Quality of Diabetes Care in the Middle- and High-Income Group Populace

The Delhi Diabetes Community (DEDICOM) survey

JITENDER NAGPAL, MD
ABHISHEK BHARTIA, ME

OBJECTIVE — We sought to evaluate the quality of care in known diabetic patients from the middle- and high-income group populace of Delhi.

RESEARCH DESIGN AND METHODS — A cross-sectional survey was conducted using a probability proportionate to size (systematic), two-stage cluster design. Thirty areas were selected for a house-to-house survey to recruit a minimum of 25 subjects (known diabetes ≥1 year; aged 35–65 years) per area. Data were collected by interview, by blood sampling, and from medical records.

RESULTS — A total of 819 subjects (of 1,153 eligible) were enrolled from 20,666 houses. In total, 13.0% (95% CI 9.6–17.3) of the patients had an HbA_{1c} (A1C) estimation and 16.2% (13.5–19.4) had a dilated eye examination in the last year, 32.1% (27.5–36.6) had serum cholesterol estimation in the last year, and 17.5% (14.2–21.5) were taking aspirin. An estimated 42.0% (37.7–46.2) had an A1C value >8%, 40.6% (36.5–44.7) had an LDL cholesterol level >130 mg/dl, and 63.2% (59.6–66.6) had blood pressure levels >140/90 mmHg.

CONCLUSIONS — A wide gap exists between practice recommendations and delivery of diabetes care in Delhi.

Diabetes Care 29:2341–2348, 2006

Type 2 diabetes is a major public health problem in India with an estimated 32.7 million patients (1) and a prevalence of ~4 and 12% in rural and urban areas, respectively (2,3). Despite its high prevalence, serious long-term complications, and established evidence-based guidelines for management (4–6), translation of practice recommendations to care is still deficient in Asian (7–9) and developed countries (10–16). Assessment of quality of care in the community can help draw attention to the need for improving diabetes management and provide a benchmark for monitoring changes over time. The two major studies from urban India (8,9) are limited by their design by sampling only those patients who were being followed in health centers or were known to community health workers. In one of these studies, 94% of patients had a monthly family income below 10,000 rupees (~225 U.S. dollars), and lower income predicted poorer care. We therefore conducted a population-based survey of quality of diabetes care restricted to the higher income group to reduce the impact of affordability. We chose to report our findings using the National Diabetes Quality Improvement Alliance (NDQIA) measures for better comparability (17).

From the Sitaram Bhartia Institute of Science and Research, New Delhi, India.
Address correspondence and reprint requests to Abhishek Bhartia, Director, B-16, Qutab Institutional Area, New Delhi 110016. E-mail: abhishek.bhartia@sitarambhartia.org.
Received for publication 10 April 2006 and accepted in revised form 8 August 2006.
Abbreviations: DEE, dilated eye examination; DQIP, Diabetes Quality Improvement Project; DSD, duration since diagnosis; NDQIA, National Diabetes Quality Improvement Alliance; OHA, oral hypoglycemic agent; PCP, primary care provider; SMBG, self-monitoring of blood glucose.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.
DOI: 10.2337/dc06-0783

RESEARCH DESIGN AND METHODS — This survey was conducted from September to December 2005. The inclusion criteria were known diabetes for 1 year (diagnosed by a registered medical practitioner on the basis of blood glucose estimation), age 35–65 years, family-owned car, and “pucca” house (house with brick-plaster walls and a concrete roof). Subjects were recruited from areas belonging to socioeconomic categories A, B, C, or D (the classifications used in Delhi for determining property tax; range A–G, where “A” is the highest). Age limits were chosen on the basis of a trial run ($n = 145$), which documented that type 1 diabetes (larger proportion below 35 years) was sometimes difficult to differentiate from type 2 diabetes in this populace (poor educational background and lack of medical records) and that subjects aged >65 years were largely dependent on their children for the quality of care received and tended to have multiple comorbidities. The exclusion criteria were type 1 diabetes; gestational diabetes; cancer, renal, hepatic, or intestinal disease requiring continuing treatment or hospital admission (>1 week in the last 1 year); and inability to communicate (due to mental illness or physical disability).

Thirty of the 150 wards were chosen using a random computer-generated seed value and then selected at a predefined sampling interval ([total population × 30]/150; probability proportionate to size, systematic method) from the available population data (18). A house-to-house survey was conducted in a randomly selected area in the ward to identify 40 known diabetic subjects sequentially. The identified patients were visited by a research team to screen for selection criteria. It was anticipated that 25 subjects would consent for participation and blood sampling. If this number was not achieved in a particular cluster, then the survey was continued. The enrolled subjects were administered a standardized pretested proforma based on the Diabetes Quality Improvement Project (DQIP; updated as NDQIA) (19). The proforma was filled by interview or record review by the research team. An overnight fasting sample was subsequently drawn.

