

Identifying Cost Management Strategies in Dialysis Clinics: Sustainable Savings With Positive Outcomes

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Objectives: To examine whether cost management strategies are used in a revenue-constrained environment without compromising clinical effectiveness.

Study Design: Cross-sectional analysis of monthly cost and acuity-adjusted hospitalization data.

Methods: This research included longitudinal regression analyses involving 10 years of data, 1990 through 1999, from each of 6 dialysis centers. Two sets of regression models were used: one set examined cost interactions and cost trends ($P \leq .001$); the second set examined clinical outcomes ($P \leq .001$). Four cost management strategies were examined: (1) selective reductions in targeted cost categories, (2) cost reductions through improved efficiencies, (3) cost avoidance by shifting responsibilities to external parties, and (4) uniform reductions across all cost categories.

Results: Managers appeared to have limited opportunity to selectively or uniformly reduce costs because of cost "stickiness" and minimal resource substitutability. Improvements in operational efficiencies and cost shifting to external parties occurred. Over time, however, realized efficiencies increased at a decreasing rate, whereas cost shifting actually declined. Contrary to prior hospital studies, these results indicate significant economies of scale. No statistical correlation was found to indicate that the physician/clinic management teams' use of cost reduction strategies affected acuity-adjusted hospitalizations of dialysis patients.

Conclusions: Strategic models that include both financial and outcomes data can enable healthcare managers to predict both positive and negative results of cost management proposals. These models can help identify aspects of an organization's cost structure that affect sustainable cost savings: cost stickiness, cost substitutability, institutional experience, realized operational improvements, and economies of scale.

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A recent series of position papers recommended the use of cost analyses to evaluate the underlying economics of clinical procedures and identify those providing maximum healthcare benefits at the lowest costs.¹⁻³ Some studies have

compared the costs of alternative treatment procedures without examining clinical outcomes.^{4,5} Other studies have examined clinical outcomes, but have either completely omitted financial data or used only aggregate cost analyses when reporting results.^{6,7} In today's revenue-constrained environment, cost containment and cost minimization are essential, and failure to link clinical outcomes with corresponding managerial cost decisions could compromise quality of care and, at the very least, makes it difficult for clinicians to choose the most economical and effective therapeutic option.

Minimizing medical practice variations has been viewed as one way to improve clinical effectiveness and decrease healthcare costs.^{8,9} Numerous studies have documented significant and costly variations in medical practice patterns that cannot be explained by differences in patient population or outcomes.¹⁰⁻¹⁶ Some studies have noted the impact of geographic variations on cost of treatments.^{17,18} Cost management decisions, however, often occur on an ad hoc basis in response to unplanned changes in

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cost levels attributed to unexpected variation in clinical processes.

Several studies have examined cost shifting and optimal cost structure.¹⁹⁻²⁴ Some have demonstrated how hospitals respond to regulatory change by internally shifting costs to maximize reimbursements. Other studies have estimated optimal cost structures for healthcare organizations.²⁵⁻²⁹ Collectively, these studies have focused on achieving maximum reimbursements, economies of scale, substitutability of resources, and operational efficiencies, but they have not addressed the issue of how cost management affects clinical outcomes. These previous studies have examined hospital operations under partially constrained revenues (prospective payment systems). Under managed care, hospitals increasingly have entered into contracts that pay fixed fees per member per month, regardless of resources consumed by individual patients.^{30,31} In today's world, providers must focus on cost management and minimization, rather than internal cost shifting because there are continuing constraints on revenues.

Renal dialysis is unique among opportunities to study cost management strategies in a revenue-constrained environment because (1) Medicare's End-Stage Renal Disease (ESRD) Program pays for more than 80% of all treatments, (2) ESRD fees have been fixed since inception, and (3) nominal fees per treatment did not increase between 1973 and 1999. Despite increasing healthcare costs over 25 years, dialysis clinic managers have been forced to operate under substantial revenue constraints.³² Some clinic managers have reduced costs by operating a single centrally located clinic, whereas others have established several smaller dialysis centers. Some have encouraged physicians and patients to shift from hemodialysis to peritoneal dialysis, believing the latter to be less costly. Some managers have reduced nursing costs by either employing fewer registered nurses (RNs) or substituting less skilled (less expensive) nursing staff. Any of these alternatives could create short-term savings, but these strategies could also affect clinical outcomes. Potential outcomes include health maintenance at existing level, episodic hospitalization, progressive illness, renal transplants, and death.

The research setting provides a unique opportunity to link cost management decisions to specific types of clinical outcomes. Questions remain unanswered concerning how specific cost management strategies impact cost interactions and clinical outcomes. What potential trade-offs exist among operating costs? Would a dollar saved in nursing payroll

be offset by increases in other operating costs? Will specific cost savings alter medical outcomes (eg, infections or hospitalizations)? We have addressed these questions in the present study.

... METHODS ...

