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The Effect of the Vermont Diabetes Information System on Inpatient and Emergency Department Use: Results from a Randomized Trial

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ABSTRACT

OBJECTIVE: To describe the effect of the Vermont Diabetes Information System (VDIS) on hospital and emergency department use.

DATA SOURCE: Statewide discharge database.

STUDY DESIGN: Randomized controlled trial of a decision support system for 7412 adults with diabetes and their 64 primary care providers.

DATA COLLECTION/DATA EXTRACTION: Charges and dates for hospital admissions and emergency department care in Vermont during an average of 32 months of observation. Data from New York hospitals were not available.

RESULTS: Patients randomized to VDIS were admitted to the hospital less often than control subjects (0.17 admissions vs 0.20; $P = .01$) and generated lower hospital charges ($3113 vs $3480; $P = .019$). VDIS patients also had lower emergency department utilization (0.27 visits vs 0.36; $P < .0001$) and charges ($304 vs $414; $P < .0001$). The intervention was particularly effective in men and in older subjects.

CONCLUSIONS: Despite data limitations that tended to reduce the apparent effect of the system, this randomized, controlled trial showed that VDIS reduces hospitalization and emergency department utilization and expenses.

KEYWORDS: Chronic disease; Clinical; Cost of care; Decision support systems; Diabetes mellitus; Emergency department use; Health services research; Hospitalization; Patient care management; Primary health care

See funding, conflict of interest, and authorship disclosures at the end of this article.

The number of individuals in the US with diagnosed diabetes is now 17.5 million, with total estimated health care costs in 2007 of $174 billion.[1] Although a range of effective treatments are available, diabetes patients continue to receive suboptimal care.[2]

The Vermont Diabetes Information System (VDIS) is a laboratory-based registry and decision support system that communicates directly with primary care providers and their adult patients with diabetes. It is designed for low-cost and easy integration into primary care. It requires no data entry, additional staff, office space, or capital investment by participating practices. Although VDIS can be easily integrated with office computers or electronic medical records, these are not required.[3]

VDIS uses the Chronic Care Model as an organizing framework, with daily data feeds from otherwise independent laboratories, automatic test interpretation using algorithms based on consensus guidelines, use of fax and mail to report to providers and patients not easily reached by electronic networks, and report formats that are accessible and useful to patients and providers. The primary function of the system is to collect pertinent clinical information (hemoglobin A1C, cholesterol, serum creatinine, and urine protein results) and generate 5 types of reports: flow sheets to providers with accurate and timely laboratory results, reminders of overdue laboratory tests to providers, overdue reminders to patients, alerts to patients with elevated test results, and summary population reports for providers regarding their diabetes roster.[4,5]

The intervention has been described in detail elsewhere, along with a prospective, cluster-randomized clinical trial in which 7412 patients and 132 providers in 64 practices were randomized to receive VDIS or usual care.[4,5] A random sample of patients completed questionnaires at the end of the study in which they recalled their use of medical services in the previous year, including hospitalization and emergency department visits. Intervention subjects recalled significantly less utilization than control subjects, with estimated savings of $2426 per patient per year (95% confidence interval −4647 to −205; $P = .03$).[6] Although randomized to minimize bias, this analysis was limited by the possibility of patient recall error.

A second analysis of the cost impact of this decision support system was undertaken in a cohort of patients covered by a single insurer, who used a commercially available version of the system called the Vermedx® Diabetes Information System (Vermedx Inc., Burlington, VT). In this observational study, total insurance claims paid before and after institution of the system were compared for 153 intervention patients and 870 control subjects.[3] Mean savings in the intervention group ranged from $504 per patient in year 1 of operation to $3563 in year 4. The cumulative net savings reached $8134 in 4 years. Although not subject to recall error, these data were limited by the nonrandomized design and reliance on data from a single insurer.

These 2 studies have methodological limitations. In order to better understand the potential cost savings associated with the VDIS, we undertook the current study to describe the effect of VDIS on cost and utilization in the original randomized cohort using hospital claims paid across all insurers.

METHODS

VDIS receives laboratory results (glycosolated hemoglobin A1C, cholesterol, 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. They include flow sheets with guideline-based recommendations for the providers and alert letters for the patient when results are above target. Patients and practices also receive reminders when test results are overdue. Population reports listing all the provider's patients are sent to each provider quarterly, along with a report card indicating population-level performance. Reports are sent electronically or by fax to the practices, and mailed to patients. The system is not linked to any pay-for-performance incentive.

