

The Vermedx[®] Diabetes Information System Reduces Healthcare Utilization

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Objective: To confirm the cost savings in a randomized clinical trial of the Vermedx Diabetes Information System (hereafter referred to as the Diabetes Information System [DIS]) in independently collected data using claims paid by a managed care insurer for patients with and without DIS participation.

Study Design: Longitudinal analysis of paid claims with concurrent and historical controls from October 2002 through October 2007.

Methods: Using locally weighted smoothing functions and linear regression analysis before and after commencement of the DIS, we compared the total claims paid per member per month for 153 patients using the DIS versus 870 control patients.

Results: For DIS patients, paid claims increased at a rate of \$8.30 (95% confidence interval [CI], \$1.12-\$15.48) per month before the DIS started compared with -\$3.92 (95% CI, -\$9.50 to \$1.67) after commencement of the DIS ($P = .008$). For control patients, the slope changed from \$6.80 (95% CI, \$3.78-\$9.82) to \$3.16 (95% CI, -\$1.06 to \$7.38) ($P = .17$). After commencement of the DIS, the slope of the claims in the DIS group is significantly lower than that of the control group (-\$3.92 vs \$3.16, $P = .046$). The mean estimated savings range from \$504 per patient in year 1 of operations to \$3563 in year 4. The cumulative net savings reach \$8134 in 4 years.

Conclusions: Participation in the DIS is associated with substantial reductions in claims paid, net of the costs of the intervention. The cost savings reported in the randomized clinical trial of the DIS are reproduced in an independent data set.

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Although effective therapies are available, diabetes care remains far from optimal,¹ and the morbidity, mortality, and economic burdens of the disease continue to grow. The estimated cost of diabetes mellitus in the United States in 2007 was \$174 billion, including \$116 billion in healthcare utilization and \$58 billion in reduced productivity.²

The Vermedx Diabetes Information System (hereafter referred to as the Diabetes Information System [DIS]), originally the Vermont Diabetes Information System, is a laboratory-based registry and decision support system based on the chronic care model.³ It is designed for low-cost and easy integration into primary care. It requires no additional staff, office space, or capital investment by participating practices. The practices need not use office computers or electronic medical records, although the DIS can easily integrate with them. The DIS costs less than \$50 per patient per year in most settings. A recent randomized clinical trial in 64 practices with 132 primary care providers and 7412 adults with diabetes showed significant improvements in clinical care (adherence to laboratory testing guidelines) (B.L. and C.D.M., unpublished data, 2008). Although no change in physiologic control was observed, the intervention group reported substantially lower hospital, emergency department, and physician utilization. Total savings were estimated at \$2426 per patient per year ($P = .03$). One of the limitations of this analysis was that utilization was estimated from patient self-report.

Our objective was to confirm these findings using actual claims. We assessed the effects of the DIS on resource utilization using independently collected data from another source.

METHODS

Intervention

The DIS has been described previously.^{4,5} The system receives laboratory results (glycosylated hemoglobin and cholesterol levels and kidney function) from clinical laboratories, maintains a registry, and produces reports for primary care providers and their patients. Reports are automatically generated whenever a laboratory test is completed and include flow sheets with guideline-based recommendations for the providers and alert letters for

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the patient (when results are above target). When test results are overdue, a reminder is sent to the patient and the practice. Population reports listing all the provider's patients are sent to the provider quarterly, along with a report card indicating population-level performance. Reports are mailed to patients and are sent electronically or by fax to the practices. The system is not linked to any pay-for-performance incentives.

Setting and Subjects

Vermont Managed Care, Inc (VMC) is a physician hospital organization serving 31,673 covered lives in Vermont. Practices began participation in the DIS in May 2003 through February 2008. All adults with diabetes covered by VMC were included, regardless of which practice they attended. Adults with diabetes covered by VMC and receiving primary care from participating practices were enrolled in the DIS when their practice first participated. All other adults with diabetes covered by VMC were included as control subjects.

Analysis

Claims paid for all covered services from October 2002 through October 2007 were aggregated per patient per month. Patient-months with no claims were set to zero if the patient was covered that month. For DIS subjects, each patient-month was assigned a number relative to the time the patient was first entered into the DIS. The month of DIS enrollment was assigned as zero. Negative numbers represent the number of months before starting the DIS, and positive numbers represent the number of months in the DIS. For control patients, a random month was chosen during the time of coverage to represent the "zero month."