Sources of Data

The data for this study included 120 consecutive months of financial and clinical outcomes data for 6 related dialysis clinics for fiscal years 1990 through 1999. All 6 clinics were located in Missouri, and all were owned by a single national dialysis company. Clinics 1 and 2 operated in larger communities and had direct access to local hospitals. The remaining 4 clinics provided hemodialysis services in smaller, mostly rural communities, although clinic 5 operated in close proximity to a local hospital. Cross-sectional cost analyses were possible because each clinic used standard accounting software and expenditure classifications. As shown in **Table 1**, 628 complete observations were obtained from the possible 720 monthly observations (87%).

Clinic financial information included revenues and expenses. Monthly totals were summed annually and checked against Medicare cost reports. Total expenses were disaggregated into 5 cost categories: labor, medical supplies, drugs, laboratory costs, and indirect costs. Labor costs represented wages paid to clinical staff. Medical supply costs included all supplies required for treatments other than prescription drugs and laboratory costs. Drug costs reflected prescription drugs used during dialysis. Laboratory costs represented fees paid by each clinic to contract laboratories that complete all patient laboratory tests. Indirect costs included administrative salaries, occupancy costs, and equipment depreciation. To identify actual (real) changes in resource consumption, the cost data were adjusted for inflation. Computation of the clinical outcomes variable will be discussed later in this section.

We expected that changes in labor mix would affect outcomes because we perceived labor cost as a surrogate for clinical expertise. To test for that possibility, nonparametric tests were performed to examine the stability of clinical expertise across time, by clinic and in total. The relative expertise in each clinic (RNs, licensed practical nurses [LPNs], etc, as a percentage of total clinical staff) has remained stable (ie, relatively small χ^2 values with no statistically significant results). When we regressed clinical labor cost on full-time equivalents (FTEs), we found that FTEs explained 98% of the

variation in labor costs. Our regression results indicated that these clinics maintained consistent relative levels of clinic staff expertise, ie, as total labor costs fluctuated, the proportion of FTEs by category remained relatively constant.

In an attempt to control for changes in volume, we included only those clinics that operated during the entire 120 months of the study. We also excluded 2 related clinics that began operations during the last half of the study period. Most patients routinely received 3 dialysis treatments per week, the maximum number of treatments allowed under Medicare's clinical protocol. During the period of study, physical facilities for the 6 clinics remained the same. However, some additional machines were added at each of the clinics to meet increased patient volumes. Throughout the study period, the clinics operated at or near capacity because the addition of machines or facilities was constrained by Certificate of Need regulations.

Trend Estimation and Interaction Analyses

We anticipated that the clinics would demonstrate some degree of improved efficiency over time. Cross-sectional quarterly averages were used to approximate power (learning) curves for revenue, total cost, and each of the 5 cost categories. For comparative purposes, revenues reflected nominal

dollars, whereas quarterly cost averages were adjusted for inflation to reflect constant dollars. We used a restricted translog cost function to examine interactions among the 5 cost categories. This methodology is consistent with prior studies that approximated total hospital cost functions to examine issues involving input substitutability and economies of scale. We also considered control variables for each fiscal year and each clinic to isolate efficiencies realized within particular years or clinics. Because external prices were unavailable, we divided nominal monthly total costs for each category by the number of treatments performed to approximate exogenous input prices. Treatments delivered represent output in the cost function. A quadratic output term was considered, but was excluded from the model because it offered no additional explanatory value.

The 5 cost categories were regressed individually on variables designed to evaluate cost stickiness, cost substitutability, institutional experience effects, efficiency effects, and clinic effects. Cost stickiness represented those situations in which an increase in costs associated with an increase in volume was greater than the decrease in costs associated with an equivalent decrease in volume. For example, managers face an ongoing challenge of matching available resources with the demand for those resources.

Table 1. Summary of Factors Affecting Final Sample Size

	Individual Clinics						Total	Percent of Total Sample
	1	2	3	4	5	6		
Possible observations (10 years × 12 months)	120	120	120	120	120	120	720	100.00
Observations omitted due to the following sources of missing data:								
Clinic fees	1	1	1	2	6	3	14	1.94
Labor cost detail	0	0	0	2	0	0	2	0.28
Supply cost detail	3	4	6	8	6	10	37	5.14
Drug cost detail	5	3	3	3	7	3	24	3.33
Laboratory cost detail	2	2	0	1	1	1	7	0.97
Treatment detail	1	1	1	4	1	0	8	1.11
Final sample size	108	109	109	100	99	103	628	87.22
Percent of total sample	17.20	17.36	17.36	15.92	15.76	16.40	100.00	

This table shows the breakdown of why certain observations were omitted from the final sample.