Quality-of-care measures

The baseline information included age, sex, ethnicity, education, marital status, medical benefits (government and private medical insurance or reimbursement), annual household income, smoking, alcohol use, duration since diagnosis (DSD), qualification of the primary care provider (PCP), place of health care, and number of visits to the PCP in the last year. Information on cholesterol; HbA_{1c} (A1C); eye, urine, and foot examination; electrocardiogram; exercise testing; self-monitoring of blood glucose (SMBG); and prescription of oral hypoglycemic agents (OHAs), insulin, aspirin, and lipid-lowering drugs was collected from records and by interview. Standardization of recorded laboratory data was not feasible. Any emergency visits for blood glucose or blood pressure control were also noted.

Considering the poor standardization and maintenance of blood pressure records in the trial run, we recorded only current blood pressure. It was not considered possible to determine the purpose of urine testing, and any routine urine examination was recorded as such. For patients without documentation, an eye examination after administration of pupil-dilating eye drops (based on drug name or photophobia after instillation) was taken as evidence of dilated eye examination (DEE).

Weight was recorded on a manual weighing scale (sensitivity 500 g), height by using an SECA stadiometer (sensitivity 0.1 cm), waist circumference at the level of umbilicus using a measuring tape (sensitivity 0.1 cm), and blood pressure by using an OMRON electronic instrument (sensitivity 1 mmHg; accuracy ±3 mmHg) validated in an earlier trial (20). Height, waist circumference, and weight were recorded with light clothing and without shoes. Three serial blood pressure recordings from the right arm were taken after 10 min rest at 10-min intervals in the sitting posture (mean was used for analysis) as per World Health Organization recommendations (21).

Biochemical analysis

Blood (5 ml) was divided into three cuvettes (plain lipid profile, fluoride blood glucose, and EDTA-A1C) and transported in ice within 3 h to the laboratory. The sample for A1C was stored at 4°C until processing (within 48 h). The other cu-

Table 1—*Baseline characteristics of the population (based on* n = *819)*

Characteristic	Overall	Men	Women
n		404	415
Age (years)	53.6 ± 0.4	53.4 ± 0.6	53.9 ± 0.5
Age distribution (%)			
35–44 years	15.6 ± 1.6	18.2 ± 2.1	13.1 ± 2.3
45–54 years	32.1 ± 2.1	29.6 ± 2.2	34.6 ± 3.0
55–65 years	52.3 ± 2.5	52.2 ± 3.3	52.3 ± 3.0
Sex (%)	—	49.3 ± 1.9	50.7 ± 1.9
Mean BMI (kg/m^2)	28.7 ± 0.3	27.5 ± 0.3	29.8 ± 0.4
BMI >25 kg/m^2	75.6 ± 2.1	69.6 ± 2.8	81.3 ± 2.7
Waist circumference (cm)	98.2 ± 0.6	99.6 ± 0.7	96.9 ± 0.7
Waist circumference ≥ cutoff*	89.0 ± 1.5	83.8 ± 2.3	94.0 ± 1.5
DSD	8.1 ± 0.3	9.0 ± 0.4	7.3 ± 0.4
Prescribed			
OHA	79.6 ± 2.2	80.6 ± 2.2	78.6 ± 3.0
Insulin	10.4 ± 1.3	11.3 ± 1.7	9.5 ± 1.5
OHA + insulin	24.0 ± 1.9	24.6 ± 2.7	23.4 ± 2.0
Neither	17.0 ± 2.0	15.7 ± 1.9	18.2 ± 2.8
Place of origin			
Migrated from other states in India†	47.7 ± 3.2	44.9 ± 4.1	50.2 ± 3.4
Residing in Delhi	39.0 ± 2.8	42.1 ± 3.7	36.0 ± 3.0
Migrated from areas now in Pakistan‡	13.4 ± 1.9	13.0 ± 2.6	13.7 ± 2.7
Education level			
College or higher	48.2 ± 3.1	61.5 ± 3.8	35.4 ± 3.2
Middle school or high school	34.3 ± 1.9	29.7 ± 2.5	38.7 ± 2.4
Less than primary school /illiterate	17.5 ± 2.6	8.8 ± 2.2	25.9 ± 3.6
Monthly income			
Refused comment	3.6 ± 0.7	1.3 ± 0.6	5.8 ± 1.2
<30,000 rupees	58.4 ± 2.8	56.1 ± 3.0	60.5 ± 3.2
>30,000 rupees	38.1 ± 2.7	42.6 ± 3.1	33.7 ± 3.2
Employment status			
Retired	18.1 ± 1.8	28.0 ± 2.9	8.5 ± 1.5
Never worked	40.0 ± 2.1	0.3 ± 0.3	78.6 ± 2.8
Employed	37.0 ± 2.4	65.3 ± 2.7	9.6 ± 2.3
Unemployed	0.5 ± 0.2	0.5 ± 0.4	0.5 ± 0.3
Medical benefits§	40.7 ± 3.5	42.0 ± 3.4	39.5 ± 4.0
Health care provided at (*n* = 819)			
Private clinics or nursing homes	52.6 ± 3.4	54.4 ± 4.1	50.8 ± 3.3
Hospitals			
Government	19.4 ± 2.7	17.4 ± 2.9	21.3 ± 3.0
Private	18.4 ± 1.9	18.7 ± 2.4	18.2 ± 2.2
Multiple	1.5 ± 0.4	1.7 ± 0.6	1.2 ± 0.5
Alternative medicine practices‖	4.1 ± 0.7	2.9 ± 0.7	5.2 ± 1.2
No doctor	4.1 ± 0.8	4.9 ± 1.1	3.3 ± 0.9
Qualification of PCP (*n* = 739)¶			
Endocrinologist	21.3 ± 2.3	22.4 ± 3.0	20.2 ± 2.6
Other practitioners#	62.6 ± 2.5	65.4 ± 3.2	59.9 ± 2.8
Qualification not known	13.7 ± 1.9	9.5 ± 1.9	17.8 ± 2.7
Alcohol user			
Current	16.8 ± 1.6	33.1 ± 2.5	1.0 ± 0.6
Former	5.3 ± 1.0	10.7 ± 2.0	—
Family type is nuclear	46.2 ± 2.5	50.2 ± 3.1	42.3 ± 2.8
Number of family members	5.4 ± 0.2	5.4 ± 0.21	5.5 ± 0.2

