Clinical Chemistry 53:11
1954–1959 (2007)

Other Areas of
Clinical Chemistry

Impact of a Multidisciplinary Intervention for Diabetes in Eritrea

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Background: **When hemoglobin A1c (HbA1c) testing was made available to diabetic patients in the nation of Eritrea, the majority of values were markedly increased. As a result, a multidisciplinary clinical education program was instituted in Eritrea and the rate of HbA1c testing was increased to monitor progress.**

Methods: **In February 2003, a cooperative diabetes project was initiated in Eritrea to train diabetes educators, enhance physician education, create patient-teaching materials, and promote glucose monitoring. Two additional visits were made in 2003 and 2004. HbA1c values from January 2003 to November 2004 (n = 3606) were reviewed to assess diabetic control for the population and for a subset of individual patients (n = 350). A cohort of 209 diabetic persons were evaluated for demographics, treatment, and prevalence of complications.**

Results: **The cohort of 209 patients was 34% female and had a mean (SD) age of 50.5 (15.5) years and diabetes duration of 8.6 (6.3) years. Prevalence of hypertension was 37% and proteinuria 6%. For diabetes treatment, 59% received insulin therapy, 35% received oral agents, and 6% received nonpharmacologic treatment. HbA1c values improved significantly between the 1st 6 months of 2003 (median 10.9%) and the last 6 months of 2004 (median 8.5%; $P < 0.001$). Individual patients in whom 2 HbA1c values were measured ≥3 months apart showed a significant mean decrease of 0.5% ($P < 0.001$).**

Conclusions: **Our experience suggests that the combination of sustainable upgraded laboratory services and training in clinical management leads to sustainable improvement in diabetes care in developing countries.**

The prevalence of diabetes in Africa for individuals in the age range of 20–79 years is expected to increase from 7.1 million in 2003 to nearly 20 million in 2025 *(1)*. Possible reasons for this trend include increased detection and urbanization and dietary and lifestyle changes *(2–5)*. The rapid increase of diabetes and other chronic diseases will present enormous challenges to healthcare systems in developing nations. Healthcare in developing countries primarily focuses on acute disease, relying little on laboratory services, and offers limited patient follow-up. In contrast, chronic disease management requires sustainable laboratory services, healthcare workforce training, availability of appropriate drugs, and patient education in nutrition and self-care. Lack of resources, poor infrastructure, and loss of healthcare workers to developed countries have all slowed progress in these areas.

The WHO recommends a stepwise approach for the prevention and control of chronic diseases in developing countries *(6)*. A planning stage includes assessing disease prevalence, formulating policy, and establishing a plan for implementation of these policies and services. This stage is followed by an implementation process that maximizes resource utilization for sustainable improvement in chronic disease management. In 2003, using the WHO STEPwise Approach to Surveillance *(6)*, the Eritrean Health Ministry prepared a report stating that 2.3% of Eritreans had a prior diagnosis of diabetes. On the basis of the likelihood that the majority of diabetes cases are undiagnosed, it was estimated that the actual prevalence of diabetes exceeded 5%. Implementation plans included building capacity for health providers at all levels, im-

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Received July 17, 2007; accepted August 31, 2007.
Previously published online at DOI: 10.1373/clinchem.2007.095067

proving drug procurement, and producing diabetes management guidelines.

Since 1996, Pathologists Overseas, Inc., has been working with the Ministry of Health in Eritrea to improve clinical laboratory services throughout the country *(7, 8)*. As part of this program, analysis for hemoglobin A1c (HbA1c) was made available through the Barnes-Jewish Hospital clinical chemistry laboratory in St. Louis, MO, USA *(7)*. Initial testing showed that the majority of HbA1c values were markedly increased, with many values above 13% HbA1c. This observation and the ability to readily monitor progress via HbA1c led to the formation in early 2003 of a team of physicians, laboratory scientists, diabetes nurse practitioners, educators, and a dietician who did an onsite evaluation that led to educational programs for physicians as well as the 1st formal training of diabetes educators in Eritrea. As a result of these programs, approximately 40 individuals received certification to act as diabetes educators using International Diabetes Federation programs. In addition, monitoring of HbA1c was extended to more diabetic patients. The results of this 2-year, multidisciplinary intervention to improve diabetes management are presented in this report.