Accordingly, some increases in volume may require large investments in capacity (higher committed costs), whereas, when volume contracts, managers may be unable to reduce committed costs proportionately. Costs are *more sticky*, therefore, when managers have less control over costs relative to volume. A lag variable (1 period) representing the prior month's cost per treatment for specific cost categories was considered as a predictor of current period costs. Interaction effects among cost categories provided evidence of cost substitutability. Each cost category variable represented the monthly *estimated* (\hat{y}) cost computed by regressing current period monthly costs on prior period monthly costs. By using estimated costs, true interaction effects can be examined because extraneous between-period variation can be eliminated from the cost variables. Institutional experience is defined as the volume of treatments, with the expectation that higher levels of experience (volume) will result in reduced costs. To further investigate potential efficiency improvement strategies, control variables were included for each fiscal year, with 1990 considered the base year. We isolated specific clinic effects by including clinic control variables.

Clinical Outcomes Effect

The clinical outcomes were weighted (severity-adjusted) hospitalizations. This variable was computed in a 3-step process. First, we identified the number of hospitalizations that occurred each month. Each clinic provided hospitalization data by unique patient identification number, date (both admission and discharge), and *International Classification of Diseases, Ninth Revision* (ICD-9) code with a brief descriptor of occurrence. Second, we linked ICD-9 codes to corresponding diagnosis-related group (DRG) codes to determine the relative severity of each hospitalization (severity-adjusted). Each hospitalization was then multiplied by the Health Care Financing Administration-determined relative weight within that DRG. The hospitalization (independent) variable represents the sum of the severity-adjusted hospital admissions across DRGs. We used a constant weighting factor (1999) to avoid the introduction of external variation into the analysis.

This effect variable was selected because it should reflect the immediate clinical result of clinic managers' cost management decisions. Because this study focused on the financial implications of variation in cost management strategies, we focused on more immediate clinical outcomes, rather than on long-term survival. Among possible clinical outcome

measures, we selected acuity-adjusted hospitalizations as the most immediate clinical indicator of patient care quality. We were not attempting to assess the impact of dialysis adequacy on patients' quality of life or survival.

We also recognize that any hospitalization decision is collaborative, involving a physician/clinic management team. This decision process inherently contains control mechanisms that monitor clinical efficacy. By adjusting for acuity, we attempted to directly account for differences in types of hospitalizations. In addition, we used 5 clinic dummy dichotomous variables to identify specific clinics and to control for potential variation in clinical practice caused by physician practice variation, patient/physician ratios, hospitalization-per-patient ratios, and clinic proximity to hospitals.

Two models were developed that regressed severity-adjusted hospitalizations (clinical outcomes) on cost variables, clinic control variables, and fiscal year control variables. Cost variables were computed by dividing total monthly inflation-adjusted costs by the corresponding number of treatments. By using monthly cost per treatment, we minimized multicollinearity problems. Clinic control variables were used to isolate clinic-specific differences, such as case mix, patient flow, and proximity to hospitals. Fiscal year control variables were included to examine whether clinics exhibited any annual differences in number of patient hospitalizations.

... RESULTS ...

Sample Characteristics

As shown in **Table 2**, clinic 1 provided significantly more dialysis treatments at higher costs per treatment than clinics 2 through 6. Clinic 1 subsidized the other 5 clinics by providing some support services without direct compensation (eg, dialysis machine maintenance, clinical consultations). Average operating costs for clinics 2 through 6 were generally the same. We analyzed the sample as a whole, and contrasted the data from clinic 1 with data from clinics 2 through 6. The split samples allowed analysis of how clinic differences affected overall results.

Trends and Interactions Among Costs

Figure 1 compares total costs and revenues per treatment. Total inflation-adjusted costs per treatment declined at a decreasing rate. The relatively high R^2 (0.52) indicates a cumulative learning curve effect that produced improved operating efficiencies

over the decade. Revenues were not adjusted for inflation to retain comparability across periods. Nominal reimbursement rates per treatment (\$129.70) from Medicare (>80% of clinics' total patients) remained unchanged during the study period. The linear trend line for revenue approximates the Medicare reimbursement rate (intercept = \$132.26). Average per-treatment revenues slightly exceeded the Medicare rate because the clinics have been able to negotiate somewhat higher reimbursement rates for non-Medicare patients over time.

Over the 10-year period of this study, revenues never appeared to cover the cost of dialysis. This gap reflects an accounting policy that recorded the cost of erythropoietin in the clinic income statements, whereas the separate reimbursements for these drugs were recorded at the corporate level.

