Does Patient Behavior or Access Factors Have the Largest Influence on Screening in Type 1 Diabetes?

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OBJECTIVE — Successful disease management is heavily influenced by access to care issues and patient behavior. Screening tests to detect chronic complications are part of diabetes management and may be influenced by access to care or patient decisions. The objective of this research was to examine how strongly access to care and patient behavior predict screening practices.

RESEARCH DESIGN AND METHODS — Information on screening practices, access to care, and diabetes management were identified from the Pittsburgh Epidemiology of Diabetes Complications Study at two time points: 1998–2001 and 2002–2006. Information on access to care and patient behavior identified in 1998–2001 were examined relative to screening practices observed in 2002–2006.

RESULTS — Access-to-care issues positively predicted subsequent screening practices. Specifically, specialist care visits, number of doctor visits, and intensive insulin therapy were all strong predictors for screening use. Receipt of the recommended level of screening tests was also positively associated with the patient behavior of daily blood glucose testing.

CONCLUSIONS — The findings of this study show that access to care, in general, and access to quality diabetes care, in specific, play a key role in the use of recommended screening tests in type 1 diabetic patients. These data suggest that future efforts to improve screening practices in the type 1 diabetic population should address issues related to access to care.

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Diabetes remains one of the most significant chronic illnesses affecting the U.S. population in terms of the number of people affected, related health care expenditures, and associated morbidity and mortality (1,2). Diabetic patients are at increased risk for developing chronic complications including nephropathy, retinopathy, neuropathy, peripheral vascular disease, and cardiovascular disease (2). Screening tests to detect early forms of these diseases are available, and routine screening for complications are widely recommended (3). However, currently few diabetic patients receive all recommended screening tests (4–10).

Optimal diabetes management includes components of screening and relies on a combination of patient and access factors that include provider and health care–system inputs (11). Multifaceted diabetes management programs are effective in improving glycemic control, monitoring lipid concentrations, and screening for diabetic retinopathy, foot lesions, peripheral neuropathy, and proteinuria (11). Diabetes is also unique in that a large component of disease management rests with the patient. Maintaining and monitoring glycemic control and adherence to diet, exercise, and prescribed medications are all essential daily components of diabetes management that are controlled by the patient (3).

Disease management is predicated on appropriate patient self-management practices, physician adherence to evidence-based guidelines, and a health care system that facilitates these activities. Interventions that address provider feedback, provider education, provider reminders, patient education, patient reminders, and patient and provider financial incentives have been associated with improvements in provider adherence to recommended guidelines and patient outcomes (12). Interventions that address health care system factors such as central computerized tracking systems and computerized decision support systems for medical personnel have also been linked to improvements in processes of diabetes care (13). Screening for diabetes complications and use of other preventive services is dependant on a combination of these factors.

The existing literature largely examines the joint effect of patient, provider, and system factors in the context of screening for complications and is based on randomized control trials that describe processes of care under ideal and controlled conditions among individuals in health maintenance organizations (11,13). Few studies examine how these factors may individually impact screening in a noncontrolled setting with varying insurance plans and how this pattern differs between type 1 and type 2 diabetic patients. This study examines influence of access to care and patient behavior on screening practices in a well-defined cohort of type 1 diabetic patients.

RESEARCH DESIGN AND METHODS

— This study is based on a cohort of type 1 diabetic subjects examined prospectively to investigate whether and how patient-related and health care–access factors are related to screening behavior. The study participants were identified from the Pittsburgh Epidemiology of Diabetes Complications (EDC) Study. The EDC Study is a longitudinal study of 658 individuals with type 1 diabetes from the Children's Hospital of

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A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Pittsburgh Diabetes Registry. All patients were diagnosed with childhood-onset type 1 diabetes between 1950 and 1980, were on insulin at diagnosis, and were seen at the Children's Hospital of Pittsburgh within 1 year of diagnosis (14,15).

The EDC Study has been investigating the factors related to the development of the long-term complications of diabetes (14). Participants were enrolled in the study in 1986 and followed frequently with clinical exams and surveys to the present time. This study focuses on health services and patient and screening data collected at two time points: 1998–2001 and 2002–2006. Patient behavior and access-to-care factors identified in 1998–2001, the baseline point of the present study, were compared with screening practices measured in 2002–2006, the follow-up time point, to identify predictors of screening use.