Data are means ± SE. *Suggested action level II cutoffs for Indian adults are >80 cm in women and >90 cm in men. †Migrated to Delhi from elsewhere in India within the last two generations. ‡Subjects migrated at the time of partition from areas now in Pakistan. §Individuals receiving any medical benefit (government insurance schemes, private medical insurance, or medical reimbursement). ‖Includes practitioners of homeopathy, ayurvedic medicine, naturopathy, and other alternative systems. ¶Excludes subjects with multiple or no PCP or those on care by alternative systems of medicine. #MBBS, MD in any specialty, or doctor of medicine in a specialty other than endocrinology. Monthly income of 30,000 rupees corresponds to ~8,000 U.S. dollars per annum.

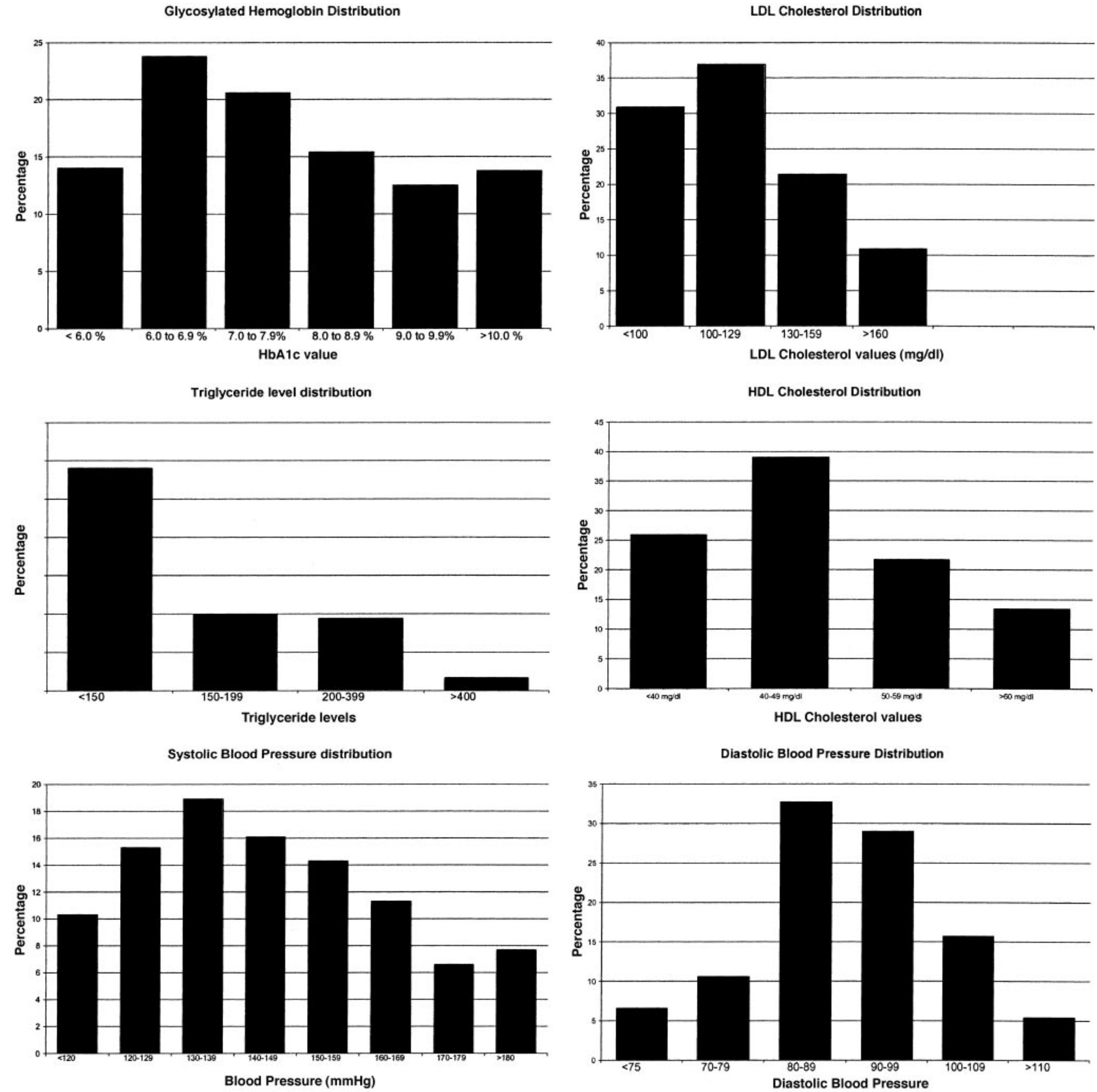

Figure 1—*Frequency distribution of quality improvement measures (based on NDQIA measures).*

