. Conversely, quality and cost may not be positively related when plans provide low quality at a high cost. There is a wide range of empirical findings on this relationship. A review of studies of domestic plans¹ yielded mixed evidence. While some showed generally no relationship,^{2,3} others demonstrated a positive relationship,^{4,5} and still others found a negative association.^{6,7} A survey of international investigations⁸ found that interventions of moderate cost can considerably increase quality.

To improve healthcare, it is critical to understand the relationship between quality and cost. If they are not necessarily positively related, improvements in quality could be achieved at relatively little cost. A recent proposal⁹ by top healthcare experts from both political parties was largely centered on this notion. On the contrary, if quality and cost are positively related, this knowledge would allow policy makers to identify goals that are feasible and the appropriate steps to achieve them.

Unfortunately, determining how quality and cost are related is difficult—very few data sets contain both quality and cost measures.¹⁰ Further, defining quality and cost is not straightforward; while some measures provide insight into certain aspects of quality, 2 issues make measuring cost especially difficult. First, prices for healthcare vary significantly across geographic regions and health plans. Thus, cost estimates may differ simply due to different price bases. Second, variation in case mix across plans may lead to cost differences that reflect enrollee characteristics rather than treatment differences.¹¹

Relative resource use (RRU) data addresses some of these issues, and these data have been used previously, such as to analyze the effects of changes in Medicare payment systems

ABSTRACT

Objectives: To investigate the relationship between quality of care and relative resource use for patients with diabetes enrolled in commercial insurance plans.

Study Design: Retrospective cohort study employing data from the Healthcare Effectiveness Data and Information Set for 2009 to 2011.

Methods: Correlations between quality of care and various relative resource use measures are estimated. In addition to overall estimates, the sample is disaggregated by year, plan type, and geographic region. Correlations are also estimated for year-to-year changes in quality and relative resource use.

Results: The overall results are generally consistent with previous findings regarding the relationship between quality of care and relative resource use. However, the disaggregated results indicate nuanced associations; for instance, the relationship appears to vary by year. Also, while there is a positive relationship between quality and evaluation and management services for preferred provider organizations, the relationship is negative for the other 2 plan types studied. The analysis of year-to-year changes indicates that changes in quality are negatively related to inpatient costs.

Conclusions: The findings suggest, given that quality and relative resource use are not necessarily positively related, that it may be possible to improve diabetes care quality at minimal cost. However, the disaggregated results suggest that the potential to increase quality can vary significantly by resource type, plan type, and geographic region. Thus, the most effective policies to improve quality may vary by plan.

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in inpatient rehabilitation facilities¹² and to compare procedures for total joint arthroplasty.¹³ A number of approaches to estimate RRU have been implemented by those in academia and industry.¹⁴ The analyses in this paper employ data published by the National Committee for Quality Assurance (NCQA). Health plans submit membership and claims data—including quality measures based on Healthcare Effectiveness Data and Information Set (HEDIS) standards that have been used extensively in industry and academia—to the NCQA that are audited for accuracy. Using these data, the NCQA calculates RRU measures based on standardized prices that abstract from price differences across plans, and they further adjust the data for case mix differences.

This study employs NCQA data to investigate the relationship between the quality of care and RRU of health plans in treating enrollees with diabetes. Diabetes is one of the most prevalent chronic conditions in the United States, with 22.3 million having the condition in 2012.¹⁵ Quality of care is compared with various categories of resource use, including procedure and surgery, evaluation and management services, and ambulatory pharmacy. The categories: 1) procedure and surgery and 2) evaluation and management, are further subdivided into inpatient and outpatient measures. This distinction is potentially important, as one may expect that higher quality care is associated with increased outpatient resource use and decreased inpatient resource use. For instance, more outpatient resources (such as preventive care visits) may lead to fewer hospitalizations.