We recruited 13 hospital-based clinical laboratories in our region, 64 practices with 128 primary care providers, and their 7412 adult patients with diabetes. Practices were randomized to receive the VDIS intervention or usual care and were observed for at least 24 months.[5]

The Vermont Association of Hospitals and Health Systems discharge dataset includes data from all 13 hospitals in Vermont. In a post hoc analysis, we linked individual records from the discharge data with records from the VDIS study using date of birth, sex, and address. Forty-four VDIS records linked to more than one patient in the discharge data were dropped, leaving a final sample of 7368 subjects. Patients were enrolled with a passive consent ("opt-out") procedure.[7]

All data were analyzed on an intention-to-treat basis. All claims paid for inpatient hospitalizations or emergency department visits from each subject's date of randomization through their date of censoring were included. Thirty-eight practices (59%) were located in Vermont and 26 (41%) in adjacent New York State. The claims data include only Vermont hospitals, although some New York residents receive care in Vermont. At the time of the study, the cost of VDIS was $4 per patient per month.

The primary null hypothesis was that there is no difference between the intervention and control groups in hospital and emergency department charges. We also analyzed the number of hospital admissions, length of stay, and number of emergency department visits. We repeated the analyses for subgroups based on age and sex. Because utilization is heavily skewed, we used the nonparametric Wilcoxon Rank-Sum Test for continuous variables and χ^2 for categorical variables.

The research was approved by the University of Vermont Committee on Human Research in the Medical Sciences.

RESULTS

Table 1 shows the demographic characteristics of the 3856 intervention and 3512 control subjects. The mean age was 63 years, with almost half over 65 years. Intervention subjects were about 1 year older than control subjects ($P < .001$). Control subjects were more likely than intervention subjects to be Vermont residents (62.0% vs 55.5%, $P < .0001$). Intervention subjects were more likely than control subjects to have poor glucose control and evidence of diabetic kidney disease.

TABLE 1: Subject Characteristics at Baseline

Characteristics	Control	Vermedx	*P* Value
Sample size	3512	3856	
Male (%)	48.1%	49.8%	.15
Age at randomization (years)			
Mean	62.4	63.5	.0005
Median	62.6	64.1	
Range	19.0 to 98.8	18.4 to 96.7	
Age >65 years	43.8%	48.0%	<.0001
Vermont resident	62.0%	55.5%	<.0001
Glycemic control at goal (A1C <7.0%)	58.2%	55.2%	.008
Cholesterol at goal (LDL <100 mg/dL)	44.1%	44.8%	.59
Creatinine normal (<1.5 mg/dL)	89.5%	89.8%	.67
Microalbuminuria present (≥30 mg/gm)	28.7%	33.2%	.007

LDL = low-density lipoprotein.

TABLE 2: Utilization

Mean Utilization per Subject	Control	Vermedx	Difference*	*P* Value
All subjects	3512	3856		
Inpatient charges	$3480.14	$3113.19	−$366.95	.02
Inpatient length of stay (days)	1.1	0.99	−0.11	.01
Number of inpatient admissions	0.20	0.17	−0.03	.01
Emergency department charges	$414.30	$303.51	−$110.79	<.0001
Number of emergency department visits	0.36	0.27	−0.10	<.0001
Seniors (age 65 years and up)	1537	1851		
Inpatient charges	$4264.36	$3699.26	−$565.10	.004
Inpatient length of stay (days)	1.44	1.22	−0.23	.002
Number of inpatient admissions	0.27	0.21	−0.06	.001
Emergency department charges	$443.27	$270.45	−$172.82	<.0001
Number of emergency department visits	0.36	0.21	−0.15	<.0001
Age <65 years	1975	2005		
Inpatient charges	$2869.84	$2572.14	−$297.70	.30
Inpatient length of stay (days)	0.84	0.79	−0.05	.25
Number of inpatient admissions	0.15	0.13	−0.02	.31
Emergency department charges	$391.76	$334.03	−$57.73	.07
Number of emergency department visits	0.37	0.33	−0.04	.11
Men	1689	1920		
Inpatient charges	$3712.22	$3098.26	−$613.96	.03
Inpatient length of stay (days)	1.10	0.94	−0.16	.03
Number of inpatient admissions	0.21	0.17	−0.04	.02
Emergency department charges	$410.91	$299.18	−$111.73	<.0001
Number of emergency department visits	0.36	0.23	−0.12	<.0001
Women	1823	1936		
Inpatient charges	$3265.12	$3128.00	−$137.12	.21
Inpatient length of stay (days)	1.10	1.05	−0.05	.15
Number of inpatient admissions	0.20	0.17	−0.02	.15
Emergency department charges	$417.45	$307.80	−$109.64	.009
Number of emergency department visits	0.37	0.30	−0.07	.01

*Negative numbers indicate savings associated with Vermedx.
Please note rounding issue with certain differences.