Materials and Methods

COORDINATED LABORATORY AND CLINICAL DIABETES INTERVENTION PROJECT OVERVIEW

Preliminary findings of poor glycemic control led to interventions targeting diabetes care in Eritrea. These interventions comprised 2 main components. First, beginning in 1996 laboratory services were continuously assessed and improved through the efforts of Pathologists Overseas and Washington University and Barnes-Jewish Hospital *(7, 8)*. Blood glucose monitoring was expanded in 2003 with the help of donated glucose meters. Analysis of HbA1c was initially performed at Barnes-Jewish Hospital but is now performed in Eritrea. The 2nd component of the program was the implementation of 2 major educational efforts.

Continuing education courses for physicians were held at the quarterly meeting of the Eritrean Physicians Association in February 2003. These courses also included joint clinic rounds with 12 key physicians (20 h each), lectures, and case-based discussions (15 h) plus the provision of educational materials on 2 different occasions 10 months apart. Other healthcare professionals involved in the management of diabetes also participated in these programs. The other program, diabetes educator training using prototype programs from the International Diabetes Federation for 40 students from throughout the country, was provided twice (Fig. 1). These training programs included production of patient nutrition education material presented in native languages and depicting regional foods.

Other activities included review and recommendations regarding the Eritrean essential medication formulary, which led to the government providing more consistent availability of longer-acting antihypertensive agents, an-

Fig. 1. The 1st group of Diabetes Educators trained in Eritrea (2003–2004).
Also present in the *back row* are 2 of the instructors, Kathy Haartmann and Cindy Merrins.

giotensin-enzyme inhibitors, metformin, and more types of insulin, including human insulin.

OUTCOME ASSESSMENT

We reviewed all HbA1c values measured for a 2-year period (2003–2004) in Eritrea (n = 3606). A subset of paired HbA1c values from 350 patients were extracted from this data set to evaluate the effect of time on follow-up values compared with baseline testing. These 350 patients were selected alphabetically from patients who had at least 2 HbA1c measurements performed at least 3 months apart during the study period. Date, age, and sex information were available for each of these patients. Clinical information was gathered from a cohort of 209 persons with diabetes who attended clinics at Halibet and Haz-Haz Hospitals (Asmara, Eritrea) while the teams were in Asmara. These clinics primarily cared for adult patients, although some adolescent patients were also included. Clinical information included duration of diabetes, current diabetes therapy, blood pressure measurement data, the presence of diagnosed hypertension, use of blood pressure medications, self-reported complications, urinalysis results, and body mass index. Patients were considered to have diabetes if they required insulin, used an oral hypoglycemic agent, or had a history of increased glucose concentrations and a recommendation for dietary restrictions. Specific medical records were not available to confirm these diagnoses using published criteria. No attempt was made to specifically differentiate type 1 from type 2 diabetes. Patients were classified as hypertensive if they required antihypertensive medications or had a single blood pressure of 140/90 mmHg or greater at a clinic visit. Peripheral neuropathy was classified as a subjective report of numbness or tingling in their extremities. The presence of proteinuria was determined by urine dipstick.

LABORATORY TESTING

Urine dipstick measurements for proteinuria were performed using Roche Chemstrips in the diabetes clinics. HbA1c testing was done by a turbidometric immunoassay performed on the Dade Dimension RXL Dimension analyzer (Dade-Behring) at Barnes-Jewish Hospital *(8)*, with the exception of 12 analyses performed at the National Health Laboratory in Asmara, Eritrea, in late 2004, when A1c testing on the Roche Hitachi 717 was implemented in Eritrea *(9)*.

This study was approved by the Washington University Investigational Review Board and by the Eritrean Ministry of Health.

STATISTICAL ANALYSIS

Nonparametric statistical tests were used for data analysis. We used the Mann–Whitney test for comparisons between 2 groups, the Wilcoxon signed-rank test for paired data, and the Kruskal–Wallis test for comparing more than 2 groups. Exact *P* values are reported to 3 significant digits except for $P < 0.001$. Stata release 9 (StataCorp) was used for all statistical calculations.