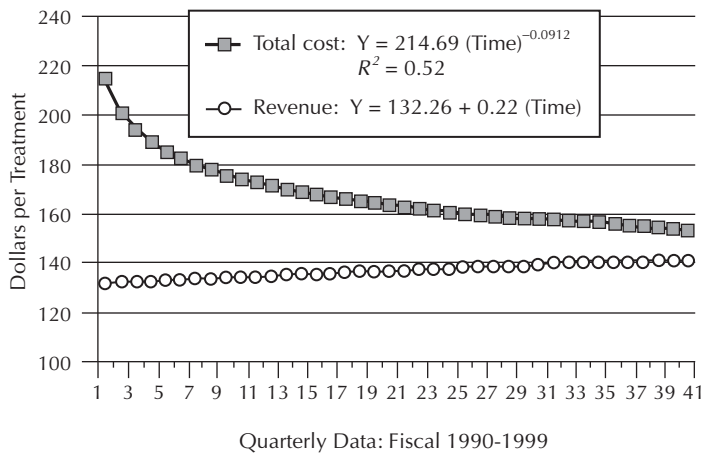
Figure 2 illustrates the trends of 4 specific cost categories: indirect costs, labor, drugs, and medical supplies. Although total cost per treatment for clinic operations declined over the 40 quarters, improved efficiencies were not realized uniformly across spe-

Table 2. Descriptive Statistics for Each of the 6 Clinics and in Total

	Clinic						Total
	1	2	3	4	5	6	
Treatments per month							
Mean	1325.18	641.27	303.03	144.75	378.41	313.89	525.98
Median	1266.00	676.00	306.00	127.00	370.00	321.00	356.00
Standard deviation	215.94	193.21	51.69	45.25	97.06	90.61	415.88
Revenue							
Mean	143.74	137.62	131.28	130.89	123.95	128.92	132.92
Median	143.66	137.07	128.77	130.57	123.74	123.82	131.15
Standard deviation	15.74	20.54	21.72	22.83	9.02	25.58	21.55
Labor costs							
Mean	71.18	41.59	46.53	49.71	41.28	41.45	48.76
Median	69.11	40.46	45.95	49.31	41.28	39.27	44.72
Standard deviation	8.88	9.37	8.46	10.56	5.67	9.31	13.85
Medical supply costs							
Mean	22.59	14.11	13.28	14.10	13.81	15.86	15.66
Median	19.81	11.46	11.98	11.15	9.84	12.39	12.41
Standard deviation	13.49	17.17	10.05	15.84	17.16	24.52	17.13
Drug supply costs							
Mean	35.28	27.53	29.57	29.16	31.10	29.90	30.43
Median	37.60	27.68	29.30	28.79	29.00	29.05	29.76
Standard deviation	12.90	12.68	12.89	11.85	12.62	9.74	12.38
Laboratory supply costs							
Mean	2.52	1.75	1.67	1.73	1.64	2.05	1.90
Median	2.08	1.47	1.57	1.62	1.54	1.57	1.61
Standard deviation	3.11	1.99	0.87	1.00	0.83	3.78	2.27
Indirect costs							
Mean	79.37	35.60	44.97	56.26	38.64	52.84	51.35
Median	76.27	35.52	44.82	52.63	40.38	52.10	47.53
Standard deviation	14.39	8.65	24.20	34.25	20.49	31.88	27.94
Weighted hospitalizations							
Mean	43.55	10.45	5.72	4.14	8.05	5.78	13.14
Median	43.90	8.77	4.75	3.10	6.95	4.77	6.73
Standard deviation	17.18	8.27	3.94	3.77	6.01	3.83	16.45

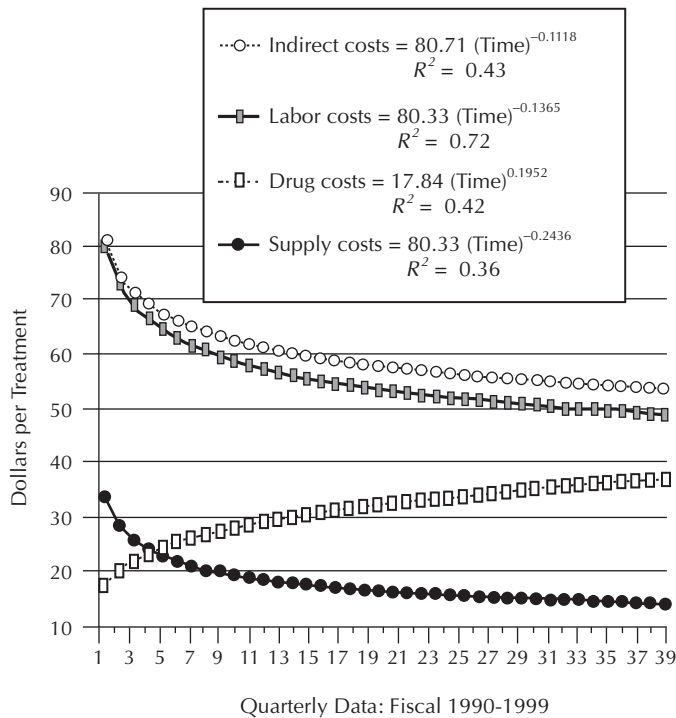
The costs represent inflation in US dollars (\$) adjusted per treatment costs. The results were computed using 628 observations.

Figure 1. Trends in Total Costs and Revenue to the 40 Quarters of Data



The trend lines represent the models fitted from the quarterly average data of the 6 clinics in this study.