Intervention subjects had 15% fewer hospital admissions during the study period than control subjects (0.17 vs 0.20, $P = .01$) and 11% lower hospital charges ($3113 vs $3480, $P = .02$; Table 2). Emergency department visits were reduced by 25% (0.27 vs 0.36, $P < .0001$) and emergency charges by 27% ($304 vs $414, $P < .0001$). The net savings attributable to VDIS is the sum of hospital and emergency department charges avoided ($477.74 or $14.94 per patient per month over 32 months of observation) less the cost of the service ($4.00 per patient per month at the time of the study), or $10.94 per patient per month.

Significantly lower utilization with VDIS was observed among seniors (age ≥65 years). Although savings also were seen in younger subjects, the differences did not achieve statistical significance. Men in the intervention group had significantly lower utilization than male control subjects. For women, the intervention group had lower utilization in all categories, but the differences were statistically significant only for emergency department visits and charges.

DISCUSSION

In this randomized, controlled trial of a primary care-based diabetes decision support system, patients in the intervention group had significant reductions in utilization of hospital and emergency care. The estimated return on investment for VDIS to a payer is at least 3.7 and is even greater among seniors and men.

Because the data analyzed here do not include other savings attributable to VDIS, the total return on investment is substantially higher.[3]

Although this is a randomized study, randomization by cluster (practice) allowed the 2 groups to be somewhat different in age and sex at baseline. However, the subgroup analyses show that the overall effect is unlikely to be due to these differences.

The analysis is limited by the unavailability of data from hospitals and emergency departments in New York State. This undoubtedly falsely lowers the estimates of utilization. However, in a randomized trial, this effect is similar in both groups. The higher proportion of control subjects among Vermont residents suggests that the relative difference between intervention and control groups would have been even larger if we had access to New York data.

All of the analyses of the effect of VDIS or Vermedx® on utilization have limitations. The initial analysis of the randomized population[5] was free of bias, but subject to recall error. The insurance claims data were not subject to recall error, but were not randomized, and applied to only one payer.[3] The hospital data presented here are randomized and apply to all payers without recall error, but exclude an unknown number of admissions and emergency department visits. The current study excludes certain costs, such as physician's office visits, medications and supplies, and laboratory testing, which may be higher in the intervention group due to improved patient monitoring and care. Although randomized, the 2 groups did differ at baseline (Table 1). However, these differences favored the control group, suggesting that any potential bias has the effect of reducing the apparent effect of the intervention.

Although each study is limited, together they comprise a consistent body of evidence that VDIS or Vermedx® reduces health care utilization of adults with diabetes. The results further support previous research that shows provider-centered interventions, such as diabetes registries and clinical decision support, improve outcomes, and reduce costs.[8-12] For instance, Bu et al[9] estimated that over a 10-year period, diabetic registries saved $14.5 billion ($1016 per enrolled patient), and clinical decision support systems saved $10.7 billion ($752 per enrolled patient), suggesting a savings of similar magnitude to VDIS.

The mechanism by which VDIS or Vermedx® reduces utilization is uncertain. The cost savings are unlikely to be related to prevention of cardiovascular complications because glycemic control, cholesterol level, blood pressure, and self-care behavior remained unchanged between the control and intervention groups.[6] However, the intervention facilitates communication between patient and primary care provider, and may stimulate more scheduled contact with the primary care provider and thereby reduce the need for emergency care. It also is possible that communications from the provider (in the form of reminder and alert letters generated by VDIS) are reassuring to the patient, raising the threshold for urgent visits to the emergency department. Further studies are needed to better understand the mechanism of cost reduction.

CONCLUSION

In this randomized, controlled trial, VDIS was associated with reduced hospital and emergency department utilization and expenses.

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