The outcome of interest for this investigation is whether a screening test to detect diabetes complications or to identify markers for complication risk was received. Screening tests for complications assessed in this evaluation included a dilated eye examination, a urine protein test (by spot urine or timed urine analysis), and a foot examination (visual or monofilament test), while screening tests for complication risk included an A1C test, a fasting lipid profile, and blood pressure measurement. Patients were asked by questionnaire in 2002–2006 if they had received the above described screening tests at least once over the previous year (twice for A1C). Only screening tests that were not part of the EDC Study protocol were considered in the context of this evaluation.

Patient behavior and health care–access issues were examined as possible factors influencing the use of screening tests. Patient behaviors were defined by the following self-care management practices: daily blood glucose testing, changing diet in response to blood glucose levels, changing insulin in response to blood glucose levels, and changing exercise in response to blood glucose levels. Subjects were asked by questionnaire from 1998 to 2001 to indicate in a yes/no fashion whether they participated in any of the aforementioned behaviors.

Health care–access variables were defined to include provider-related and system-related factors that may facilitate the use of screening tests. Provider-related variables included specialist care visits, number of doctor visits, and intensive insulin therapy. Individuals were considered to have specialist care visits if their usual health care provider was a diabetologist, endocrinologist, or nurse, nurse practitioner, or physician assistant working with a diabetologist or endocrinologist. Subjects with at least two doctor visits over a 12-month period were considered to have enhanced access to care and the potential to get screened. Intensive therapy was defined as three insulin injections per day or insulin pump therapy and was regarded as an access factor because it signals provider adherence to accepted diabetes care practices. Traditional access-to-care variables based on health system issues were also examined. They included report of barriers to seeing a doctor and the presence of a usual place of care when sick.

It is recognized that health care use, including screening, can be affected by multiple processes. Therefore, we also examined several potential confounders to the patient/access and screening test link. These include disease duration, sex, health insurance status, and diabetes complications status. Insurance status was classified as having a full year of coverage or not. Self-reported complications included the presence of proliferative retinopathy or diabetic eye disease requiring laser therapy, myocardial infarction, stroke, diabetes-related renal failure, or amputation. Duration of diabetes and sex were identified from the baseline data of the EDC Study and adjusted to reflect the experiences at the time of this report.

Statistical analysis

Screening was analyzed in two ways in this study: *1*) the use of specific, individual screening tests and *2*) the use of multiple screening practices at the optimal level. Optimal screening was defined as at least two A1C tests, a dilated eye exam, a urine protein test, a foot exam, and a fasting lipid test in the last year. Blood pressure readings were not included as a part of the optimal variable because they are typically part of routine office visits and were reported in the overwhelming majority of this population. If individuals were not eligible for a specific screening test (e.g., had end-stage renal disease or blindness in both eyes) they were considered as having satisfied that screening criteria for the purposes of this evaluation. The impact of this consideration was small, as only 38 individuals had either end-stage renal disease or blindness.

Analyses were conducted using SPSS 13.0. Baseline patient and access-to-care factors were compared with screening tests at both baseline and follow-up. The prevalence of screening was tabulated at each time point. Models were created to examine the effect of patient factors, access factors, and combined patient and access factors on screening practices. Stepwise logistic regression analysis was conducted with the receipt of a screening test as the outcome variable. Models were adjusted for disease duration, complications status, sex, and health insurance status. Variables identified as significant in univariate analyses at the 0.05 level were included in the model, starting with the variable with the smallest P value. Variables identified in the literature as being associated with diabetes care, even if not found to be significant at $P \leq 0.05$, were also added to examine if these variables influenced the model. When making models combined with access and patient level factors, the most significant variable in univariate analysis at the 0.05 level was added to the model, regardless of the category the variable fell under (i.e., access or patient level), and model specification continued in a stepwise manner.