Results

HbA1c VALUES

Fig. 2 depicts a significant ($P < 0.001$) shift in the distribution of HbA1c values in the country of Eritrea from 2003 (n = 572) compared with values obtained in 2004 (n = 3034). Median HbA1c values decreased from 10.9% in the 1st 6 months of 2003 to 8.9% in the last 6 months of 2004 (Table 1). These changes were significant ($P < 0.001$),

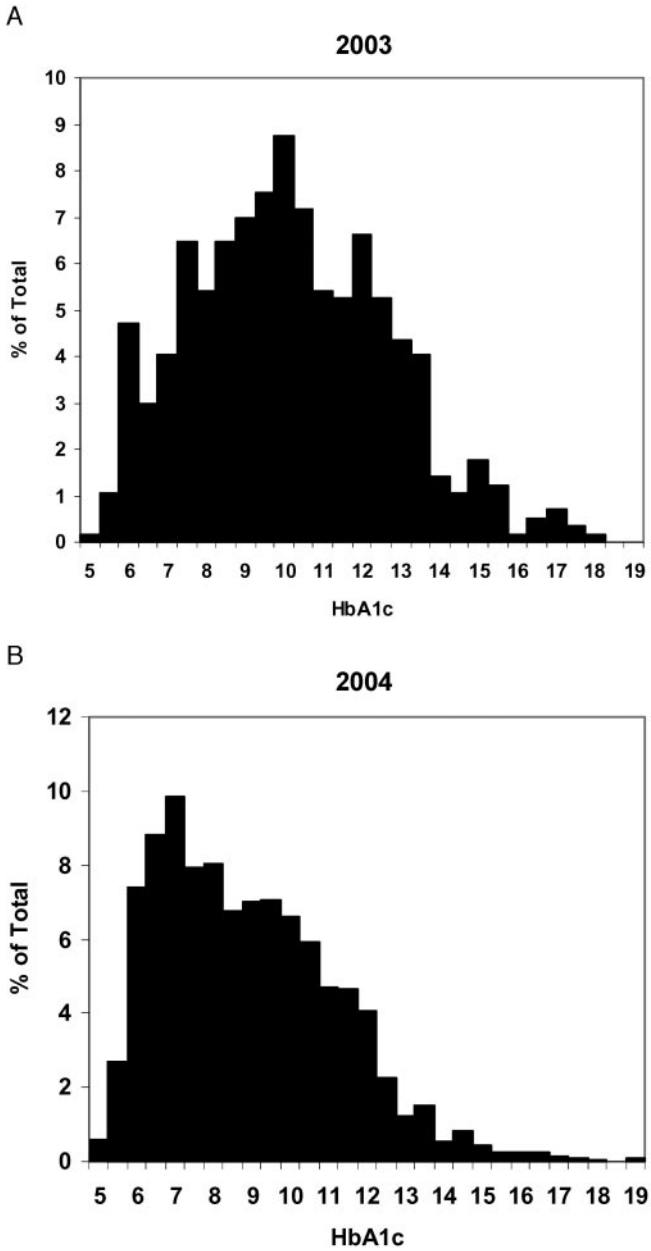

Fig. 2. Distribution of HbA1c values in the country of Eritrea in 2003 (n = 572; *A*) and 2004 (n = 3034; *B*).

The larger number in 2004 was attributable to expansion of availability of HbA1c testing to all diabetes patients in Eritrea.

Table 1. Percentage of HbA1c values in consecutive 6-month intervals in 2003 and 2004.

	HgbA1C, %			
	Jan–Jun 2003	Jul–Dec 2003	Jan–Jun 2004	Jul–Dec 2004
n	249	323	1524	1512
Median	10.9	9.8[a]	9.1[a]	8.5[a]
25%–75% range	8.9–13.1	8.1–11.4	7.4–10.8	7.0–10.4

[a] Wilcoxon rank-sum tests showed that each interval is significantly different from the preceding value ($P \leq 0.0001$ for all). Kruskal–Wallis test for a difference among the groups showed $P < 0.0001$.

as were the decreases observed in the intervening 6-month intervals, suggesting a rapid impact of the educational efforts begun in 2003 (Table 1).