vettes were centrifuged at 3,000g, and the serum/plasma was immediately processed or stored at −70°C. Lipid profile and blood glucose were estimated using a Hitachi 902 analyzer. A1C was estimated by low-pressure liquid chromatography (BioRad Diastat analyzer; Diabetes Control and Complications Trial aligned). Five percent of the samples were randomly rerun for quality control (coefficients of variation for A1C, serum cholesterol, and fasting blood glucose were 5, 3, and 2.5%, respectively).

Sample size considerations

It was estimated (accounting for the multistage cluster design) that a sample size of 768 subjects would be required to estimate the prevalence of poor diabetes control (A1C >8%; expected to be ~50% based on earlier data [7]) with an acceptable relative error of 10%, assuming an α error of 0.05 and 80% power. This sample size was based on an estimated population of known diabetes patients in Delhi (600,000 individuals based on available data [2]) and an assumed design effect of 2.0 (considering the lack of data on within- or between-cluster variations). It was decided to include a minimum of 25 subjects from each of the 30 clusters on the above basis and feasibility considerations.

Data analysis

Data entry and analysis were done using Epi-Info 2002 and SPSS version 13.0 software. "Complex Samples Procedure" accounting for the sampling design (inter- and intracluster variation) was used for percentage estimates on the DQIP mea-

Table 2—*Quality of diabetes care* (n = 819)

Characteristic	Overall Percentage	Overall 95% CI	Men Percentage	Men 95% CI	Women Percentage	Women 95% CI
NDQIA-based quality-of-care measures						
Accountability measures (based on questionnaire and medical records)*						
≥1 A1C estimation in last year	13.0	9.6–17.3	11.3	7.5–16.7	14.7	10.7 to 20.0
Dilated eye examination†	16.2	13.5–19.4	16.1	12.2–20.9	16.4	13.1 to 20.3
Foot examination in last year‡	3.1	2.0–5.0	2.4	1.2–4.7	3.8	2.2 to 6.8
Serum cholesterol estimation within last year	32.1	27.5–36.6	36.7	30.2–43.2	27.7	23.0 to 32.4
Aspirin use	17.5	14.2–21.4	21.3	17.2–26.2	13.8	9.6 to 19.4
Current smokers	9.6	7.4–12.3	18.9	14.9–23.4	0.5	0.1 to 2.1
Quality improvement measures (assessed at study examination)						
A1C (%)						
<6.0	14.0	11.4–17.1	13.5	10.4–17.4	14.4	11.1–18.6
6.0–6.9	23.8	20.4–27.5	23.7	19.3–28.7	23.9	19.5–28.9
7.0–7.9	20.6	18.0–23.4	20.4	17.0–24.1	20.8	17.1–25.1
8.0–8.9	15.4	12.9–18.2	16.3	13.0–20.2	14.5	11.1–18.7
9.0–9.9	12.5	9.9–15.6	14.2	10.9–18.3	10.8	7.7–14.9
≥10	13.8	11.1–16.9	12.0	9.0–15.7	15.5	11.9–19.9
LDL cholesterol level (mg/dl)						
<100	30.9	27.7–34.2	35.5	31.3–40.1	26.3	21.9–31.3
100–129	36.9	32.8–41.1	34.1	28.8–39.9	39.5	34.5–44.7
130–159	21.4	17.8–25.4	19.6	14.9–25.4	23.1	18.9–27.9
≥160	10.9	8.6–13.7	10.7	8.4–13.5	11.1	8.0–15.2
HDL cholesterol level (mg/dl)						
<40	25.9	23.4–28.5	36.0	32.1–40.1	16.0	12.6–20.1
40–49	39.0	36.0–42.1	42.5	38.8–46.3	35.6	30.8–40.7
50–59	21.7	19.3–24.3	15.1	11.6–19.4	28.1	24.3–32.1
>60	13.4	11.4–15.8	6.4	3.9–10.2	20.4	17.0–24.2
Triglyceride levels (mg/dl)						
<150	58.1	54.4–61.7	55.0	49.7–60.3	61.2	56.4–65.7
150–199	19.8	16.2–23.9	17.4	13.4–22.3	22.1	17.7–27.2
200–399	18.8	16.6–21.2	22.8	18.9–27.3	14.8	11.9–18.3
>400	3.3	2.1–5.1	4.7	2.8–7.8	1.9	0.9–3.9
Systolic blood pressure (mmHg)						
<120	10.3	7.9–13.4	8.0	5.5–11.6	12.5	9.1–17.0
120–129	15.3	13.0–17.8	12.6	9.9–15.9	17.9	14.3–22.1
130–139	18.9	16.0–22.2	21.1	16.6–26.5	16.8	13.0–21.4
140–149	16.1	13.8–18.8	18.1	14.3–22.7	14.2	11.0–18.2
150–159	14.3	11.3–17.9	14.6	10.9–19.3	14.0	10.4–18.5
160–169	11.3	9.4–13.6	12.6	9.4–16.6	10.1	7.4–13.7
170–179	6.6	4.9–8.7	6.4	4.1–10.0	6.7	4.6–9.6
≥180	7.1	5.5–9.3	6.4	4.6–9.0	7.8	5.4–11.3
Diastolic blood pressure (mmHg)						
<75	6.6	5.0–8.7	5.5	3.5–8.4	7.7	5.5–10.7
75–79	10.6	8.6–12.9	10.8	8.3–13.8	10.4	7.6–13.9
80–89	32.7	30.0–35.5	33.8	29.7–38.3	31.6	26.9–36.7
90–99	29.0	25.7–32.4	28.1	23.3–33.4	29.8	25.5–34.6
100–109	15.7	13.3–18.5	16.6	12.6–21.5	14.9	12.2–18.2
≥110	5.4	4.2–7.0	5.3	3.4–8.1	5.6	3.6–8.2
Additional quality-of-care measures (based on questionnaire and medical records)						
Diabetes self-management education§	10.3	8.1–13.0	12.4	9.5–16.2	8.1	5.6–11.8
Nutrition counseling‖	56.1	50.6–61.5	55.2	48.4–61.8	57.0	50.6–63.2
Smoking cessation counseling	8.3	4.1–16.3	8.5	4.2–16.5	0.0	0.0–100.0
Satisfied with care provided (yes)	56.9	51.8–61.7	57.3	51.5–63.0	56.4	50.9–61.7