RESULTS — There were 393 subjects available for analysis in 1998–2001, and 324 of those subjects had complete information on screening in 2002–2006. Individuals missing follow-up data ($n = 69$) were less likely to report favorable patient self-care behaviors that consisted of daily blood glucose testing ($P < 0.001$), changing exercise in response to blood glucose levels ($P = 0.019$), changing insulin in response to blood glucose testing ($P = 0.042$), and changing diet in response to blood glucose levels ($P < 0.001$). Individuals missing follow-up data were also less likely to report specialist care visits ($P = 0.007$) and more likely to report a barrier ($P < 0.001$).

At baseline, the mean age of the cohort was 37.1 ± 7.9 years and the mean disease duration 26.9 ± 3.9 years. Demographic data at baseline is provided in Table 1. The majority reported health insurance coverage (94.2%), and a large portion of subjects reported at least one late-stage diabetes complication (48%).

Screening frequency and characteristics

The prevalence of screening test use at baseline and follow-up is reported in Table 2. Overall, the prevalence of screening increased from baseline to follow-up. The

Table 1—*Characteristics of the study population (1998–2001)*

n	393
Demographic	
Disease duration (years)	26.9 ± 3.9
Age (years)	37.1 ± 7.9
Sex (female)	211 (53.4)
Health insurance coverage (yes)	358 (94.2)
Diabetes complication (yes)	189 (48.0)
Education level	
Greater than high school	194 (49.4)
Patient	
Daily blood glucose testing (yes)	282 (74.0)
Change in diet in response to blood glucose levels (yes)	263 (73.5)
Change in exercise in response to blood glucose levels (yes)	162 (45.8)
Change in insulin usage in response to blood glucose levels (yes)	297 (79.0)
Access	
Presence of a barrier to seeing doctor (yes)	82 (21.6)
Two doctor visits (yes)	303 (79.3)
Intensive insulin therapy (yes)	241 (61.8)
Specialist care (yes)	251 (63.7)
Usual place of care when sick (yes)	345 (90.6)

Data are *n* (%) and means ± SD. Due to missing data, percentages may vary.

largest improvement was in optimal screening, where the rates doubled between baseline and follow-up. Optimal screening, however, was only reported by 21.9% of respondents at baseline and 44.1% at follow-up. Screening components most frequently missed by subjects included lipid testing and A1C testing (two tests) at both baseline and follow-up.

Daily blood glucose testing, changing exercise in response to blood glucose levels, changing diet in response to blood glucose levels, and changing insulin in response to blood glucose levels were significantly and independently associated with receipt of screening tests. At baseline, after adjustments for disease duration, sex, complications, and the presence of health insurance, daily blood glucose testing was positively correlated with all tests. At follow-up, daily blood glucose testing was positively associated with all tests, with the exception of the foot exam. Changing insulin in response to blood glucose levels was associated with fasting lipid testing and receipt of dilated eye exams at baseline and optimal screening at baseline and follow-up, after adjusting for health insurance, sex, complications, and disease duration. In adjusted regression analysis, changing exercise levels in response to blood glucose levels was positively associated with dilated eye examination at baseline and follow-up and foot examinations at follow-up. Changing diet in response to blood glucose levels was correlated with dilated eye exam at baseline and adjusted for disease duration, sex, health insurance, and complications.

Multiple regression models were created for access factors and screening tests at baseline and follow-up. At baseline, specialist care visits, presence of barriers to care, intensive therapy, and the number of physician visits were associated with recommended screening tests. Specifically, specialist care visits (odds ratio [OR] 3.5 [95% CI 1.9–6.4]), intensive therapy (1.8 [1.0–3.4]), and the presence of a barrier (0.48 [0.24–0.93]) were each independently associated with dilated eye examinations. Urine protein screening was associated with number of doctor visits (2.6 [1.4–5.1]), specialist care visits (2.8 [1.6–5.0]), intensive therapy (1.9 [1.1–3.3]), and the presence of a barrier (0.52 [0.27–1.]). At follow-up, the number of doctor visits and specialist care visits was independently correlated with urine protein testing (2.3 [1.1–4.6] and 2.0 [1.1–3.7]) and A1C testing (2.0 [1.1–4.1] and 3.4 [1.6–7.1]).