We evaluated data from 350 persons with diabetes who had at least 2 HbA1c measurements performed 3 months or more apart in 2003 and 2004 (Fig. 3). In these paired studies, the mean (SD) HbA1c value decreased from 9.2 (2.5%) to 8.7 (2.3%) ($P < 0.0001$), with a mean time between values of 153 days. HbA1c values decreased in 205 patients (59%), increased in 131 (37%), and showed no change in 14. Patients with initial values ≥9% showed the greatest decrease (Fig. 3; $P < 0.001$). Patients ≤20 years old (n = 48) had a mean decrease of 1.0% compared with a decrease of 0.4% in patients >20 years old (n = 302), but this difference was not statistically significant ($P = 0.094$).

CHARACTERISTICS OF DIABETES IN ERITREA

The characteristics of persons with diabetes seen at the Asmara clinics were examined in the cohort of 209 patients seen during the team's visits. This patient group was 66% male, with a mean (SD) age of 49.4 (16.3) years for males and 52.4 (13.9) years for females (range 13–81 years for all patients). The mean reported duration of diabetes was approximately 8 years, and the mean (SD) age at diagnosis was 42 (15.3) years. The mean (SD) body mass indices were 23.0 (4.7) kg/m^2 for males and 22.2 (4.6) kg/m^2 for females.

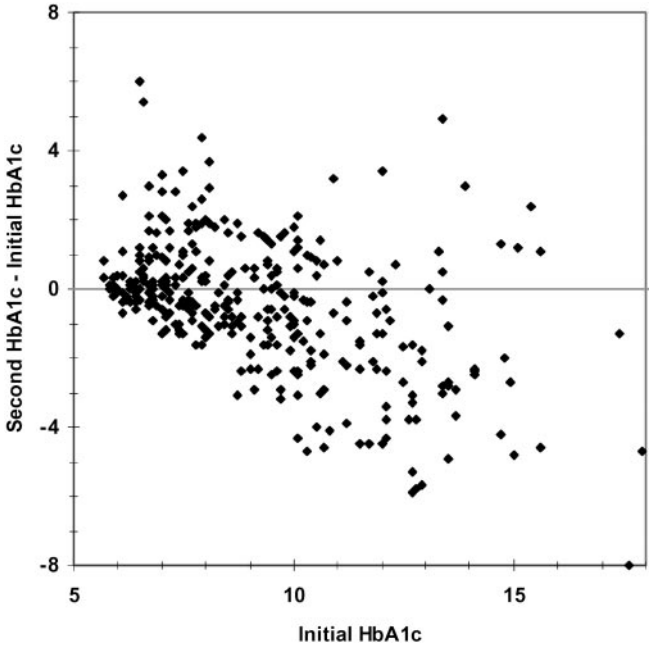

Fig. 3. Difference between initial and subsequent HbA1c values for 350 patients with paired values ≥3 months apart.

Initial %HbA1c values are depicted on the *x*-axis, with the *y*-axis depicting the 2nd value minus the 1st value.

The majority of patients (59%) were taking insulin for glycemic control. This group was evenly divided between once and twice daily insulin injections. In 2004, a conversion from nonhuman to human forms of insulin for injection was taking place, and 35% of our patient cohort were taking the sulfonylurea glibenclamide. Diet control had been prescribed for 6%. The combined use of insulin and oral therapy was very unusual. The mean (SD) age of patients on insulin was 46 (16) years and of those on oral agents was 59 (10) years ($P < 0.001$).

Complications of diabetes and comorbid conditions were also assessed in this cohort. Hypertension was present in 37% of the group. Symptoms suggesting neuropathy were reported in 35% of the group. There was no significant difference in the duration since diagnosis of diabetes in those with or without neuropathies [9.1 (6.0) and 8.3 (6.6) years, respectively]. Proteinuria was detected by dipstick in 6% of diabetic patients. The presence of proteinuria did not correlate with the known duration of diabetes or the presence of hypertension (data not shown). Self-reported awareness of heart disease was present in 5% of patients. Both weight and body mass index were higher in the group with hypertension than the group without hypertension.

Discussion

The results of our initial 2-year assessment of diabetes control after a multidisciplinary program of clinical diabetes education and increased laboratory services Eritrea demonstrate that HbA1c values improved dramatically over the 2-year period of observation. The largest improvements in HbA1c values were in diabetic patients younger than 20 years old with higher initial HbA1c values. It is likely that most, if not all, of the younger age group had type 1 diabetes. At the time of initial assessment in early 2003, many of the younger patients with diabetes were receiving a single dose of intermediate-acting animal insulin daily. By mid-2004, more than 80% of these patients were on twice-daily human insulin,

suggesting that improved control was due to changes of insulin management. We believe that broad availability of HbA1c testing in conjunction with physician education regarding glycemic control targets and methods played a major role in the improvement of HbA1c values for these patients.

