The Association of Diabetes Specialist Care With Health Care Practices and Glycemic Control in Patients With Type 1 Diabetes

A cross-sectional analysis from the Pittsburgh Epidemiology of Diabetes Complications Study

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OBJECTIVE — To determine whether diabetes care characteristics and glycemic control differ by use of specialist care in a representative cohort of patients with type 1 diabetes.

RESEARCH DESIGN AND METHODS — Health care, sociodemographic characteristics, and glycemic control were compared between participants in the Pittsburgh Epidemiology of Diabetes Complications Study who reported receiving specialist care (n = 212) and those who did not (n = 217). Specialist care was defined as having received care from an endocrinologist or diabetologist or diabetes clinic attendance during the last year.

RESULTS — Patients who reported receiving specialist care were more likely to be female, to have an education level beyond high school, to have an annual household income >$20,000, and to have health insurance. Additionally, patients receiving specialist care were more likely to have received diabetes education during the previous 3 years, to have knowledge of HbA_{1c} testing and to have received that test during the previous 6 months, to have knowledge of the Diabetes Control and Complications Trial results, to self-monitor blood glucose, and to inject insulin more than twice daily. A lower HbA_1 level was associated with specialist care versus generalist care (9.7 vs. 10.3%; P = 0.0006) as were higher education and income levels. Multivariate analyses suggest that the lower HbA_1 levels observed in patients receiving specialist care were restricted to patients with an annual income >$20,000.

CONCLUSIONS — Specialist care was associated with higher levels of participation in diabetes self-care practices and a lower HbA_1 level. Future efforts should research and address the failure of patients with low incomes to benefit from specialist care.

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Abbreviations: ABMS, American Board of Medical Specialties; CAD, coronary artery disease; DCCT, Diabetes Control and Complications Trial; DSP, distal symmetric polyneuropathy; EDC, Pittsburgh Epidemiology of Diabetes Complications Study; LEAD, lower-extremity arterial disease; ON, overt nephropathy; PDR, proliferative diabetic retinopathy.

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

Patients with diabetes often have early morbidity, mortality, and decreased quality of life (1). In 1997, the direct and indirect costs associated with diabetes in the U.S. were $98 billion (2). This chronic disease represents a significant public health burden, and the prevention of its complications is critical to both patients and health care costs. However, studies have suggested that patients with diabetes do not participate in preventive services at the recommended frequency (3), and health care providers do not adhere to established practice standards that were developed to improve the health of patients with diabetes (3–9).

Care delivered by specialists has been associated with better glycemic control and delivery of process measures that are more consistent with established practice guidelines (10–14). This evidence, however, has been based on biased populations or health care systems outside of the U.S. This study thus sought to examine health care practices and glycemic control by type of health care provider in a representative U.S. cohort of type 1 diabetic patients who were recruited independently of current source of care.

RESEARCH DESIGN AND METHODS

Participants for this evaluation were identified from the Pittsburgh Epidemiology of Diabetes Complications Study (EDC) cohort. The EDC was a 10-year prospective follow-up study of childhood-onset (<17 years of age) type 1 diabetes and has been previously described (15). Briefly, study participants were diagnosed between 1950 and 1980 and were examined within 1 year of diagnosis at Children's Hospital of Pittsburgh, PA. Although this population is clinic based, it has been shown to be representative of the type 1 diabetes population of Allegheny County, PA (16). A total of 658 patients (mean age 28 years; mean duration of dia-

Table 1—*Sociodemographic characteristics, lifestyle behaviors, and health care practices according to use of specialist care*