While these data have previously been used to investigate the relationship between quality and cost,¹⁶⁻¹⁸ this study makes a number of contributions. First, data for multiple years are utilized, allowing for more precise estimates of the relationship. Second, the relationship is analyzed along a number of dimensions, including by year, plan type, and geographic region. Finally, first differences are used to relate changes, rather than levels, in quality and utilization. By analyzing changes, the effects of differences across plans that are constant over the sample period are mitigated.

METHODS

Data

The sample in this analysis consists of 407 commer-

Take-Away Points

This study employs data from commercial plans to investigate the relationship between quality and relative resource use for patients with diabetes.

- The results, similar to those of previous studies, indicate that quality and relative resource use are largely negatively related for the full sample.
- However, the relationship varies significantly by year, plan type, and region.
- Year-to-year changes in quality and relative resource use are also negatively related, especially for inpatient resources.
- Results suggest that there may be opportunities to increase quality of diabetes care with minimal effects on cost. However, the best approach may need to be tailored to the specific environment.

cial health plans that submitted annual HEDIS data for any year in the 2009-2011 period. Before submitting their data, the data collection and measurement calculations were audited by NCQA. After limiting the sample to only those plan/years that had valid data for all variables, the number of observations is 813.

The RRU measures are based on standardized prices provided by the NCQA. Specifically, health plans multiply the standardized prices by the number of units of the service that were provided to obtain the standard costs. For each member diagnosed with diabetes, the total standard costs are calculated by adding the standard costs across all areas of care (ie, including nondiabetes care). The plan's actual standard costs are divided by the expected standardized cost for the plan, taking into account the plan's case mix and the average utilization of other plans. Finally, this ratio is indexed such that the average is 1.0.

RRU measures are calculated for 2 broad categories: medical services and ambulatory pharmacy services. The medical services category is disaggregated into inpatient facility (exclusive of physician services), procedure and surgery, and evaluation and management services. The 2 latter subcategories are further disaggregated into inpatient and outpatient services. The RRU specifications can change slightly by year, and thus, some caution is warranted in interpreting the results by year shown below.

Quality is measured as an unweighted composite of 10 individual components of the HEDIS Comprehensive Diabetes Care measure: A1C testing; A1C control (3 measures: greater than 9%, less than 8%, less than 7%); eye exam (retinal) testing; low-density lipoprotein cholesterol (LDL-C) screening; LDL-C control (less than 100 mg/dL); medical attention for nephropathy; and blood pressure control (2 measures: less than 130/80 mm Hg, less than 140/90 mm Hg). (The indicator for blood pressure less than 130/80 mm Hg was not included in the 2011 measure.) As is the case for RRU, the quality measure is indexed across plans such that the average is 1.0. Unlike

■ **Table 1.** Correlations of Quality Measure With RRU Measures: Overall, by Year and Plan Type

RRU Measure	Overall	Year			Plan Type		
		2009	2010	2011	HMO	POS	PPO
Medical							
Total	-0.053 (.13)	-0.100 (.10)	-0.029 (.62)	-0.021 (.74)	-0.055 (.58)	-0.076 (.13)	-0.048 (.40)
Procedure and surgery services							
Total	0.044 (.21)	0.040 (.51)	0.017 (.77)	0.095 (.13)	-0.053 (.59)	0.190 ^a (.000)	-0.044 (.44)
Inpatient	-0.107 (.002)	-0.189 ^a (.002)	-0.10 (.08)	0.00 (.92)	0.13 (.16)	-0.08 (.09)	-0.257 ^a (.000)
Outpatient	0.095 (.007)	0.130 (.03)	0.059 (.32)	0.111 (.08)	-0.103 (.29)	0.251 ^a (.000)	0.054 (.34)
Evaluation and management services							
Total	-0.023 (.51)	-0.081 (.18)	0.074 (.20)	-0.120 (.05)	-0.186 (.06)	-0.150 ^a (.003)	0.162 ^a (.004)
Inpatient	-0.210 (.000)	-0.240 ^a (.000)	-0.145 ^a (.01)	-0.300 ^a (.000)	-0.277 ^a (.004)	-0.386 ^a (.000)	-0.072 (.20)
Outpatient	0.029 (.40)	-0.025 (.68)	0.122 (.04)	-0.062 (.32)	-0.143 (.14)	-0.058 (.25)	0.201 ^a (.000)
Inpatient facility							
Total	-0.061 (.08)	-0.125 (.04)	-0.064 (.28)	0.058 (.36)	0.065 (.51)	-0.104 (.04)	-0.071 (.21)
Ambulatory pharmacy							
Total	0.069 (.05)	0.245 ^a (.000)	0.016 (.78)	-0.039 (.54)	0.227 ^a (.02)	0.141 ^a (.005)	0.007 (.9)
Sample size	813	269	290	254	106	394	313

