Determinants of Quality in Diabetes Care Process

The population-based Torino Study

ROBERTO GNAVI, MD[1]
ROBERTA PICARIELLO, BSC[1]
LUDMI LA KARAGHIOSOFF, BSC[1]
GIUSEPPE COSTA, MD[1,2]
CARLO GIORDA, MD[3]

OBJECTIVE — To investigate the role of clinical and socioeconomic variables as determinants of adherence to recommended diabetes care guidelines and assess differences in the process of care between diabetologists and general practitioners.

RESEARCH DESIGN AND METHODS — We identified diabetic residents in Torino, Italy, as of 31 July 2003, using multiple independent data sources. We collected data on several laboratory tests and specialist medical examinations registered during the subsequent 12 months and performed regression analyses to identify associations with quality-of-care indicators based on existing guidelines.

RESULTS — After 1 year, only 35.8% of patients had undergone a comprehensive assessment. In the multivariate models, factors independently and significantly associated with lower quality of care were age ≥75 years (prevalence rate ratio [PRR] 0.66 [95% CI 0.61–0.70]) and established cardiovascular disease (0.89 [0.86–0.93]). Disease severity (PRR for insulin-treated patients 1.45 [1.38–1.53]) and diabetologist consultation (PRR 3.34 [3.17–3.53]) were positively associated with high quality of care. No clear association emerged between sex and socioeconomic status. These differences were strongly reduced in patients receiving diabetologist care compared with patients receiving general practitioner care only.

CONCLUSIONS — Despite widespread availability of guidelines and simple screening procedures, a nonnegligible portion of the diabetic population, namely elderly individuals and patients with less severe forms of the disease, are not properly cared for. As practitioners in diabetes centers are more likely to adhere to guidelines than general practitioners, quality in the diabetes care process can be improved by increasing the intensity of disease management programs, with greater participation by general practitioners.

Diabetes Care 32:1986–1992, 2009

Diabetes is a major cause of morbidity and mortality for millions of people all over the world. The type of diabetes care can greatly affect the prognosis of patients with regards to survival (1), morbidity, and hospital usage (2). Recall of patients and screening processes have proved to be effective in identifying and treating patients at risk (3). Large geographic (4), socioeconomic (5–8), and ethnic (8,9) variations in the quality of care are present in most countries, irrespective of the health system or economic development (10). These inequalities are influenced by a complex web of factors, including prevalence of diabetes, behaviors and attitudes of patients and health care professionals, and the health care organization.

To improve the quality of diabetes care, surveillance systems monitoring the process of care over geographical areas, population subgroups, and time are needed to allow timely identification of critical points and rational planning for primary and secondary prevention of the disease (11). In answer to this need, a population-based surveillance program has been implemented in the city of Torino, Italy. The program has made it possible to assess socioeconomic differences in the prevalence of diabetes (12) and the impact of diabetes on prescription drug costs (13).

As a further step, we tested the feasibility of generating a set of established quality-of-care indicators (3,14–16) from administrative databases. We report the role of certain clinical and socioeconomic variables as determinants of adherence to recommended guidelines for monitoring diabetes and assess whether the quality of diabetes care differs between patients cared for by a diabetologist or by other physicians.

RESEARCH DESIGN AND METHODS

The study base included all residents in the city of Torino (900,000 inhabitants), aged ≥20 years, with a diagnosis of diabetes, and alive as at 31 July 2003. As described in detail elsewhere (12), patients were identified using three data sources: the file of subjects registered in the Regional Diabetes Registry (RDR), the file of prescriptions for antidiabetes drugs, and the file of hospital discharges with a diagnosis of diabetes. All data sources were matched by a deterministic linkage procedure using a unique identifier and were linked to the Torino Population Register to determine each individual's educational level. This was classified according to three levels: high (university/high school, i.e., ≥13 years of education), medium (middle school, up to 12 years of education), and low (primary school/no formal education, i.e., ≤8 years of education). Census tract median income data were used as a proxy of individual income and calculated through record linkage between the Torino Population Register and the 1998 Tax Register of the Ministry of Finance. The 3,419 census tracts (median number of 207 inhabitants) were grouped according to census tract median income percentiles into four