The DIS and control patients were compared using Wilcoxon signed rank sum test for continuous variables or χ^2 test for categorical variables. The relationship between claims paid and time was estimated using nonparametric locally weighted smoothing functions⁶ and 2-piece ordinary least squares linear regression analysis with adjustment for clustering within members.⁷ Two-tailed $P < .05$ represented statistical significance.

This study was performed in accordance with ethical research standards. The research protocol was approved by the University of Vermont Committees for the Protection of Human Subjects.

RESULTS

The utilization records of 153 patients participating in the DIS and of 870 control patients were analyzed. All claims

paid for the period of analysis were available, with no missing data. The DIS subjects received 193 alert letters (0.8 per patient per year) and 764 reminder letters (3.3 per patient per year). Their providers received 818 flow sheets (3.6 per patient per year) and 725 reminders (3.1 per patient per year). Overall, the system generated 2500 reports (10.7 per patient per year). The control patients and providers received none. Fifty-five percent of the subjects were male. The mean age at enrollment was 52.4 years, with 7.8% being 65 years or older at enrollment. The mean period of enrollment was 44.5 months. The DIS patients had longer periods of observation and fewer paid claims per month (Table 1). The number of subjects contributing data varied from 11 control and 21 DIS subjects at 48 months before the start of the DIS, to 860 control and 131 DIS subjects at the start of the DIS, to 89 control and 18 DIS subjects at 48 months after the start of the DIS.

The nonparametric curve of claims paid per member per month as a function of time relative to starting the DIS has a distinct inverted-U shape (Figure 1), with the peak at 9 months after the start of the DIS. For control patients, the curve continues to rise without decline.

Fitting a straight line to the data for the period before the start of the DIS (Figure 2) shows that paid claims increased at a rate of \$8.30 (95% confidence interval [CI], \$1.12-\$15.48) per month. A second line that was fit to the data after the DIS started decreased, with a slope of $-\$3.92$ (95% CI, $-\$9.50$ to $\$1.67$) per month. The difference between the 2 slopes is highly statistically significant ($P = .008$). For control patients, the slope changed from $\$6.80$ (95% CI, $\$3.78$ - $\$9.82$) to $\$3.16$ (95% CI, $-\$1.06$ to $\$7.38$) per month ($P = .17$). The slopes of the 2 lines for the earlier period are not significantly different ($\$8.30$ vs $\$6.80$, $P = .70$).

A later phase was assessed (after the start of the DIS or the random control date). At that time, the slope of the claims in the DIS group is significantly lower than that of the control group ($-\$3.92$ vs $\$3.16$, $P = .046$).

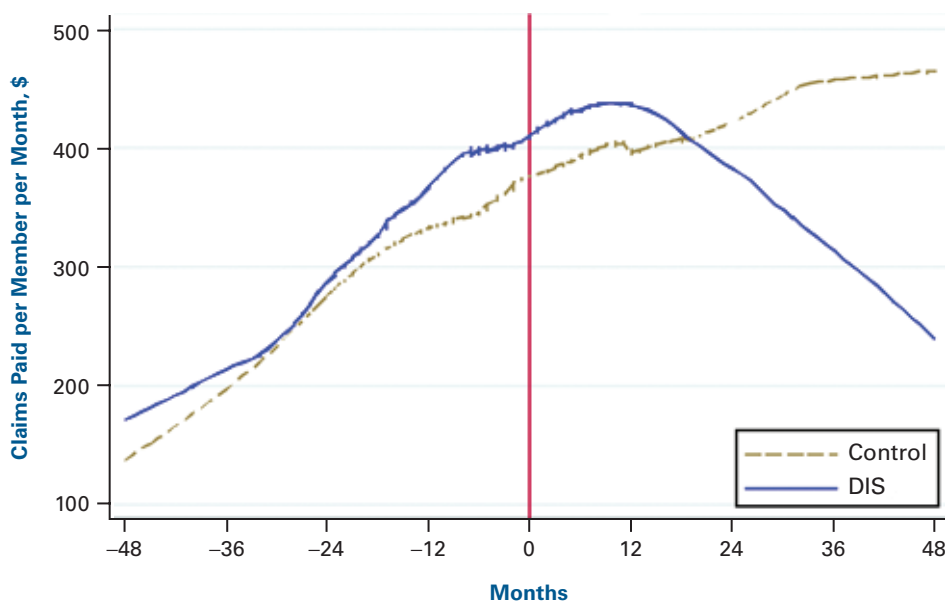
We estimated the savings due to the DIS by subtracting the claims paid during the DIS from the claims expected based on extrapolation of the control experience (Table 2). The savings grow larger each month as the 2 data lines diverge. In the first month of the program, the difference in claims paid is negligible. By the end of the first quarter of operations, DIS patients had \$30.48 less in claims than other patients with diabetes. In the first year, the mean estimated savings is \$504 per patient. Savings in the following years are \$1524 in year 2, \$2543 in year 3, and \$3563 in year 4. For the 12 months ending 32 months after the program commencement (the period analyzed in the randomized clinical trial), the net reduction in claims paid is \$2203. The cumulative net savings reach \$8134 in 4 years.