HMO indicates health maintenance organization; POS, point of service; PPO, preferred provider organization; RRU, relative resource use.
^aThe coefficient is statistically significant at the 5% level after using the Simes procedure to account for multiple tests.
 The top number in each cell is the correlation coefficient and the lower number in parentheses is the associated *P* value.

RRU, the quality measure is not adjusted for case mix, but rather indexed based on submission by other plans.

Analysis

All of the data management and calculations were performed using Stata version 12 (StataCorp LP, College Station, Texas). The estimates consist of correlation coefficients between the quality measure and the various RRU measures.

The analysis exploits the availability of multiple years of data. The first level of analysis pools the data across all years, then correlations are calculated after subsetting the data by year, plan type, and geographic region. These estimates provide insight as to whether the observed overall relationships are stable or whether they vary significantly across these dimensions. The final set of analyses is based on year-to-year changes (first differences) in the quality and RRU measures.

An important caveat to the results follows from the multiple comparisons below. Specifically, the likelihood

of type I error (incorrectly identifying a statistically significant correlation) increases with the number of correlations estimated. For instance, in the analyses of the 7 regions, the probability of erroneously identifying at least 1 statistically significant effect for a given RRU measure is roughly 30%. (This probability is based on a 5% significance level and is calculated as 1 minus the probability that the null hypothesis is incorrectly rejected in at least 1 of the 7 tests.) This issue is addressed by employing the Simes procedure that accounts for multiple tests.¹⁹

RESULTS

Overall

Table 1 reports correlation coefficients between the diabetes quality measure and various RRU measures. The first column lists the 2 primary measures, total medical and total ambulatory pharmacy. The submeasures within medical are listed below the row for total medical. The top number in each cell of the body of the table is the coefficient, while

the lower number is the associated *P* value. It has been indicated if the coefficient is statistically significant at the 5% level after applying the Simes correction for multiple tests.

The second column of Table 1 contains the correlation coefficients when the observations are pooled. For instance, the correlation between the quality measure and the total medical RRU measure is approximately -0.05 with $P = .13$. While not statistically significant, the negative point estimate is consistent with earlier findings but of a lower magnitude.⁷ The correlations for the medical subcategories indicate that the overall negative relationship is driven by the inpatient dimensions of both procedure and surgery and evaluation and management services and by inpatient facility. Conversely, the estimate for the outpatient dimension of procedure and surgery services indicates a positive relationship. The positive overall relationship for ambulatory pharmacy is also consistent with previous results, but the estimate is again of a lesser magnitude.

Disaggregated

The disaggregated estimates may provide deeper insight into the relationship between quality and relative resource use. The remaining columns of Table 1 report the correlation coefficients when the sample is subset by year and plan type. There is interesting variation in the estimates by year. The total medical correlation only differs from 0 in 2009, and then it is of marginal statistical significance. Within the 2 medical subcategories, a relatively consistent pattern emerges of negative correlations for the inpatient RRU measures and positive (but not statistically significant) correlations for the outpatient measures. Further, there is also a positive estimate for the ambulatory pharmacy measure in 2009, but the association dissipates in the 2 subsequent years.