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Table 2—*Continued*

Characteristic	Overall		Men		Women	
	Percentage	95% CI	Percentage	95% CI	Percentage	95% CI
Advised on SMBG ≥1/week (either by self or a relative)	7.5	5.5–10.1	7.8	5.5–11.0	7.2	5.0–10.2
Possess home blood glucose monitoring device	28.4	22.8–34.7	31.8	26.0–38.1	25.1	19.0–32.2
Advised MOM (≥1/week)¶	1.7	1.0–3.1	2.5	1.3–4.8	1.0	0.4–2.6
Advised SMBG or MOM ≥1/week	8.0	6.0–10.6	8.8	6.2–12.4	7.2	5.0–10.2
Exercise prescription	56.2	50.6–61.6	60.9	54.6–67.0	51.6	44.9–58.2
Foot care advice	26.2	22.3–30.6	28.6	23.9–33.7	24.0	18.9–29.9
≥1 emergency visit to PCP in last year#	15.1	12.5–18.2	11.1	8.8–14.4	19.0	14.2–25.0

*Written documentation of the measures was available for A1C in 44.9% (of those who claimed that it was done in the last year; $n = 48$), for 4.7% for DEE (out of those who claimed it was done within 1 year; $n = 15$), for foot examination in 3.7% (out of those claiming that it was done in accordance with the definition specified; $n = 1$), and in 33.4% for serum cholesterol estimation within the last 2 years (of those claming it was done within 2 years; $n = 123$). †Any eye examination using a lighted device after putting pupil dilating eye drops (judged from name of the drops or whether it caused sensitivity to bright light afterwards) within the last year. ‡Any foot examination using weights placed on the great toe, fork-like vibration device, and hammer, pin, or hot and cold object. §Any group class or individual counseling on self-management for a minimum of 15 min by a dietician/diabetes counselor/nurse/doctor. ‖Any group class or individual counseling on diet by for a minimum of 5 min by a dietician/diabetes counselor/nurse/doctor. ¶Includes monitoring by self-urine testing and laboratory estimation of blood or urine glucose. #For hypoglycemia, hyperglycemia, or high blood pressure. MOM, monitoring by other methods.

sures, compliance, and awareness. Complex samples' linear and logistic regression were used to study the influence of baseline characteristics.

RESULTS — A total of 20,666 houses (289–1,030 per cluster) were screened to identify 1,529 known diabetic subjects, of which 328 failed to meet the inclusion criteria (38 had diabetes for <1 year, 28 had never had any blood glucose estimation, 161 were outside the specified age, and 101 had no car or were not residing in a pucca house) and 48 were excluded (7 had gestational diabetes, 3 had physical or mental disability, 11 had type 1 diabetes, and 27 belonged to the same family). Of the 1,153 eligible subjects, 249 were unwilling to participate in the study and 85 later refused consent for blood sampling. Thus, 904 subjects were recruited (range 25–30 per cluster), of which 819 were available for blood sampling. The recruited subjects ($n = 904$) were comparable with those who refused consent for age, sex, and ethnicity ($P > 0.05$; data not shown). Subjects who refused consent for blood sampling ($n = 85$) were comparable with those who consented ($n = 819$) for all baseline characteristics ($P > 0.05$; data not shown).

The baseline characteristics of the subjects are depicted in Table 1. Three-fourths of known diabetic patients had a BMI >25 kg/m^2, while 89.0% had abdominal obesity (20). Women had a shorter DSD and higher mean age at diagnosis; fewer women had received a college education, and most were never employed. About one-fifth of the population received care from an endocrinologist.