We considered other possible causes for the significant changes observed in HbA1c values in Eritrea. Quality assurance efforts at the Barnes-Jewish Hospital make a shift in assay results over this period highly unlikely. For instance, imprecision values (%CV) for the Barnes-Jewish Hospital HbA1c methods were 4.42% at HbA1c of 5.8% (n = 1740) and 5.36% at HbA1c of 9.8% (n = 1829) for a 13-month period (April 2003–May 2004), when a single lot of Bio-Rad Lyphochek quality control material was used. Although shifts of 0.1%–0.3% in HbA1c were observed following calibrations or reagent lot number changes, none were consistently in one direction or persisted for long periods. It is also possible that the increase in the number of patients over this period could have resulted in the inclusion of more patients with better glycemic control, but we consider such a scenario to be an unlikely explanation for our results, because improvement was continual over the 2-year period and individual patients had greatly improved HbA1c values over shorter time periods.

Our experience strongly suggests that clinical management training and the development of patient educators and laboratory infrastructure must all be addressed if improvement of overall care of persons with chronic diseases is to be achieved. With our work in Eritrea, the efforts began in the laboratory. If they had started with clinical activities, however, we believe that the need to develop sustainable laboratory services would have become apparent. The ability to monitor glucose, HgbA1C, electrolytes, and renal function is essential to improve long-term care of diabetic patients. Likewise, improvement in laboratory monitoring without the knowledge and tools to improve the overall care of the patient would be frustrating and ultimately meaningless. We are continuing our efforts in Eritrea, particularly in regard to education in chronic disease management and development of better assessment tools. We are also extending and refining these principles for diabetes management in other developing countries with the view that assessment and upgrade of laboratory services are a mandatory component of any chronic disease management program.

The general characteristics of persons with diabetes in Sub-Saharan Africa have been described *(2, 4, 5, 9, 10)*. Both type 1 and type 2 diabetes are readily found in this population. In addition, a ketosis-prone form of adult type 2 diabetes has been recognized *(11, 12)*. The body mass index in diabetic persons from Sub-Saharan Africa is lower than that typically found in diabetic persons in more developed countries, as we also found in Eritrea. Physicians caring for these patients in Eritrea felt that poor nutrition and poor knowledge of nutrition were major problems in diabetic patients. Recognition of this situation led to patient nutrition education with a major focus on local rather than Western foods.

Educational programs must be tailored to the current context of healthcare in the country, a task that requires direct observation of day-to-day clinical services, nurturing of collegial and trusting professional relationships, and development of a thorough understanding of the healthcare culture. In regard to physician practice, there is a need for knowledge of current practices; understanding of clinic structure and workflow; and availability and training of support staff such as nurses, diabetes educators, nutrition experts, and consultants to assist with complication management. Eritrean physicians had traditionally been completely responsible for care of high volumes of patients. The addition of healthcare workers to take responsibility for patient education and self-care training was desired by the Ministry of Health and is expected to partially remedy this manpower shortfall, as has been reported in other developing countries *(13–16)*.

Methods of chronic disease management used in developed countries will continue to be limited by financial constraints in countries such as Eritrea, which is ranked by the World Bank as among the poorest countries. Nevertheless, coordinated efforts between health ministries and interested groups with a multidisciplinary approach should significantly improve the healthcare of patients with diabetes and other chronic diseases in developing nations.

Grant/funding support: We gratefully acknowledge the many corporate donors to projects of Pathologists Overseas. Specifically, for the project described in this report we thank Lori Gabrek of Roche Diagnostics U S A for the gift of a Hitachi 717. We thank Lifescan for donation of glucose meters and strips. This project was funded by USAID Grant 661-006-G-00-6500-00 and by Pathologists Overseas, Washington University School of Medicine, and the Wilding Foundation.

Financial disclosures: None declared.

Acknowledgments: We thank Lydia Beyene and the many volunteers of Pathologists Overseas. We thank Saleh Meky (Minister of Health of Eritrea) and Dr. Haile Mezghebe (Howard University).

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