The final 3 columns of Table 1 contain correlations when the sample is subset by plan: health maintenance organization (HMO), HMO and point of service (POS) combined, and preferred provider organization (PPO). (Three plan types were excluded because each was composed of 17 or fewer observations: HMO/POS/PPO combined, HMO/PPO combined, and POS.) While the total medical point estimates are negative, none are statistically significant. By contrast, for HMO/POS combined there is a large positive relationship for the outpatient measure. Finally, for ambulatory pharmacy there are positive associations for HMO and HMO/POS combined but no association for PPO.

The third layer of disaggregation is detailed in Table 2, where the results are reported by geographic region. (Esti-

mates are reported only for regions with 50 or more observations.) Even though splitting the sample by region leads to relatively small samples, there are a number of significant findings. Chicago and New York appear to be the primary drivers for the negative relationship between quality and the total medical RRU measure. In both regions there is a relatively large negative association between quality and the inpatient aspect of evaluation and management services measure and the inpatient facility measure. The pattern of negative correlations for this measure persists across all regions. By contrast, there is a positive association in Atlanta and Boston for the outpatient aspect of procedure and surgery services.

First Differences

While the findings in Table 1 and Table 2 provide insight into how the levels of quality and RRU are related, they do not indicate how changes in quality and RRU are related. Although plans differ significantly, correlations of first differences can provide insight into the relationship between quality and cost within plans. Since differencing abstracts from the initial quality and costs levels, any differences in plan attributes, such as population, that may affect quality and costs and do not vary during the sample period will be at least partially controlled for.

Table 3 presents the correlations of first differences. Because first differences are examined, the sample sizes are significantly lower and results are only available for the last 2 years of the sample period. Further, the observations are limited to those plans that submitted consecutive annual reports. Correlations by region are not reported because of the small samples due to first differencing.

An important limitation to this analysis is that the RRU measures are indexed based on the group of plans that submit in that year. Thus, a plan could have a higher or lower index value due to changes in the composition of plans that submitted data in that year. Further, the RRU measures are calculated using a ratio that is year-specific. Given these factors, the correlations should be interpreted as describing the relationship between changes in quality and changes in the relative standing in RRU.

The overall results indicate a negative association between changes in quality and (changes in relative standing in) the total medical RRU measure. The subcategory results show that this negative relationship is driven by the inpatient measures in each subcategory and often by the inpatient facility measure. The findings by year show that while the negative total medical association is due largely to changes observed in 2010, the pattern of correlations is largely consistent across both years.

■ **Table 2.** Correlations of Quality Measure With RRU Measures, by Region

RRU Measure	Atlanta	Boston	Chicago	Dallas	New York	Philadelphia	San Francisco
Medical							
Total	0.095 (.26)	0.078 (.48)	-0.166 (.04)	-0.094 (.46)	-0.370 ^a (.001)	0.067 (.51)	-0.060 (.62)
Procedure and surgery services							
Total	0.288 ^a (.001)	0.116 (.29)	0.076 (.35)	0.07 (.59)	-0.026 (.83)	0.076 (.46)	0.042 (.73)
Inpatient	-0.058 (.50)	-0.420 ^a (.000)	0.015 (.86)	-0.198 (.11)	-0.336 ^a (.003)	0.010 (.92)	-0.135 (.26)
Outpatient	0.325 ^a (.000)	0.31 ^a (.004)	0.093 (.25)	0.135 (.28)	0.110 (.35)	0.083 (.41)	0.097 (.42)
Evaluation and management services							
Total	0.051 (.55)	0.100 (.36)	-0.196 (.02)	0.017 (.89)	-0.382 ^a (.001)	-0.017 (.87)	-0.156 (.19)
Inpatient	-0.159 (.06)	-0.036 (.74)	-0.429 ^a (.000)	-0.11 (.38)	-0.489 ^a (.000)	-0.105 (.30)	-0.216 (.07)
Outpatient	0.104 (.22)	0.131 (.23)	-0.115 (.16)	0.046 (.72)	-0.251 (.03)	0.013 (.90)	0.125 (.29)
Inpatient facility							
Total	-0.101 (.90)	0.134 (.22)	-0.185 (.02)	-0.131 (.30)	-0.392 ^a (.0005)	0.073 (.47)	-0.056 (.64)
Ambulatory pharmacy							
Total	0.149 (.08)	-0.019 (.86)	0.13 (.11)	0.025 (.85)	0.136 (.25)	0.005 (.96)	-0.030 (.80)
Sample size	139	86	153	65	74	99	73

RRU indicates relative resource use.