Quality-of-care measures

Table 2 and Fig. 1 summarize the quality-of-care measures. Half of the patients had a routine urine examination in the last year. However, only a small proportion underwent a DEE, foot examination, A1C estimation, smoking cessation counseling, exercise prescription, foot care advice, or self-management education. We found that 63.2 ± 1.7% (mean ± SE) of patients had uncontrolled hypertension (systolic blood pressure >140 mmHg or diastolic blood pressure >90 mmHg), 41.8% had poor glycemic control (A1C >8%), and 74.5% had a deranged lipid profile (LDL >130 mg/dl or HDL <40 mg/dl in men or HDL <50 mg/dl in women or triglyceride >150 mg/dl). Only one-fifth were taking aspirin, and 3.1% were taking lipid-lowering drugs.

Compliance and awareness

We found that 79.4 ± 2.2% of patients ($n = 649$) were compliant with the OHA and insulin prescribed; 41.4 ± 3.2% ($n = 340$) had not visited their PCP in the last year, and 77.4 ± 2.2% ($n = 639$) were following the advice on SMBG (Fig. 1). On combining these parameters into a composite compliance score (assigning score of +1 for following the advice on taking OHAs and insulin, on SMBG, and on visiting the PCP in the last year), only 41.8 ± 2.9% ($n = 349$) of the subjects were compliant (score = 3). Only 21.7% of patients had heard of the words "hemoglobin A1C," "glycosylated hemoglobin," or "any investigation estimating glycemic control over the past months." Awareness of the need for regular testing of blood glucose, eye examination, and electrocardiogram was reported by 89.1, 61.1, and 48.1%, respectively.

Factors affecting glycemic control

To study the relationship between demographic characteristics and quality of care, regression models were built for glycemic control, lipid control, blood pressure control, and process-of-care measures using variables found to have a significant correlation ($P < 0.1$) in bivariate analysis and other factors considered relevant (Table 3). College education and higher income were associated with improved glycemic control. After adjusting for DSD, higher age was associated with better glycemic control. Further, higher BMI was associated with better glycemic control, provided that waist circumference was included in the model, implying that for those with the same waist circumference, A1C was worse in those with lower BMI.

Higher age, availing medical benefits, and female sex were associated with lower LDL-to-HDL cholesterol ratio. Age, DSD, and place of origin were associated with poorer blood pressure control, whereas college education was associated with better control. Similarly, age was associated with higher triglyceride levels (modeling not shown). The probability of an individual having an annual DEE increased with DSD, institutional care, place of origin, and use of OHAs; chances of biennial cholesterol estimation increased with income, education, and medical benefits, while chances for emergency visit were higher in men and decreased with DSD (controlled for age) and OHA and insulin use. Similarly, the chances of an individual taking aspirin in-

Table 3—*Linear regression models based on glycemic control (A1C), lipid control, systolic blood pressure, DEE, emergency visits, and biennial cholesterol estimation* (n = *792*)

	A1C value (r^2 = 0.118)			LDL-to-HDL cholesterol ratio (r^2 = 0.080)			Mean systolic blood pressure (r^2 = 0.091)		
Parameter	Mean difference	95% CI	Significance	Mean difference	95% CI	Significance	Mean difference	95% CI	Significance
Age*	−0.023	−0.042 to −0.003	**0.024**	−0.014	−0.023 to −0.006	**0.002**	0.375	0.121–0.629	**0.005**
Sex†	−0.359	−0.728 to 0.010	0.056	0.250	0.110–0.390	**0.001**	0.718	−2.428 to 3.864	0.644
Smoking	0.041	−0.397 to 0.479	0.850	0.144	−0.102 to 0.390	0.240	−1.098	−5.090 to 2.895	0.578
Alcohol use‡	0.332	−0.119 to 0.782	0.143	−0.002	−0.196 to 0.193	0.987	2.072	−1.553 to 5.696	0.252
DSD*	0.042	0.021–0.063	**<0.001**	−0.006	−0.017 to 0.006	0.314	0.316	0.103–0.529	**0.005**
BMI*	−0.067	−0.100 to −0.034	**<0.001**	0.011	−0.006 to 0.027	0.192	−0.316	−0.837 to 0.206	0.226
Waist circumference*	0.017	0.002–0.032	**0.028**	0.001	−0.004 to 0.007	0.583	0.104	−0.124 to 0.332	0.360
Institutional care	−0.224	−0.573 to 0.126	0.201	−0.114	−0.241 to 0.012	0.075	0.134	−4.039 to 4.308	0.948
Qualification of PCP§	0.122	−0.139 to 0.383	0.348	−0.051	−0.181 to 0.080	0.432	−1.278	−4.387 to 1.831	0.407
Medical benefits‖	0.132	−0.171 to 0.436	0.380	−0.180	−0.309 to −0.052	**0.008**	0.831	−2.852 to 4.515	0.648
Migration from Pakistan	−0.144	−0.648 to 0.359	0.563	0.138	−0.083 to 0.360	0.211	5.182	1.673–8.690	**0.005**
College education¶	−0.283	−0.537 to −0.030	**0.030**	−0.005	−0.177 to 0.167	0.954	−4.758	−7.685 to −1.830	**0.002**
Income#	−0.339	−0.556 to −0.121	**0.003**	0.028	−0.106 to 0.162	0.675	0.084	−2.397 to 2.565	0.945
Number of members in family*	0.072	0.032–0.111	**0.001**	0.000	−0.024 to 0.025	0.974	0.172	−0.331 to 0.675	0.489
OHAs**	0.645	0.224–1.066	**0.004**	−0.030	−0.215 to 0.156	0.746	0.833	−3.413 to 5.079	0.691
Insulin user††	0.900	0.462–1.338	**0.000**	−0.113	−0.316 to 0.091	0.266	1.417	−3.739 to 6.573	0.578
Compliance score*	−0.235	−0.367 to −0.102	**0.001**	−0.019	−0.105 to 0.067	0.658	0.032	−1.777 to 1.842	0.971