From the [1]Epidemiology Unit, ASL TO3, Regione Piemonte, Grugliasco, Italy; the [2]Department of Public Health, University of Torino, Torino, Italy; and the [3]Metabolism and Diabetes Unit, ASL TO5, Regione Piemonte, Chieri, Italy.
Corresponding author: Roberto Gnavi, roberto.gnavi@epi.piemonte.it.
Received 3 April 2009 and accepted 27 July 2009. Published ahead of print at http://care.diabetesjournals.org on 12 August 2009. DOI: 10.2337/dc09-0647.
© 2009 by the American Diabetes Association. Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. See http://creativecommons.org/licenses/by-nc-nd/3.0/ for details.
The costs of publication of this article were defrayed in part by the payment of page charges. This article must therefore be hereby marked "advertisement" in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024

income levels: low (<20th percentile; median level income €21,313), medium-low (20th–49th percentile; €24,085), medium-high (50th–79th percentile; €26,604), and high (≥80th percentile; €34,074) (17). We considered all those discharged from a hospital in the previous 5 years with a diagnosis of coronary heart disease (ICD-9-CM code 410–414), cerebrovascular disease (ICD-9-CM code 430–438), or disease of arteries (ICD-9-CM code 440–448) as individuals with established cardiovascular disease (CVD). Treatment was classified into three groups: diet only, oral antidiabetes drugs, and insulin. Information about therapy was retrieved from the RDR and, for patients not registered in the RDR, from prescriptions of antidiabetes drugs. Subjects who were prescribed both insulin and oral antidiabetes drugs were assigned to "insulin treatment"; all diabetic individuals who were not registered in the RDR and had not received any antidiabetes drug prescription (1,986 individuals) were considered within the "diet-only treatment" group.

The care process

All Italian citizens are cared for by a general practitioner (~1,100 in Torino) as part of the National Health System (NHS). Primary care for individuals with diabetes is provided mainly by a public network of ~700 diabetes clinics (14 in Torino), delivering diagnostic confirmation, therapy, help in prevention, and early diagnosis of complications through close patient follow-up by a team of specialists and the scheduling of regular check-ups. Most patients are referred to these care units by their general practitioner and care is free.

All laboratory tests and specialist medical examinations reimbursed by the NHS in the study period were linked to the population with diabetes to identify the following indicators of process of care: assessment of A1C, serum cholesterol (total, HDL, and LDL), microalbuminuria, examination of the eye (including at least one from among ocular examinations, observation of the fundus oculi, and retinography), and electrocardiogram (ECG) (including either an ECG alone or examination by a cardiologist). We also considered measurements of fasting glucose and triglycerides, but these results are not reported as they are similar to those for A1C and cholesterol. Finally, we generated a "guidelines composite indicator" (GCI) that included assessment of A1C and at least two assessments from among eye ex-

Table 1—*Kaplan-Meier estimates for indicators of diabetes care process; 1-year follow-up*