Figure 2. Trends in Total Costs



The trend lines represent the models fitted from the quarterly average data determined using the 6 clinics in this study.

cific cost categories. Cumulative learning curve effects were found for indirect costs ($R^2 = 0.43$), labor ($R^2 = 0.72$), and medical supplies ($R^2 = 0.36$). These results are consistent with cumulative clinic learning rates of approximately 85%. Inconsistent with our initial expectation, drug costs increased at a decreasing rate ($R^2 = 0.42$). Laboratory costs were excluded from Figure 2 because they remained virtually constant across the 10-year period because of clinic contracts with outside laboratories. These initial trend results led us to investigate the relative substitutability of these costs.

Table 3 presents the results of 3 cost interaction models: combined clinics (model 1), clinic 1 only (model 2), and clinics 2 through 6 (model 3). As expected, the R^2 for each model was close to 1.0, typical for cost function approximation. Each individual cost variable and the treatment variable were statistically significant in each of the 3 models. The treatment coefficient (0.870) indicated the existence of potential economies of scale (ie, coefficient < 1.0). Model 2 identified clinic 1 as the source of these scale efficiencies (coefficient = 0.629), whereas the results for model 3 demonstrated that the smaller clinics in the group failed to realize similar efficiencies. The clinic control variables indicate that clinic 3, after controlling for other factors, operated at a somewhat lower cost than other clinics. Also, the fiscal year control results, although overall not consistently statistically significant, demonstrated possible trends in the data over time.

Table 4 provides the results of regression analysis designed to investigate potential trends (price effects) in the data along with issues involving cost stickiness, cost interaction (substitutability), experience, cost subsidization, and clinic effects. Clinical labor and indirect costs demonstrated the strongest effects. Both clinical labor ($\beta = 0.444$) and indirect costs ($\beta = 0.447$) had characteristics of cost stickiness (ie, costs were difficult for managers to change from 1 period to the next). These costs also appeared to be subsidized significantly by clinic 1 (labor, $\beta = 0.131$; indirect costs, $\beta = 0.343$). Furthermore, labor and indirect costs appeared to have the only significant

clinic effects with clinics 2, 3, and 5 having higher labor costs, and clinics 2 through 5 having lower indirect costs than clinic 6. Medical supplies also demonstrated cost stickiness to a lesser extent. In terms of experience effects, labor costs ($\beta = -1.015$) and medical supply costs ($\beta = -0.163$) declined as institutional experience increased.

As shown in Table 4, only labor costs provided statistical evidence of an upward price trend over time. Using 1990 as the base year for comparison, labor costs increased each year (except for a small decline in 1998) relative to the previous year. For example, compared with labor costs in 1990, the price of labor in 1994 was significantly higher ($\beta_{1994} = 0.776$). The trend continued in 1995 relative to both 1990 and 1994 ($\beta_{1995} = 0.918 > \beta_{1994} = 0.776$). Given the inflation-adjusted nature of the cost variables, this trend indicates smaller rural clinics pay a wage premium to attract and retain clinical staff.

Impact of Costs on Clinical Outcomes

Table 5 presents the results of 2 clinical outcomes models: an aggregate cost model (model 1), and a cost decomposition model (model 2). Overall, each model was statistically significant ($P < .01$) with R^2 of 0.769 (model 1) and 0.771 (model 2), respectively. As shown in model 2, the higher cost of drugs per treatment ($P < .01$) coincided with higher weighted (severity-adjusted) hospitalizations and somewhat offset the marginal cost savings in labor, supplies, and laboratory costs. Clinics 1, 2, and 5 had higher levels of hospitalizations relative to the base clinic used for

comparison (clinic 6). As previously mentioned, these clinics operated in close proximity to community hospitals. Furthermore, clinic 1 provided contract dialysis services for a local teaching hospital. These results were consistent across model 1 and model 2. The cost management strategies examined in the dialysis centers studied were not shown to significantly affect acuity-adjusted hospitalization rates.

The fiscal year control variables highlighted that weighted hospitalizations generally have been

Table 3. Analysis of 3 Total Cost (Dependent Variable) Models Using a Restricted Translog Transformation Model

Explanatory variables	Model 1 (All Clinics)	Model 2 (Clinic 1 Only)	Model 3 (Excludes Clinic 1)
In clinical labor rate	0.119 [†]	0.115 [†]	0.139 [†]
In clinical supply rate	0.074 [†]	0.171 [†]	0.121 [†]
In drug rate	0.089 [†]	0.202 [†]	0.150 [†]
In laboratory rate	0.015 [†]	0.032*	0.027 [†]
In indirect costs rate	0.134 [†]	0.244 [†]	0.193 [†]
In treatments	0.870 [†]	0.629 [†]	1.059 [†]
Control variables (clinic)			
Clinic 1	-0.014	NA	—
Clinic 2	-0.007	NA	-0.012
Clinic 3	-0.010 [†]	NA	-0.019*
Clinic 4	0.000	NA	-0.002
Clinic 5	-0.002	NA	0.003
Fiscal year control variables			
1991	0.027 [†]	0.104 [†]	0.045 [†]
1992	0.014 [†]	0.025	0.025*
1993	-0.001	0.036	-0.002
1994	0.004	0.067*	0.004
1995	-0.001	0.062*	-0.003
1996	-0.003	0.082*	-0.010
1997	0.005	0.076	0.005
1998	0.010	0.067	0.015
1999	0.012	0.100*	0.019
N	558	104	474
F	4596.66	334.12	1346.58
P<	.001	.001	.001
Adjusted R ²	0.994	0.980	0.982