	Nonspecialist	Specialist	Odds ratio (95% CI)
Characteristic			
n	217	212	—
Age (years)	37.9 ± 8.0	37.1 ± 7.8	*
Duration (years)	29.5 ± 7.7	28.7 ± 7.4	*
Sex (male)	54.8 (119)	41.5 (88)	1.7 (1.2–2.5)†
Education level (beyond high school)	61.7 (132)	77.3 (163)	2.1 (1.4–3.2)‡
Income (earning >$20,000/year)	74.2 (152)	83.8 (166)	1.8 (1.1–3.0)§
Have health insurance	91.6 (196)	97.1 (203)	3.1 (1.2–8.0)§
Ever smoked	40.5 (87)	32.7 (69)	0.72 (0.5–1.1)
Alcohol use (drinks/week)	5.8 ± 14.8	5.0 ± 7.9	*
Health care practices			
Self-monitoring of blood glucose	79.4 (170)	93.8 (196)	3.9 (2.0–7.5)‡
Glucose tests/week	11.1 ± 11.0	18.9 ± 13.9	‡
Glucose tests/day	1.6 ± 1.6	2.7 ± 2.0	‡
More than 2 insulin injections a day	25.7 (52)	47.8 (98)	2.6 (1.7–4.0)‡
Diabetes education during the previous 3 years	13.3 (28)	23.0 (47)	2.0 (1.2–3.3)†
Knowledge of DCCT	35.2 (75)	52.2 (109)	2.0 (1.4–3.0)‡
Knowledge of HbA_{1c} testing	67.5 (143)	83.1 (172)	2.4 (1.5–3.8)‡
HbA_{1c} test during the previous 6 months	65.7 (90)	85.4 (146)	3.1 (1.8–5.3)‡
Hospitalized during the last 3 years	46.5 (101)	41.5 (88)	0.82 (0.6–1.2)
Physician visits during the last year	3.1 (3.0)	3.2 (1.5)	*
Saw an ophthalmologist during the past 2 years	76.1 (159)	84.2 (170)	1.7 (1.02–2.7)§

Data are n, means ± SD, % (n), or odds ratios (95% CIs). *NS; †$P \leq 0.01$; ‡$P \leq 0.001$; §$P \leq 0.05$.

betes 20 years) participated in the baseline examination (1986–1988) when most patients were receiving care in the general community. Subjects for this analysis were participants in the sixth biennial examination (10-year follow-up 1996–1998).

Before their scheduled clinic visits, participants were sent questionnaires to gather demographic, health care, self-care, and medical history information, which included the name of the physician caring for their diabetes during the previous 12 months. The specialty of this physician was determined from the *American Medical Directory* (17) and was further defined by the American Board of Medical Specialties (ABMS) (18). Diabetes specialist care was defined as care from a board-certified endocrinologist or a diabetologist (i.e., any physician not board certified in endocrinology but whose self-reported specialty was diabetes or endocrinology) or attendance at a diabetes clinic (defined as hospital-based clinics offering a fellowship training program in endocrinology).

HbA_1 values were determined using high-performance liquid chromatography (Diamat; Bio-Rad, Hercules, CA; upper limit of normal 7.3%). Proliferative diabetic retinopathy (PDR) was determined using stereo fundus photography (classified according to the Arlie House System) (19) or a history of laser therapy. Overt nephropathy (ON) was defined as an albumin excretion rate of >200 µg/min on two of three timed urine samples or, in the absence of a urine sample, a serum creatinine level of >2 mg/dl, renal failure, or transplant. Distal symmetric polyneuropathy (DSP) was considered present if on examination, according to the Diabetes Control and Complications Trial (DCCT) protocol (20), the participant had at least two of the following: symptoms consistent with DSP, decreased or absent deep tendon reflexes, or signs of sensory loss. Coronary artery disease (CAD) was determined by EDC physician-diagnosed angina, myocardial infarction confirmed by Q-waves on an electrocardiogram, hospital records, or angiographic stenosis >50%. Lower-extremity arterial disease (LEAD) was diagnosed by a history of amputation or claudication or an ankle brachial index of <0.8 at rest. Hypertension was defined by a blood pressure level of ≥140/90 mmHg or the use of antihypertensive medication. Participants gave their consent for the study, and the University Institutional Review Board approved the protocol.