Multiple regression models were created for combined access and patients factors and screening tests at baseline and follow-up. Combined models are presented in Table 3. At baseline, access factors that included the number of doctor visits, barriers to care, specialist care visits, and the patient level factor of daily blood glucose testing were associated with screening. At follow-up, the number of doctor visits and daily blood glucose testing was associated with urine protein screening and optimal screening, and the number of doctor visits and changing insulin in response to blood glucose levels was associated with foot exams.

Table 2—*Screening prevalence at baseline (1998–2001) and follow-up (2002–2006)*

Screening test	Baseline	Follow-up
n	393	324
A1C (at least two)	263 (68.7)	241 (76.8)
Fasting lipid	254 (65.1)	257 (79.8)
Dilated eye	312 (79.8)	278 (86.3)
Urine protein	266 (68.2)	240 (74.3)
Foot exam	230 (61.3)	249 (76.9)
Optimal	107 (21.9)	137 (44.1)
Blood pressure*	360 (91.6)	311 (95.7)

Data are *n* (%). *Not included in optimal screening test.

CONCLUSIONS

— In this study, we examined the relationship between patient-level behavior and access to care and the receipt of screening tests for diabetes complications. Screening was most often found to be associated with access factors rather than patient behavior issues. Specifically, specialist care visits, the number of doctor visits, the presence of barriers to care, and intensive insulin therapy were all strong predictors for screening. Receipt of recommended tests was also associated with the patient-level factor of daily blood glucose testing.

Several access-to-care factors were consistently associated with receipt of screening tests, including barriers to care, specialist care visits, and two annual doctor visits. The reported presence of a barrier to seeing a physician was inversely associated with receipt of screening tests. Lack of access to physician care has been highlighted in the literature (16) as a barrier to receipt of diabetes care in general among patients.

Another finding of our study was the strong correlation between specialist care visits and the receipt of screening tests. Previous studies (17) have linked special-

Table 3—*Significant independent access and patient factors related to screening tests at baseline and follow-up*

Test	Baseline		Follow-up	
	Factor	RR (95% CI)	Factor	RR (95% CI)
Dilated eye exam	Specialist	3.1 (1.7–5.7)	None	
	Barrier (present)	0.48 (0.23–0.87)		
	Daily blood glucose testing	2.0 (1.1–3.8)		
Urine protein screen	Two doctor visits	2.7 (1.7–5.2)		
	Specialist	2.4 (1.4–4.4)	Two doctor visits	2.6 (1.4–5.2)
	Barrier (present)	0.49 (0.25–0.95)	Daily blood glucose testing	2.9 (1.5–5.7)
	Daily blood glucose testing	1.9 (1.1–3.6)		
Foot exam	Specialist	2.1 (1.2–3.4)	Two doctor visits	3.2 (1.6–6.4)
	Daily blood glucose testing	1.8 (1.1–3.2)	Changing exercise in response to blood glucose level	2.5 (1.3–4.8)
Optimal screening	Two doctor visits	9.9 (2.3–43.1)	Two doctor visits	3.2 (1.5–6.7)
	Specialist	3.0 (1.4–6.3)	Daily blood glucose testing	2.4 (1.2–4.7)
	Daily blood glucose testing	2.6 (1.2–5.9)		

Data are based on multiple logistic regression models. RR, relative risk.

ist care visits to higher screening rates among diabetic patients and general improvements with diabetes outcomes. Specifically, specialist care visits have been linked to improvements in blood pressure management, foot ulcers, infection, and screening for complications. These data provide additional evidence of the utility of specialty care visits (17–19). Along with intensive therapy and specialist care visits, visiting a physician at least two times per year was also positively associated with each screening test evaluated. These data reaffirm the notion that physician as well as patient care plays an integral role in chronic disease management. For instance, Cook et al. (20) found that quarterly physician visits were associated with higher rates of foot examination. Likewise, a recent study conducted by Hensley et al. (21) found improvements in intermediate outcomes including blood pressure measurement, lipid levels, and A1C level correlated with increasing visits to a health care provider. Gary et al. (22) also found that patients more likely to have at least four physician visits per year had higher rates of A1C testing.