Cost variables represent the natural log of the cross-sectional monthly costs per treatment (input prices). Output in the model is defined as the natural log of treatments. We report the standardized regression coefficients.

*Significant at $P \leq .05$.

[†]Significant at $P \leq .01$.

NA = not applicable.

Table 4. Regression of the Cost Per Treatment of Individual Cost Categories on Explanatory Variables

	Labor	Medical Supplies	Drug	Laboratory	Indirect Costs
Lag variables—cost stickiness (1 period lag)					
In clinical labor rate	0.444 [†]	—	—	—	—
In medical supply rate	—	0.155 [†]	—	—	—
In drug rate	—	—	0.017	—	—
In laboratory rate	—	—	—	0.019	—
In indirect costs rate	—	—	—	—	0.447 [†]
Estimated variables—cost substitutability					
In clinical labor rate	—	-0.056	-0.038	-0.052	0.144
In medical supply rate	0.013	—	0.066	-0.069	-0.047
In drug rate	0.001	0.033	—	0.018	0.020
In laboratory rate	-0.008	0.027	0.028	—	0.024
In indirect costs rate	0.029	0.046	0.028	0.046	—
Additional explanatory variables—experience effect and cost-subsidization effect					
In cumulative treatments	-1.015 [†]	-0.163*	-0.067	-0.272	-0.077
In clinic 1 cost per treatment	0.131*	-0.284	0.254 [†]	0.067	0.343 [†]
Fiscal year control variables—price effects					
1991	0.043	-0.034	-0.180 [†]	0.003	-0.160 [†]
1992	0.256 [†]	-0.138	0.004	0.088	-0.078
1993	0.596 [†]	0.286	0.162	0.231	-0.151
1994	0.776 [†]	0.413	0.109	0.301	-0.159
1995	0.918 [†]	0.331	0.128	0.319	-0.134
1996	0.893 [†]	0.291	0.180	0.331	-0.121
1997	0.967 [†]	0.330	0.222	0.545	-0.174
1998	0.928 [†]	0.353	0.228	0.532	-0.195
1999	1.099 [†]	0.440	0.247	0.521	0.235
Clinic control variables					
Clinic 2	0.325 [†]	0.119	-0.011	0.080	-0.301 [†]
Clinic 3	0.275 [†]	0.027	0.026	0.099	-0.160 [†]
Clinic 4	-0.053	-0.108	-0.088	-0.081	-0.099 [†]
Clinic 5	0.094*	-0.108	0.058	0.058	0.206*
N	396	396	396	396	396
F	18.12	3.818	2.793	5.479	36.02
P	<.001	<.001	<.001	<.001	<.001
Adjusted R ²	0.464	0.125	0.185	0.075	0.639

Explanatory variables included cost stickiness (lag variables as predictors), cost interactions, experience (cumulative treatments), cost subsidization being provided by Clinic 1, price effects (fiscal year control variables), and clinic effects (clinic control variables). The analyses were performed across 5 clinics. Standardized regression coefficients are reported.

*Significant at $P \leq .05$.

[†]Significant at $P \leq .01$.

increasing throughout the 10-year period of this study. The regression coefficients on these variables were statistically significant for 1992 through 1999. Each coefficient was positive, indicating that relative to the base year (1990), hospitalizations exceeded 1990 hospitalizations in each subsequent year. In 6 of 9 years, the relative size of the coeffi-

cients also increased relative to the preceding fiscal year. Model 2 results illustrate the trend of increasing hospitalization rates during the periods 1991 through 1994 ($\beta_{1991} = 0.030 < \beta_{1992} = 0.079 < \beta_{1993} = 0.090 < \beta_{1994} = 0.123$), and 1996 through 1998 ($\beta_{1996} = 0.091 < \beta_{1997} = 0.152 < \beta_{1998} = 0.211$). This result was statistically significant after controlling for clin-

ic effects (eg, case mix) and changes in resource consumption patterns (ie, costs per treatment). Clinic managers appeared to identify complications and refer patients for hospitalization as an effective cost management strategy.

... DISCUSSION ...