This was a cross-sectional analysis of data provided at the 10-year follow-up. Subjects reporting no physician or clinic for their diabetes care were included in the nonspecialist care group ($n = 16$). Student's t test was used to compare continuous variables by specialty, and the χ^2 test was used for categorical variables. Annual household income and education were dichotomized (cutoff points were an annual income of $20,000 and an education level beyond high school). Logistic regression analysis was used to determine independent associations with specialist care (outcome variable). Explanatory variables included duration of diabetes, any major complication (neuropathy, ON, PDR, CAD, or LEAD), education, and income. Significance was defined as $P < 0.05$, and borderline significance was defined as $P > 0.05$ and ≤ 0.1. Analyses were performed using SAS Version 6.08 (Cary, NC).

RESULTS

Study population

A total of 429 of the original 658 EDC participants completed questionnaires at the 10-year follow-up examination (68 participants had died since the baseline examination). Patients attending the 10-year follow-up did not differ by sex or age at baseline from those not attending, but attendees had a shorter diabetes duration ($P = 0.04$); were more likely to have an annual income >$20,000 ($P = 0.001$); were more likely to have lower HbA_1 ($P = 0.004$), LDL cholesterol ($P = 0.0002$), and triglyceride ($P = 0.0001$) levels and a lower albumin excretion rate ($P = 0.0001$); and were more likely to have a higher HDL cholesterol level ($P = 0.01$). Attendees were also less likely to be hypertensive ($P = 0.0001$) and to have all complications.

Use of specialist care

A total of 49% of participating subjects reported receiving care from a specialist (board-certified endocrinologist, $n = 137$; diabetologist, $n = 69$; diabetes clinic, $n = 6$).

Table 2—*Summary of the association between use of specialist care and socioeconomic status with glycemic control and health care characteristics*

	Specialist care		Education		Income	
Characteristic	No	Yes	High school level or less	More than high school	≤\$20,000/year	>\$20,000/year
n	217	212	130	295	85	318
HbA_1 (%)	10.3 ± 1.9	9.7 ± 1.5*	10.4 ± 1.8	9.8 ± 1.7†	10.5 ± 1.8	9.9 ± 1.7†
Self-monitoring of blood glucose	79.4 (170)	93.8 (196)*	85.7 (108)	87.0 (255)	84.5 (71)	86.9 (273)
Glucose tests/week	11.1 ± 11.0	18.9 ± 13.9*	13.5 ± 12.3	15.5 ± 13.4	15.6 ± 12.4	14.5 ± 12.7
Two or more injections/day	25.7 (52)	47.8 (98)*	25.2 (32)	42.1 (117)*	26.6 (21)	39.6 (120)‡
Diabetes education during the previous 3 years	13.3 (28)	23.0 (47)†	13.8 (17)	20.0 (58)	23.5 (19)	15.8 (49)
Knowledge of DCCT results	35.2 (75)	52.2 (109)*	28.6 (36)	50.7 (148)*	29.8 (25)	47.9 (150)†
Knowledge of HbA_{1c} testing	67.5 (143)	83.1 (88)*	63.2 (79)	80.3 (233)*	69.5 (57)	77.6 (242)
Had an HbA_{1c} test	65.7 (90)	85.4 (146)*	77.9 (60)	76.4 (175)	69.8 (37)	77.8 (186)
Hospitalized during the previous 3 years	46.5 (101)	41.5 (88)	43.1 (56)	44.8 (132)	57.7 (49)	39.9 (127)†
Physician visits during the previous year	3.1 ± 3.0	3.2 ± 1.5	3.2 ± 1.8	3.1 ± 2.6	3.4 ± 2.8	3.0 ± 2.3
Saw an ophthalmologist during the last 2 years	76.1 (159)	84.2 (170)‡	74.8 (92)	82.8 (235)	75.3 (61)	81.8 (252)
Have health insurance coverage	91.6 (196)	97.1 (203)‡	93.7 (118)	94.5 (277)	85.7 (72)	96.5 (303)*
Problems obtaining care	13.8 (13)	13.3 (16)	12.2 (15)	11.3 (33)	21.7 (18)	9.3 (29)†
Number of emergency department visits during the previous year	0.66 ± 1.4	0.71 ± 1.3	0.62 ± 1.1	0.72 ± 1.4	1.2 ± 2.0	0.56 ± 1.1†

Data are *n*, means ± SD, or % (*n*). $*P \leq 0.001$; $†P \leq 0.01$; $‡P \leq 0.05$.

