Clinical Outcomes and Cost-Effectiveness of Retinopathy Screening in Youth With Type 1 Diabetes

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Since type 1 diabetes can lead to asymptomatic microvascular disease, regular screening for diabetic retinopathy (DR) in youth with type 1 diabetes has been recommended. The American Diabetes Association (ADA) (1) advises annual retinopathy screening once a child is 10 years old and has had type 1 diabetes for 3–5 years. This recommendation may have been appropriate in the pre-intensive treatment era, when elevated A1C levels were associated with early development of DR (2). However, results of the Diabetes Control and Complications Trial (3) demonstrated that intensive treatment in adolescents markedly delayed early microvascular changes in the retina. Since A1C levels in youth with type 1 diabetes are much lower now than they were 20 years ago (4,5), the yield from such screening examinations is also likely to be reduced.

Most DR screening studies have been carried out by retinal specialists using state-of-the-art technology (6). In many pediatric diabetes clinics like ours, however, general ophthalmologists and optometrists do not use advanced techniques to perform most routine eye screening, which may reduce the likelihood of identifying early retinal changes. The aim of this study was to examine the prevalence of positive DR exams in our Pediatric Diabetes Clinic population in comparison to the yield from blood pressure and microalbuminuria screening in the same patients.

RESEARCH DESIGN AND METHODS

— Charts of all type 1 diabetic patients in our Diabetes Clinic were reviewed. Patients were included if they were aged ≤21 years and had written reports in their charts from an examining ophthalmologist/optometrist. Data regarding A1C, albumin-to-creatinine ratios, blood pressure, and use of antihypertensive medications were extracted. The study was approved by the Yale Human Investigation Committee. The study population was stratified into the four categories shown in Table 1.

DR screening involved ophthalmoscopy with dilated pupils. Diagnosis of DR was based on the written reports of the examining ophthalmologists ($n = 195$) and optometrists ($n = 2$). Reports indicating the presence of DR were confirmed by a follow-up discussion with the original ophthalmologist (one patient) or by referral for a second opinion by a retinal specialist (two patients).

Microalbuminuria was defined as an albumin-to-creatinine ratio ≥30 mg/g from at least two of three consecutive spot urine collections in a 3- to 6-month period (Quest Laboratories). Hypertension was defined as at least three consecutive blood pressure readings with values >90% for age, sex, and height (7).

We also calculated the total billings for eye exams that would have accrued if patients aged ≥10 years had initiated annual DR screening at ≥3 years duration of diabetes, and we compared that sum with that of annual exams initiated at ≥5 years duration. A new patient visit cost $200, and follow-up visits cost $175.

RESULTS

— Of diabetic patients, 197 (104 male and 93 female subjects) met the inclusion criteria (Table 1). Of these, 67 patients (34%) were either aged <10 years or had <3 years duration of type 1 diabetes and did not require screening. Eye exam reports were available in 130 of the 281 patients in our clinic who were aged >10 years and had >3 years duration of type 1 diabetes. The mean A1C averaged <8.0% in all four age-groups.

Only three eye exams were positive for DR. In one of the three positive reports, the examining ophthalmologist acknowledged that DR was misdiagnosed based on minor tortuosity of retinal vessels. The presence of microaneurysms in one eye in each of the other two patients was not confirmed by a retinal specialist; these patients were classified as having transient DR. In contrast, 19 patients (10%) who were aged ≥10 years had hypertension, and 7 (3%) had microalbuminuria.

There were 130 subjects (66%) aged ≥10 years with ≥3 years duration of type 1 diabetes. If all of these patients had followed ADA recommendations and commenced screening after 3 or 5 years of type 1 diabetes, the total eye exam charges would have been $96,615 or $67,170, respectively.

CONCLUSIONS

— The most striking finding of the study is that none of the patients who met ADA screening criteria had any verifiable or sustained evidence of early DR. At most, only two cases with possibly transient microaneurysms were identified. Since diabetes-related services impose a large economic burden, the identification and elimination of unnecessary examinations could improve the efficiency of current health care delivery. The results of this study make it very difficult to justify routine screening for DR in all youth with type 1 diabetes based solely on patient age and duration of diabetes. Although standard screening only involved ophthalmoscopy with dilated pupils, it is

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Abbreviations: ADA, American Diabetes Association; DR, diabetic retinopathy.

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

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Table 1—*Clinical characteristics and prevalence of diabetes complications in patients at the date of the most recent eye exam among each age-group*

	Prescreen (age <10 years)	Early adolescent (age 10–14 years)	Late adolescent (age 14.01–18 years)	Young adult (age 18.01–22 years)
n	32	61	84	20
Age (years)	7.5 ± 2.0	12.2 ± 1.0	16.1 ± 1.3	19.2 ± 1.0
Sex (% female)	17 (53)	30 (49)	42 (50)	4 (20)
Duration of type 1 diabetes (years)	3.7 ± 2.3	4.6 ± 3.0	7.4 ± 4.1	7.6 ± 3.5
A1C (%)	6.6 ± 0.8	7.3 ± 1.5	7.5 ± 1.2	7.9 ± 1.5
Retinal screen				
Transient positive	0 (0)	1 (2)	1 (1)	0 (0)
False positive	0 (0)	1 (2)	0 (0)	0 (0)
Retinal screen				
Transient positive	0 (0)	1 (2)	1 (1)	0 (0)
False positive	0 (0)	1 (2)	0 (0)	0 (0)
Microalbuminuria	0 (0)	1 (2)	5 (6)	1 (5)
Hypertension	0 (0)	2 (3)	10 (12)	7 (33)
Microalbuminuria & hypertension	0 (0)	0 (0)	0 (0)	0 (0)

Data are *n* (%) or mean ± SD. A1C levels were measured by the DCA 2000+ Analyzer (Bayer Diagnostics, Tarrytown, NY).

very unlikely that practicing ophthalmologists and optometrists would have missed more advanced retinal lesions that would require treatment or more frequent surveillance.

Our data indicate that routine eye screening for youth with type 1 diabetes also fails the criteria of cost-effectiveness. Indeed, the $67,000–96,000 cost in eye exams is only the tip of the iceberg, since it does not include costs for transportation and time lost from work and school. In contrast, screening for hypertension and microalbuminuria in patients aged ≥10 years were positive in 10 and 3%, respectively, all of whom were undergoing treatment with an ACE inhibitor or an angiotensin receptor blocker. Considerable evidence (1) supports early identification and treatment of hypertension and microalbuminuria to delay or prevent clinical nephropathy and macrovascular disease.

The very low yield from the DR exams is due in large part to the low A1C levels achieved by our patients, representing the successful translation of the Diabetes Control and Complications Trial results (3) into clinical practice. Similarly, our 3% prevalence of microalbuminuria is lower than the 13% recently reported in a large population-based study (8) of children and adolescents with type 1 diabetes in Western Australia with mean A1C values >9.0%.

In conclusion, current ADA recommendations for DR screening are not cost-effective for pediatric type 1 diabetic patients who maintain strict glycemic control with intensive insulin therapy. These results suggest that it would be more cost-effective to limit routine eye screening to youth with type 1 diabetes who have persistent elevations in A1C levels, hypertension, or microalbuminuria, all of which involve assessments that can be carried out during regular diabetes clinic visits and do not require extra days being lost from work or school.

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