The results of this study indicate that, in a revenue-constrained environment, managers use multiple cost management strategies in an effort to realize sustainable savings without risking inappropriate increases in hospitalization rates. Our ultimate objective was to identify cost and organizational characteristics that affect cost management effectiveness. We chose renal dialysis for our study because these real fees have been fixed at nominal rates since Medicare's ESRD Program was enacted. Adjusted for inflation, these real fees per patient per treatment have declined 65%, forcing clinics to manage and minimize costs. Medicare established through its ESRD Program, in effect, the first fixed-fee managed care contract for treating a specific disease. Dialysis clinics have survived by implementing cost management strategies. Inefficient operations consumed excessive economic resources, resulting in reduced (if not negative) cash flows. Most new centers opened in the 1990s were for-profit clinics that depended on cost management for their profitability. As for-profit centers entered the market, Medicare was able to preserve its fixed nominal reimbursement rate. Today, more than 80% of all patients receiving routine dialysis treatments are covered under Medicare's ESRD Program, making the program a \$15.6 billion industry, serving more than 200,000 patients.

Typically, an organization's profitability depends on managing both costs and revenues. In a revenue-constrained environment, cost management deci-

Table 5. Results From 2 Regression Models That Examined the Impact of Inflation-Adjusted Costs Per Treatment and Control (Clinic and Fiscal Year) Variables on Clinical Outcomes (Severity-Adjusted Hospitalizations)

	Model 1 (Aggregate Costs) Standard Coefficient	Model 2 (Disaggregate Costs) Standard Coefficient
Cost variables		
Total cost/treatment	0.023	—
Labor costs/treatment	—	-0.042
Medical supply costs/treatment	—	-0.016
Drug supply costs/treatment	—	0.056 [†]
Lab supply costs/treatment	—	-0.003
Indirect costs/treatment	—	0.023
Clinic control variables		
Clinic 1	0.861 [†]	0.892 [†]
Clinic 2	0.117 [†]	0.122 [†]
Clinic 3	0.004	0.010
Clinic 4	-0.037	-0.027
Clinic 5	0.057*	0.055*
Fiscal year control variables		
1991	0.036	0.030
1992	0.089 [†]	0.079 [†]
1993	0.111 [†]	0.090 [†]
1994	0.143 [†]	0.123 [†]
1995	0.133 [†]	0.109 [†]
1996	0.118 [†]	0.091 [†]
1997	0.184 [†]	0.152 [†]
1998	0.247 [†]	0.211 [†]
1999	0.229 [†]	0.194 [†]
N	628	628
F	138.79	110.83
P	.001	.001
Adjusted R ²	0.769	0.771

Standardized regression coefficients are reported.

*Significant at $P \leq .05$.

[†]Significant at $P \leq .01$.

sions become critical because cost management mistakes cannot be offset by increases in volume or price. When revenues are constrained, managers must choose from 5 possible cost management alternatives: (1) selective reductions in targeted cost categories, (2) cost reductions realized through improved efficiencies, (3) cost avoidance by shifting financial responsibilities to external parties, (4) uniform reductions across all cost categories, and (5) cost shifting through internal allocations to maximize reimbursement revenues and cost recovery. For dialysis clinic managers, the first 4 alternatives were considered possible; the fifth, shifting internal

costs to maximize revenue, was not an option. In this study, therefore, we examined the effectiveness of 4 cost management strategies: selective cost reductions, realization of operational improvements, external cost shifting by identifying more accurately when patients needed referrals to hospitals, and uniform cost reductions.

First, we examined how changes in cost categories interact, ie, how cost reductions in 1 component of a clinic's cost structure affect other cost categories. For example, managers might target labor for cost reduction by either reducing the number of RNs, or substituting LPNs for RNs. The underlying assumption behind this strategy was that significant interactions among resources may occur, and that substantial substitutability may exist. Our results indicated that substitutability is limited among clinic resources. Furthermore, the relative cost stickiness of clinical labor, indirect costs, and medical supplies indicates that managers do not have much flexibility when it comes to selective cost management strategies. These results also provided no evidence that managers implemented a uniform cost reduction strategy.

Second, we investigated the role that cumulative clinic volume (institutional experience) plays in the realization of cost savings through improved operational efficiency. Experience appeared to reduce overall costs somewhat, although statistically significant cost reductions were realized for only labor and medical supplies. The relatively mature technology and treatment protocol associated with dialysis, we believe, limited managers' ability to count on institutional experience to assure improved efficiency over time. Given the rapid learning effects demonstrated in Figure 2, we conclude that experience could result in greater efficiency gains in less mature clinical areas.

Third, we examined whether clinics attempted to shift costs to external parties by increasing the frequency of severity-adjusted patient hospitalizations over time. ESRD patients typically require hospitalization 1 or more times each year to treat complications. Dialysis clinics play a critical role as an early warning system by identifying unstable toxicity levels, internal infections, and other episodic problems that result from chronic kidney disease. Timely recognition of these problems and prompt referrals to hospitals improve patient health and reduce clinic costs. The rate of hospitalizations generally increased over the 10-year period of this study. Timely identification of complications and subsequent hospitalizations represented an expected and

positive outcome of clinic treatment and an effective cost management strategy. Some of this trend, however, may have reflected changes in physician practice patterns: physicians are prescribing dialysis for older patients (who generally experience more complications than younger dialysis patients), and for younger patients with many complications. The physician/clinic manager teams identify complications and refer patients for hospitalization as an effective cost management strategy.