^aThe coefficient is statistically significant at the 5% level after using the Simes procedure to account for multiple tests.

The top number in each cell is the correlation coefficient and the lower number in parentheses is the associated *P* value. Regions with fewer than 50 observations (Denver, Kansas City, and Seattle) are excluded.

By contrast, the estimates differ significantly across plan types. While there is a negative association between quality and total medical for HMO/POS and PPO, there is virtually no association for HMO. Also, while the negative relationship for PPO is driven by both inpatient measures, for HMO/POS the negative correlation is due largely to the outpatient aspect of evaluation and management services.

DISCUSSION

The correlations presented above based on the full sample roughly follow those found in earlier analyses of the relationship between quality and relative resource use in diabetes.⁷ There is a generally negative relationship between quality and total medical services. However, the negative association is stronger for the inpatient facility measure and the inpatient facility components of procedure and surgery and evaluation and management. There

is a generally positive relationship with total ambulatory pharmacy.

However, the disaggregated and first difference estimates provide greater detail than previous studies do. For instance, the relationship between quality and the RRU measures appears to vary over time. Also, while quality and total evaluation and management services were negatively correlated for the HMO and HMO/POS samples, the correlation was positive for the PPO sample. Finally, the analysis of first differences suggests that changes in quality and RRU are strongly negatively related, driven largely by the inpatient RRU measures.

Limitations

There are several important limitations to this analysis. Arguably the most significant is the inability to go beyond correlations and estimate the causal relationship between quality and cost. The effects of unobserved confounders may bias the estimated associations away from

■ **Table 3.** Correlations of First Differences of Quality Measure With RRU Measures: Overall, by Year and Plan Type

RRU Measure	Overall	Year		Plan Type		
		2010	2011	HMO	HMO/POS	PPO
Medical						
Total	-0.146 (.005)	-0.182 ^a (.007)	-0.085 (.30)	-0.028 (.85)	-0.180 ^a (.01)	-0.237 ^a (.006)
Procedure and surgery services						
Total	-0.095 (.07)	-0.077 (.25)	-0.101 (.22)	-0.036 (.81)	-0.098 (.17)	-0.211 ^a (.02)
Inpatient	-0.089 (.09)	-0.112 (.09)	-0.061 (.46)	0.171 (.26)	-0.106 (.14)	-0.215 ^a (.01)
Outpatient	-0.072 (.17)	-0.015 (.82)	-0.100 (.22)	-0.090 (.55)	-0.064 (.37)	-0.139 (.11)
Evaluation and management services						
Total	-0.072 (.16)	-0.087 (.19)	-0.144 (.08)	-0.162 (.28)	-0.140 (.05)	-0.129 (.14)
Inpatient	-0.134 (.001)	-0.181 ^a (.007)	-0.175 ^a (.03)	-0.070 (.66)	-0.093 (.19)	-0.246 ^a (.005)
Outpatient	-0.050 (.33)	-0.046 (.49)	-0.131 (.11)	-0.184 (.22)	-0.133 (.06)	-0.041 (.64)
Inpatient facility						
Total	-0.152 (.003)	-0.186 ^a (.005)	-0.082 (.32)	0.146 (.33)	-0.128 (.07)	-0.264 ^a (.002)
Ambulatory pharmacy						
Total	-0.005 (.92)	0.054 (.42)	-0.094 (.25)	-0.275 (.06)	0.090 (.21)	-0.039 (.66)
Sample size	374	223	151	46	197	131

HMO indicates health maintenance organization; POS, point of service; PPO, preferred provider organization; RRU, relative resource use.
^aThe coefficient is statistically significant at the 5% level after using the Simes procedure to account for multiple tests.
 The top number in each cell is the correlation coefficient and the lower number in parentheses is the associated *P* value.

the true effects of cost on quality. However, as mentioned above, the first differences estimates may somewhat mitigate this concern.