■ **Table 1.** Characteristics of Vermont Managed Care, Inc Patients With and Without Diabetes Information System (DIS) Participation

Characteristic	Control (n = 870)	DIS (n = 153)	P ^a
Male sex, %	55	54	.83
Age, y			
Mean	52.0	55.0	
Median	54	56	.08
Range	18-93	33-74	
Age ≥65 y, %	7	10	.30
Observation time, mo			
Mean	43.4	50.7	
Median	51	61	<.001
Range	1-66	3-66	
Total	37,736	7762	
Claims paid per member per month, \$			
Mean	357	344	
Median	0	36	<.001
Range	0-304,152	0-187,414	

^aSignificance was assessed by Wilcoxon signed rank sum test or by χ^2 test.

■ **Figure 1.** Claims Paid per Member per Month Estimated Using Nonparametric Locally Weighted Smoothing Functions



The vertical line represents the start date for Diabetes Information System (DIS) patients and a randomly chosen date for control patients.

Repeat analyses included patient age, insurance plan, and length of observation as covariates and excluded high-cost patient-months and patients with high total costs. These analyses gave very similar results.

costs, the data were limited by patient recall as the source of utilization estimates. Although potentially confounded, the claims analysis uses objective claims data that are not subject to recall bias. The similarity of the results of 2 analyses sup-

DISCUSSION

These data from an independent data source support the findings of the randomized clinical trial of the DIS in which the intervention was associated with savings of \$2426 per patient per year after 32 months. The comparable savings from the present analysis total \$2203. Start-up costs of \$5000 to \$15,000 per laboratory are usual. The ongoing operation costs of the DIS total less than \$50 per patient with diabetes per year. Although the randomized clinical trial data were unlikely to be confounded by differences in the randomized groups or by secular trends in

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ports the conclusion that the DIS is responsible for the observed reductions in costs.

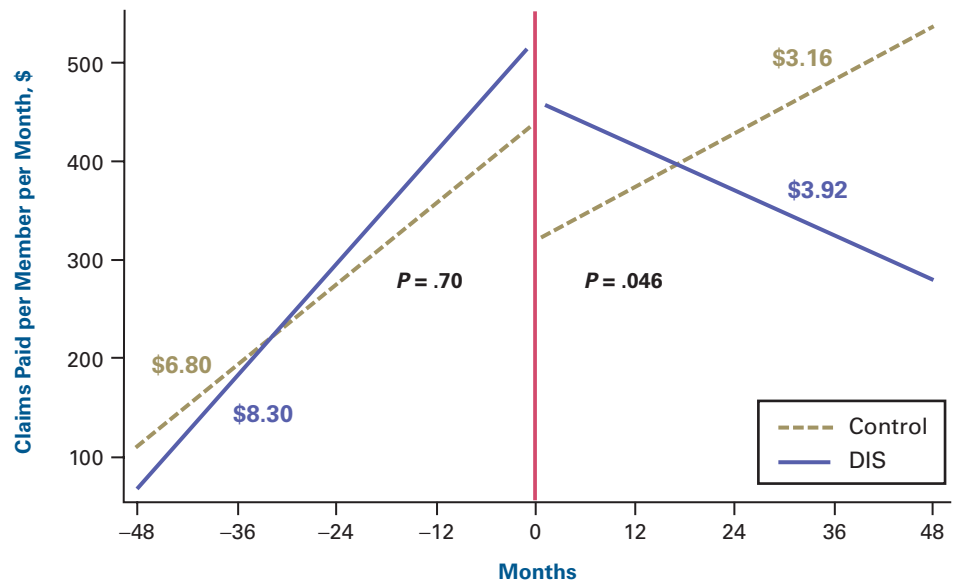
The mechanism whereby the DIS reduces utilization is unknown. In the randomized clinical trial, glycemic control, cholesterol level, blood pressure, and self-care behaviors were largely unchanged. Therefore, the savings seen in that study, and again herein, are unlikely to be related to the prevention of vascular complications. It is possible that letters from the DIS reduce patients' concerns about being ignored or lost to follow-up. With confidence that the provider is paying attention to their needs, patients may be more willing to accommodate or tolerate a minor symptom versus obtaining unscheduled care from the provider, emergency department, or hospital. Further research regarding patient perspectives on decision support and reminder systems, as well as the DIS in particular, is warranted.