No differences were noted in age or diabetes duration according to use of specialist care (Table 1). Patients receiving specialist care, however, were more likely to be female, to have an education level beyond high school, to have an annual household income of >\$20,000, and to have health insurance. Similar patterns were observed in sex-specific analyses; however, the magnitude of difference regarding education and income was greater for women than for men. Female sex and having an education level beyond high school were independently associated with specialist care, whereas having any complication and a higher income showed a borderline association.

Participation in health care practices according to use of specialist care is presented in Table 1. Patients receiving specialist care were more likely to self-monitor their blood glucose, to inject insulin more than twice daily, to have knowledge of HbA_{1c} testing and to have had that test during the previous 6 months, to have received diabetes education, to have seen an ophthalmologist, and to have knowledge of the results of the DCCT (patients were asked "Have you heard or read any information of the results of the Diabetes Control and Complications Trial?"). Although these participants were also less likely to have been hospitalized, no significant difference was evident in the prevalence of complications.

These analyses were repeated by eliminating those who reported no care during the previous 12 months. Results were similar with two exceptions: the association between specialists and nonspecialists was no longer significant for health insurance (the odds ratio decreased to 1.2) and for visiting an ophthalmologist (the odds ratio decreased to 1.5).

Socioeconomic factors

The relative effects of specialist care and socioeconomic status on health care characteristics and HbA_1 are presented in Table 2. Specialist care was associated with a lower HbA_1 level (9.7 vs. 10.3%; $P = 0.0006$); however, the absolute difference was similar to that when comparing higher versus lower income or a higher versus lower level of education. Results also demonstrated significant associations between education and/or income and certain health care practices in which a higher level of education was associated with diabetes knowledge and a higher income was associated with having health insurance, fewer hospitalizations, fewer emergency department visits, and fewer problems obtaining medical care. The absolute difference by specialty care was greater for self-monitoring of blood glucose, frequency of testing, intensive insulin therapy (more than two injections per day), and HbA_{1c} testing compared with differences by level of education or income. Because education and income were associated with both specialist care and improved glycemic control, the association of glycemic control with specialist care was further examined after stratification by level of education and income (Table 3). For patients with lower incomes, no effect of specialist care was evident, whereas a significant difference was observed in patients with a higher level of income. When examined by level of education, the effect of specialist care was greater in patients with an education level of high school or less. Thus, the effect of specialist care appears to be greatest in patients with higher incomes and lower levels of education.

CONCLUSIONS

The current results confirm that patients who report receiving specialist care participate in diabetes health care practices to a greater degree and have a lower HbA_1 level than those receiving care from a nonspecialist (10–14). However, users of specialist care also reported higher education and income levels. Therefore, the characteristics of both the health care provider and the individual patient are important. These data expand our knowledge of these interrelationships by showing that specialist care is particularly associated with lower HbA_1 levels in patients with higher incomes and lower education levels. Higher income may facilitate access to specialist care and the means

Table 3—*The association between specialist care and glycemic control by level of income and education*

		Nonspecialist		Specialist	
Annual household income					
≤$20,000/year					
n		44		30	
Mean (range)	NS*	10.5 (6.0–15.3)	NS‡	10.5 (7.4–15.8)	P = 0.02*
>$20,000/year					
n		140		154	
Mean (range)		10.3 (5.8–15.6)	P = 0.001‡	9.6 (5.1–12.5)	
Education					
High-school level or less					
n		74		43	
Mean (range)	P = 0.02†	10.7 (6.8–15.5)	P = 0.009‡	9.8 (7.0–15.8)	NS†
More than high school					
n		117		154	
Mean (range)		10.1 (5.8–15.6)	P = 0.052‡	9.7 (5.1–14.7)	

Data are *n* or means (range). *Income comparison; †education comparison; ‡specialist/nonspecialist comparison.

to take advantage of more intensive care. Patients with a lower level of education, on the other hand, may have a greater potential to improve health care practices because more educated patients are likely to already be aware of the means to improve care and control. No significant difference was evident in the prevalence of the complications studied by use of specialist care. This, however, is not surprising because these complications develop over time, and differences by specialty may not be observed in cross-sectional analyses (which do not consider previous care). This analysis did not, however, demonstrate a major referral bias for the most severely ill patients to be receiving care from a specialist.