Another impediment to discerning the causal relationship is ambiguity in the directional relationship: Does quality affect cost or does cost affect quality? While the simple correlations presented above cannot provide insight into this issue, a possible framework in which to view the relationship is to consider a simple health production function²⁰ where medical spending has a positive effect on health up to the “flat of the curve.” After this point, increased spending does not affect health. In the present context, the quality measure may act as a proxy for health, especially given the nonprocess measures included in the index. Nevertheless, this proposed framework is speculative and this study cannot speak to this important question.

Further, as noted above, the statistical significance of the results should be interpreted with caution. The num-

ber of comparisons for each RRU measure implies that there is a considerable probability that some of the findings of a statistically significant correlation are spurious. Thus, the number of findings of a statistical significance could be interpreted as an upper bound.

Also, the RRU measures are indexed values rather than actual costs. Thus, for instance, a plan’s costs may increase yet the indexed value may fall. However, while the indexed values may not reflect the actual absolute change in costs, they may provide important insight. For instance, the relative ranking controls for health cost inflation across all plans and does not penalize plans whose costs follow overall trends. Also, given that the correlations estimated above are intended to measure directional associations, relative rankings are well suited for the analysis. Finally, the rankings reflect important adjustments to account for case-mix differences across plans.

Finally, the use of plan-level data abstracts significantly from individual conditions and choices. For instance,

while the severity of diabetes is closely related to an individual's medical costs,²¹ the data employed here do not contain any information regarding severity. Thus, it is not possible to distinguish between a plan incurring potentially wasteful costs and a plan with high costs due to serving a large proportion of patients with advanced diabetes. While first differences may somewhat address these concerns, the analysis would be improved by incorporating this information and estimating the effects of these characteristics.

Implications

Despite these caveats, the results in this paper suggest potentially useful implications. The correlations suggest that quality and RRU are not necessarily positively related. The especially negative association for the inpatient measures could indicate that some of these resources may not be efficiently utilized. Alternatively, they could reflect that patients with lower quality of care are more likely to require hospitalizations due to their diabetes not being properly treated. The generally positive correlations for ambulatory pharmacy are also consistent with this interpretation, in that patients who stay current with their medications are more likely to have their LDL-C and blood pressure under control.

The first difference results further indicate that changes in quality and RRU are also not necessarily positively related. Thus, there may be "low-hanging fruit" scenario, in that increases in quality may be attainable without increases in resource use. The finding of regional differences in the relationship may also provide insight into the geographic variation in healthcare utilization. For instance, the negative relationship between quality and total medical in Chicago and New York may reflect earlier findings that geographic variation is due in part to levels of insurance coverage and wealth.²²

Future Research

There are numerous potential extensions to the analyses in this paper. Arguably the most important would be to attempt to identify causal relationships. Given random assignment does not appear to be feasible, an instrumental variables approach could be used to go beyond the associations described here. Another important extension would be to analyze conditions other than diabetes, as the associations observed for diabetes necessarily may not necessarily hold for other conditions. Finally, there is an inherent tension in analyzing costs for chronic conditions, as improved medical care implies patients live longer, which in turn increases the costs to treat these

conditions. Measures of indirect costs could potentially provide improved insight into truly wasteful costs.

CONCLUSIONS

The findings suggest, given that quality and RRU are not necessarily positively related, that it may be possible to improve diabetes care quality at a relatively low cost. However, the disaggregated results suggest that the potential to increase quality can vary significantly by resource type, plan type, and geographic region. The analysis of first differences further indicates that quality and certain RRU measures may not be positive related. Thus, the most effective policies to improve quality may vary by plan and type of care.

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