Because the DIS does not directly change the flow of patients through the practice or require data entry, new staffing, or capital equipment, it is well accepted by primary care practices. Likewise, patients are generally pleased with the service. Less than 3% of patients opt not to participate in the DIS.⁸

What would be the economic effect of wide deployment of the DIS? The number of US adults diagnosed as having diabetes in 2007 was 17.4 million.² Assuming that only 75% receive primary care and 5% of those patients will refuse the service, and conservatively estimating savings at \$2000 per patient per year after deducting the costs of the service, healthcare utilization could be reduced by \$24 billion per year in America.

This analysis is subject to certain limitations. The sample is small and represents 1 insurer in 1 region. Paid claims per

Figure 2. Claims Paid per Member per Month Estimated Using 2-Piece Ordinary Least Squares Linear Regression Analysis



The vertical line represents the start date for Diabetes Information System (DIS) patients and a randomly chosen date for control patients. The numbers indicate the slopes of the lines in dollars per patient per month.

Table 2. Net Savings per Patient as a Function of Duration of the Diabetes Information System^a

Duration, mo	Savings, \$		
	Monthly	Annual	Cumulative
12	80.96	504.24	504.24
24	165.92	1523.76	2028.00
36	250.88	2543.28	4571.28
48	335.84	3562.80	8134.08

^aSavings are calculated net of the costs of the program.

month are variable, with positive outliers. However, eliminating extreme outliers had little effect on the results. As in any nonrandomized study, the observed associations may be confounded by unmeasured differences between the 2 groups. The results seen herein do not apply to other disease management, cost reduction interventions, or conditions.

In conclusion, participation in the DIS is associated with substantial reductions in claims paid, net of the costs of the intervention. Savings range from \$504 per patient in the first year of participation to \$3563 in the fourth year. Therefore, the cost savings reported in the randomized clinical trial of the DIS are reproduced in an independent data set.

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Take-Away Points

Diabetes mellitus continues to be a major source of morbidity, mortality, and healthcare utilization.

- The Vermedx Diabetes Information System is a low-cost provider-friendly decision support system for the primary care of adults with diabetes.
- The system results in improved care and reduction in the total costs of care.
- Net savings range from \$504 per patient in year 1 of operations to \$3563 in year 4.

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Author Disclosure: Drs Littenberg and MacLean hold equity in Vermont Clinical Decision Support, LLC, which distributes the Vermedx Diabetes Information System. Mr Zygarowski, Ms Drapola, Dr Duncan, and Mr Frank are employees of Vermont Managed Care, Inc, which purchases Vermedx Diabetes Information System services for its subscribers.

Authorship Information: Concept and design (BL, CDM, KZ, BHD, CRF); acquisition of data (BL, CDM, KZ, CRF); analysis and interpretation of data (BL, CDM, BHD, JAD, CRF); drafting of the manuscript (BL, JAD); critical revision of the manuscript for important intellectual content (BL, CDM, KZ, BHD, JAD, CRF); statistical analysis (BL, CRF); provision of study materials or patients (KZ, CRF); obtaining funding (BL); and administrative, technical, or logistic support (KZ, BHD).

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