Although this study is consistent with the findings of others (10–14) in showing that the care delivered by specialists was more consistent in following practice guidelines, the study extends these results to a representative cohort of type 1 diabetic patients who receive care from various community practitioners.

This study population inevitably demonstrated characteristics of a healthy survivor effect, as indicated by the lower complication rates and more favorable baseline clinical profiles versus those of nonparticipants. For example, >10% of the original cohort died before the 10-year follow-up examination used for this report. However, these results are likely to be an accurate reflection of such patients with the duration distribution seen in the EDC cohort (16).

This study is limited by its cross-sectional design; therefore, causal relationships between the use of specialist care and outcomes or health care practices cannot be determined. A cross-sectional design was chosen because the practices of current health care providers may more closely relate to current health care practices and glycemic control. Longitudinal analyses of health care provider data in the EDC cohort are being conducted and suggest that patients receiving specialist care at the time of the study were significantly more likely to report receiving specialist care throughout their diabetes duration.

Another possible limitation is the ability to define what constitutes a specialist. Various physician specialty classification methods have been reported throughout the literature. The most common method, the practice setting of the physician (e.g., general medicine or diabetes clinic) (10–14,21), may underestimate the number of specialty contacts by a patient because a specialty contact with a diabetologist who does not practice in a diabetes clinic may be missed. Other studies have relied on professional membership (22) or the American Medical Association Masterfile (23). These methods rely on self-report from the physicians and may therefore result in an overestimation of specialists. In the present study, physicians were classified by the *American Medical Directory* (17) and were further defined by the ABMS (18); therefore, ascertainment of specialists in this population was not likely problematic.

In this population, almost half of the participants reported receiving specialist care. In national studies, only 8% (1) of those with diabetes reported receiving specialist care; however, this figure did not distinguish between patients with type 1 and type 2 diabetes. Additionally, 63% of this population reported testing blood glucose at least daily, which is lower than the rate reported by Beckels et al. (9) of 94% in the 1994 Behavioral Risk Factor Surveillance System Survey. Only 36% of the study patients reported injecting insulin more than twice daily, which is a marker of intensive therapy according to DCCT criteria (24). Because these health care practices differed by provider, this suggests that nonspecialists may be less comfortable in recommending more intensive regimens. Because intensive therapy and enhanced self-care practices have been associated with the prevention of short-term complications (25) and a delay or slowing of the progression of long-term complications (21,24), the fact that patients receiving care from nonspecialists are either not receiving or are not accepting this message to the same degree as patients receiving care from specialists is of concern.

The present study demonstrated similar absolute differences in glycemic control according to use of specialist care as it did according to level of education or income. Previous studies have also demonstrated associations between socioeconomic status and chronic disease (26–30).

In other studies of patients with diabetes, associations between lower socioeconomic status and worse glycemic control have been observed (28,29). Patients with lower socioeconomic status have been found to have a lower level of diabetes knowledge (27) and thus may not have the necessary information to participate in self-care. Patients with lower levels of education in the present study were also less likely to have knowledge of HbA_{1c} testing or the results of the DCCT, factors that may serve as surrogate measures of diabetes knowledge and provide support for the influence of education on health care behavior. Interestingly, in terms of glycemic control, the association with specialist care appears to be strongest in patients with lower levels of education, which indicates that this subgroup of the population may be more likely to benefit from specialist care.

In conclusion, this study suggests that specialist care is associated with better health care practices and glycemic control. This association, however, may be modified by socioeconomic status, where its effect is greatest in patients with higher incomes.

Future efforts must research and address the barriers that may prevent patients with lower incomes from benefiting from specialist care.

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