Model: 792 subjects were included in the model, and blood sampling was done in 819 subjects, of which 27 refused to comment on income. Dependent variables were A1C value, LDL-to-HDL cholesterol ratio, systolic blood pressure, DEE in the last year, any emergency visits in the last year, and biennial cholesterol estimation. Independent variables were age, sex, smoking status, alcohol use, DSD, BMI, waist circumference, institutional care, qualification of PCP, medical benefits, migration from Pakistan, college education, income, number of family members, prescribed OHAs, prescribed insulin, and compliance score. Significant *P* values are in boldface. *These variables were used as continuous variables in the above model. †Mean difference indicates males minus females. ‡Alcohol use (current or former) versus no alcohol use (never). §Denotes difference between diabetologist versus other practitioners. ‖Denotes difference between those receiving any kind of medical benefit versus those not receiving benefits. ¶Mean difference indicates college level education minus school or lesser education. #Mean difference indicates income >30,000 vs. ≤30,000 rupees. **Difference between patients advised OHAs versus those not requiring/advised the same. ††Difference between patients advised insulin versus those not requiring/advised the same.

creased with age (β = 0.04, P = 0.03), institutional care (mean difference = 0.54, P = 0.04), and compliance score (β = 0.52, P = 0.002) (modeling not shown).

CONCLUSIONS— Our study documents that known diabetic patients from the higher-income group populace of Delhi have poor glycemic, lipid, and blood pressure control. Diabetes self-management education, nutrition counseling, exercise prescription, and screening evaluations recommended for early detection of complications are suboptimally used. Family income, family size, female sex, education, DSD, BMI, waist circumference, institutional care, migration from areas now in Pakistan, compliance, medical benefits, and OHA and insulin use are all independent predictors of various aspects of the quality of diabetes care. The poorer quality of care in women may be attributable to sex bias, as suggested by lower rates for lipid measurements, self-management education, and possession of glucose monitoring device or underlying biological differences or baseline differences in education, DSD, income, BMI, waist circumference, smoking status, alcohol use, and employment status. The higher rate of emergency visits in men may be attributable to more visits related to uncontrolled blood pressure.

The current study was conducted in India, a hotbed of diabetes, to generate relevant population-based data on the quality of diabetes care using centralized laboratory estimates, blood pressure measurements, and a standard-measure set fulfilling the gap in existing knowledge. It was restricted to the 35- to 65-year age-group from the higher socioeconomic strata to provide estimates from a subgroup where income and age were unlikely to be major constraints. However, income remained an independent predictor in the regression models and this also limited the representativeness of the data. Other limitations of the study include that it is partly based on self-reported data, which can increase bias. The NDQIA/DQIP sets were designed to evaluate the quality of care in managed care institutions and were modified to accommodate the poor availability of records.

Several studies (7–16) have attempted to evaluate the quality of diabetes care in developed countries and in India using data from public health databases, from hospitals, or from diabetes clinics. In comparison with data from the U.S. (16), the current study documents similar proportions of population with poor glycemic control despite a younger population and shorter duration of disease. Our study had a smaller proportion with raised LDL cholesterol (>130 mg/dl), which may be attributable to the poor applicability of the measure in the given populace (23). Also, a lower proportion of the Delhi subjects were being screened for early detection of complications, and blood pressure control was poorer. SMBG was often not prescribed or done at the