Overall, our results have provided evidence that managers, in this limited setting, actively pursue 3 cost management strategies. Selective cost reduction, cost reduction by realized operational efficiencies, and external cost shifting appear to provide sustainable cost savings over time. Moreover, no evidence was found to indicate that managers compromised quality of care for cost reduction. We recognize that other possible measures of clinical outcomes and quality exist. If we had compared costs with alternative outcome measures (eg, mortality rates, nonhospitalized complications, clinical laboratory measurements of dialysis adequacy, or even patient satisfaction), we could have gotten different results. Truly sustainable cost savings require that physician/clinic manager teams monitor both cost and clinical process to assure that the quality of care is not sacrificed in the name of cost management.

We documented 3 additional findings that could affect managers' cost management strategies. The first 2 involved economies of scale and increasing wage pressure. The third involved cost subsidization among clinics. Clinic 1 realized substantial cost savings due to economies of scale. When clinical procedures follow relatively routine methods, clinic size and the volume of procedures apparently result in scale efficiencies and lower costs. Clinics 2 through 5 failed to realize any economies of scale. Regarding wages, upward wage pressures for clinics 2 through 5 exacerbated their economies-of-scale problem. This result may have reflected a price premium that rural clinics must pay to obtain clinical staff comparable to the staff employed by clinics in larger communities. To some extent, this result may indicate that attracting skilled labor to a rural setting is becoming more costly. However, reimbursement schemes may incorrectly assume lower cost structures in rural areas.

Regarding cost subsidization across facilities, we recognized that healthcare organizations frequently operate at several sites. A lead location may provide other sites in the group with indirect support

through consultation or direct support by transferring supplies or drugs. Although the transfer of direct costs is often monitored through formal costing systems (eg, inventory management), indirect support costs may not be charged to the other sites consuming these services. Accordingly, individual sites may be incorrectly evaluated in terms of cost efficiencies when their cost structure fails to reflect cost subsidizations that actually occur among facilities. Managers may incorrectly perceive certain sites as more or less efficient in terms of costs, depending on the level of cost subsidy they receive or provide. Consequently, managers could make decisions regarding facility closure or expansion based on inaccurate cost information.

In terms of demographics, the 1999 United States Renal Data System (USRDS) Annual Report indicated that dialysis patients in Missouri are similar to those in the rest of the country.^{33,34} Nationally, the average number of patients per dialysis station per day was 4.1. The 5-year increase in the number of patients was 45%. More than 84% of ESRD patients received hemodialysis treatments, average patient age was 61, 53% were male, 63% were white, 29% were African-American, 44% began dialysis because of diabetes, and 96% had fewer than 3 comorbidities (65% had fewer than 2). The average number of hospitalizations per patient was 1.4 (regardless of age), average length of stay was 8.2 days, and total annual hospital days per patient totaled 11.7 days. USRDS used length of stay as a proxy for severity-adjusted hospitalizations. Our results were consistent whether we used weighted hospitalizations or length of stay as our clinical outcome variable.

In summary, our results have provided evidence, in the specific setting of dialysis clinics, that 3 cost management strategies are effective, but to different degrees. Managers recognize that potential cost trade-offs, and both the level and mix of costs, may impact sustainable and effective savings over time. However, the relative lack of substitutability among resources and their relative cost stickiness limit the potential for effectively implementing a selective cost reduction strategy. We also found that institutional experience resulted in operating efficiencies and cost reductions. In a stable and mature clinical environment, however, managers may be unable to sustain cost reductions through improved operational efficiencies. The cost management strategy that managers used most effectively over time was referral of patients to hospitals to avoid the episodic costs of complications. Nonetheless, this cost reduction strategy may not be sustainable for dialysis clin-

ics in the future, because hospitals may also find their revenues constrained when providing these services. Finally, we observed that economies of scale, upward wage pressures, and cost subsidization are important to analyzing the effectiveness of cost management strategies. We recognize, however, that our study included a limited set of related dialysis clinics serving a relative homogeneous population (ie, economic conditions, patient access to care, and physician preferences), and therefore our results may not be generalizable to clinics of differing size, patient mix, or in varying relationships with other healthcare facilities.

Today's healthcare environment reflects many of the same characteristics found in dialysis clinics. Hospital administrators face constrained revenues because of managed care and capitated contractual relationships among third-party payers. Opportunities for internal cost shifting to maximize reimbursements have continued to diminish as fixed-fee payment models have been implemented. Most healthcare providers recognize the importance of implementing effective cost management strategies. Analysis of ESRD cost management strategies, therefore, may be instructive for the healthcare industry as a whole because ESRD reflects well the managed care environment faced by most healthcare administrators today.

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