In our study, daily blood glucose testing was the only patient behavior that was consistently associated with screening. Self-monitoring of blood glucose and maintaining appropriate glycemic control are critical components of diabetes management. It is likely that patients who test their blood glucose daily are in more control of their disease, and thus they are probably proactive in other areas of management. Day et al.(23) found that individuals with better glycemic monitoring and control had higher levels of self-efficacy, emotional adjustment to disease, and practical self-management skills. Patient characteristics that confer self-monitoring of blood glucose may also lead patients to obtain screening tests.

In our data, access-level factors appear to have a greater influence on screening than patient-level factors. The observed relationship between access factors and screening is plausible because research examining factors related to disease management have consistently shown physician and system level variables associated with optimal care. Our findings must be interpreted with a degree of caution, as patient, provider, and system factors are not independent and work together to influence health care (11,12,16). In this study we grouped covariates according to patient or access factor categories that largely characterize the variable; however, overlap may still occur. For instance, specialist care visits and the number of annual doctor visits may be related to patient motivation and health-seeking behavior, in addition to provider characteristics, to influence screening behavior. Likewise, daily blood glucose testing is typically strongly encouraged by health care providers, which may have an impact on a patient's decision to monitor blood glucose daily. Further exploration on the influence of patient motivation on provider type, screening, and disease management is warranted.

There are several limitations to consider when interpreting these findings. First, the data were based upon the self-reported experiences of the participants and are subject to recall bias. It was not possible to validate the reported responses for the present study. However, a study conducted by Fowles et al. (24) assessed the validity of self-reported disease management data among diabetic patients and found that self-report data are likely to overestimate eye examination and A1C testing. Thus, if these findings were applicable to this study, it is possible that our estimates for screening may be high. Additionally, our classification of complications was self-reported and subject to recall error and thus may not accurately reflect the influence of complications on practices. We compared the self-reported complication data on retinopathy in this study to previous clinical exam findings collected as a part of the EDC Study in 1997–1998. The coefficient of correlation between the two methods of identifying complications was 0.85, suggesting that the potential bias related to complications may be small. Furthermore, proxy variables were used to describe patient and access factors. We did not have access to administrative databases, pharmacy records, or patient medical records to directly measure level of access or self-care. The indirect assessment of these measures may have contributed to misclassification of patient behavior or level of access.

There is also the potential for selection bias, as all respondents are involved in the longitudinal Pittsburgh EDC Study. Health care use for study subjects may differ from that of type 1 diabetic patients not participating in the study, and participation in the study may influence health care use. The data reported may also reflect survivor bias. Many in the original study cohort have passed away or become too ill to participate. Remaining subjects may have better disease management and higher screening rates, which has allowed them to remain in the study.

Approximately18% of subjects surveyed at baseline (1998–2001) did not complete a subsequent follow-up survey (2002–2006). Baseline differences between those with follow-up data compared with those without follow-up data were observed. We found that individuals missing follow-up data were less likely to report self-care behaviors and specialist care visits and more likely to report a barrier to care. This could have influenced our findings, as these patients had poorer self-management practices and access to care and may also have poorer screening behaviors compared with those available for follow-up analysis. Considering the above-mentioned limitations, it is possible that screening practices of the type 1 diabetic population may be more accurately reflected in baseline findings rather than follow-up findings.

In summary, diabetes management relies on patient-level as well as access factors that include provider and health care system inputs. Previous research that has examined the combined effect of these factors on general diabetes outcomes and processes of care has consisted of randomized trials, and the majority of these studies were not designed to examine their effect on screening practices. In addition, it has been noted that dissemination of models shown to be effective in randomized trials is often impeded by incompatibility with the health care system and a disconnect with provider practice (25). This report investigated which factors influence screening in a natural setting, as this likely represents a large portion of patients.

The findings show that access-to-care factors may play the largest role in use of recommended screening tests. Unlike other areas of diabetes management, such as glycemic control, these data suggest that access factors may play a larger role in driving screening rather than patient-level factors. The findings from this report imply that disease management strategies aimed at increasing screening should have a strong focus on access-to-care issues that are at the provider or health system, rather than the patient level.

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