Table 3—*Continued*

DEE ($r^2 = 0.120$)			Emergency visits ($r^2 = 0.075$)			Biennial cholesterol estimation ($r^2 = 0.098$)		
Mean difference	95% CI	Significance	Mean difference	95% CI	Significance	Mean difference	95% CI	Significance
0.028	−0.006 to 0.061	0.105	0.008	−0.022 to 0.038	0.584	0.012	−0.007 to 0.030	0.219
−0.220	−0.825 to 0.385	0.463	0.690	0.018 – 1.36	**0.044**	0.251	−0.244 to 0.746	0.309
0.068	−0.765 to 0.901	0.868	0.007	−0.719 to 0.732	0.985	0.209	−0.334 to 0.751	0.438
0.012	−0.556 to 0.581	0.965	0.209	−0.449 to 0.868	0.520	−0.272	−0.725 to 0.181	0.229
0.082	0.050–0.114	**<0.001**	−0.039	−0.070 to −0.008	**0.015**	0.019	−0.007 to 0.045	0.153
−0.002	−0.078 to 0.074	0.951	0.019	−0.047 to 0.084	0.563	0.032	−0.019 to 0.083	0.208
0.011	−0.023 to 0.045	0.520	−0.017	−0.050 to 0.015	0.279	0.004	−0.017 to 0.024	0.718
0.552	0.160–0.943	**0.007**	−0.183	−0.650 to 0.284	0.430	0.294	−0.060 to 0.649	0.100
−0.288	−0.889 to 0.312	0.334	−0.056	−0.610 to 0.499	0.839	0.166	−0.101 to 0.433	0.213
0.237	−0.175 to 0.649	0.250	0.066	−0.395 to 0.527	0.771	0.486	0.235–0.736	**<0.001**
0.624	0.195–1.053	**0.006**	−0.280	−0.802 to 0.242	0.282	−0.101	−0.609 to 0.407	0.687
0.447	−0.034 to 0.927	0.067	0.450	−0.073 to 0.973	0.089	0.980	0.693–1.266	**<0.001**
−0.121	−0.546 to 0.304	0.566	−0.019	−0.448 to 0.411	0.930	0.472	0.191–0.754	**0.002**
−0.025	−0.093 to 0.043	0.455	−0.001	−0.061 to 0.060	0.982	−0.005	−0.074 to 0.064	0.879
0.896	0.370–1.423	**0.002**	−0.690	−1.277 to −0.104	**0.023**	0.092	−0.364 to 0.548	0.682
−0.355	−1.052 to 0.342	0.307	−0.628	−1.183 to −0.073	**0.028**	0.298	−0.259 to 0.855	0.283
−0.274	−0.517 to −0.030	0.029	−0.181	−0.552 to 0.189	0.325	0.064	−0.132 to 0.261	0.507

recommended frequency. (Of subjects, 77.4% were following advice on SMBG, but only 8.3% were monitoring more than one time per week versus 55.4% monitoring more than one time per day in the U.S. population.) The level of glycemic and lipid control in the current study was comparable with data from the U.K. (13) (A1C <7.5% in 48%; serum cholesterol level <193 mg/dl in 59.8%); however, the proportion of diabetic patients undergoing a DEE and foot examination was much lower (DEE 60.0 vs. 16.2% and foot examination 27.1 vs. 3.1%, respectively).

Our results differ from an earlier multicentric clinic-based study (7) from India where subjects with a longer mean duration of diabetes (10.0 vs. 8.1 years), comparable mean age (53.4 vs. 53.6 years), higher A1C value (8.9 vs. 7.9%), and an equivalent prevalence of SMBG at any frequency (88.0 vs. 87.4%) had acceptable blood pressure control (systolic blood pressure >140 mmHg in 27% and diastolic blood pressure >90 mmHg in 13%), lower proportion with lipid abnormalities (54.0 vs. 74.5%), and lower rates of myocardial infarction (4.4% in those with A1C >8%) and stroke (1.6% in those with A1C >8%). This may be due to the shorter duration of disease (lower mean A1C value), community-based recruitment in our study versus those under active follow-up (excluding a proportion of subjects with less severe or shorter disease, possibly explaining our lower A1C value and worse lipid or blood pressure control [a larger proportion on appropriate management]), or may reflect the higher BMI of our subjects (75.6 vs. 39% with BMI >25 kg/m^2). In an urban health center–based study (9) from Bangalore, India, the frequency of ever having had a particular investigation was higher for foot examination (11.9 vs. 3.1%), whereas it was lower for blood lipids (7.7 vs. 51.3%) and electrocardiogram (20.6 vs. 70.9%). The higher rate for foot examination may reflect the higher likelihood of foot complications in this lower income population. Comparable data are not available on other screening investigations, self-monitoring, advised care, compliance, and awareness from the Indian studies.

The poor quality of diabetes care documented by our study threatens a large fraction of the population with a high-decadal risk of having coronary artery disease (~84,000 new cases projected to Delhi's ~600,000 diabetic patients, based on the U.K. Prospective Diabetes Study risk engine [24]) and stroke (~34,000), with an estimated 60,000 fatalities. Also, these comorbidities are preventable, with evidence documenting that a 1% reduction in A1C can reduce the risk of myocardial infarction by 16% (25); a 10-mmHg reduction in systolic blood pressure could decrease all-cause mortality, myocardial infarction, stroke, and microvascular complications by 18, 21, 44, and 37%, respectively (26); and improving lipid profile can reduce the risk for coronary artery disease by 25–55% (27).

In conclusion, a wide gap exists between effective diabetes management practices and their implementation, even among the middle- and high-income population of urban Delhi. The study strengthens the case and provides benchmark data for developing interventions targeted at patients, providers, and other stakeholders for improving the quality of diabetes care.

Acknowledgments— This study was supported by intramural funding from Sitaram Bhartia Institute of Science and Research (SBISR).

The authors appreciate suggestions from Prof. H.P.S. Sachdev and Dr. A.S. Lata, SBISR, and Prof. C.S. Pandav, All India Institute of Medical Sciences, New Delhi. We acknowledge the statistical input provided by Dr. Clive Osmond, University of Southampton, U.K. We are also indebted to A. Manoharan and the research teams for their efforts.

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