	n	A1C	Cholesterol	Microalbumin	Diabetologist	Eye examination	ECG	GCI
All	33,453	71.0 (70.5–71.5)	64.7 (64.1–65.2)	31.0 (30.5–31.5)	67.5 (67.0–68.0)	23.6 (23.2–24.1)	33.3 (32.8–33.8)	35.8 (35.3–36.3)
Sex								
Women	16,517 (49.4)	70.6 (69.9–71.3)	64.4 (63.6–65.1)	29.6 (28.9–30.3)	67.4 (66.7–68.2)	22.5 (21.9–23.2)	32.2 (31.5–32.9)	34.5 (33.8–35.3)
Men	16,936 (50.1)	71.3 (70.7–72.0)	65.0 (64.2–65.7)	32.4 (31.7–33.1)	67.6 (66.9–68.3)	24.6 (24.0–25.3)	34.4 (33.6–35.1)	37.1 (36.4–37.8)
Age (years)								
21–44	1,446 (4.3)	66.9 (64.5–69.3)	55.0 (52.5–57.6)	38.0 (35.5–40.5)	61.1 (58.6–63.6)	30.3 (28.0–32.7)	17.5 (15.6–19.6)	40.4 (37.9–43.0)
45–54	2,983 (8.9)	66.4 (64.7–68.1)	60.7 (58.9–62.4)	35.7 (34.1–37.5)	67.1 (65.4–68.8)	27.2 (25.7–28.9)	27.3 (25.7–28.9)	39.9 (38.1–41.6)
55–64	7,690 (23.0)	73.9 (72.9–74.9)	67.4 (66.4–68.5)	38.4 (37.3–39.5)	72.4 (71.4–73.4)	28.0 (27.0–29.0)	34.2 (33.2–35.3)	42.9 (41.8–44.0)
65–74	11,478 (34.3)	76.4 (75.6–77.2)	72.2 (71.3–73.0)	33.9 (33.0–34.8)	73.5 (72.7–74.3)	25.5 (24.7–26.4)	38.2 (37.3–39.1)	40.2 (39.3–41.1)
≥75	9,856 (29.5)	64.1 (63.1–65.1)	57.2 (56.2–58.2)	19.3 (18.5–20.1)	58.7 (57.7–59.7)	15.3 (14.5–16.0)	31.7 (30.7–32.6)	23.2 (22.4–24.1)
Education								
High	5,018 (15.0)	68.4 (67.1–69.7)	63.5 (62.2–64.9)	31.8 (30.5–33.1)	59.6 (58.2–61.0)	23.1 (22.0–24.3)	26.5 (25.3–27.7)	35.9 (34.6–37.2)
Medium	8,901 (26.6)	72.5 (71.5–73.4)	66.8 (65.9–67.8)	33.7 (32.7–34.7)	67.9 (66.9–68.8)	25.3 (24.4–26.2)	32.9 (31.9–33.9)	38.8 (37.8–39.8)
Low	19,534 (58.4)	71.0 (70.3–71.6)	64.5 (63.8–65.2)	29.8 (29.1–30.4)	70.0 (69.4–70.7)	22.9 (22.3–23.5)	35.6 (34.9–36.3)	34.7 (34.0–35.4)
Income								
High	4,664 (13.9)	69.5 (68.1–70.8)	64.2 (62.8–65.6)	27.5 (26.2–28.8)	58.4 (57.0–59.8)	21.0 (19.8–22.2)	27.0 (25.7–28.3	32.5 (31.1–33.8)
Medium-high	9,431 (28.2)	72.7 (71.8–73.6)	66.9 (66.0–67.9)	32.0 (31.0–32.9)	67.8 (66.8–68.7)	23.0 (22.2–23.9)	33.3 (32.4–34.3	36.7 (35.7–37.7)
Medium-low	10,789 (32.3)	72.1 (71.2–73.0)	66.5 (65.5–67.4)	32.8 (31.9–33.7)	70.7 (69.8–71.5)	25.0 (24.1–25.8)	35.1 (34.2–36.1)	38.3 (37.4–39.2)
Low	8,569 (25.6)	68.7 (67.7–69.7)	61.7 (60.7–62.8)	30.2 (29.2–31.2)	69.8 (68.8–70.8)	23.9 (23.0–24.8)	35.1 (34.1–36.1)	34.3 (33.3–35.3)
CVD								
No	26,638 (79.6)	72.3 (71.8–72.9)	64.8 (64.3–65.4)	32.7 (32.1–33.3)	69.1 (68.6–69.7)	24.5 (24.0–25.0)	30.9 (30.4–31.5)	37.4 (36.8–38.0)
Yes	6,815 (20.4)	65.4 (64.3–66.6)	64.0 (62.8–65.2)	24.1 (23.1–25.2)	61.1 (59.9–62.2)	20.1 (19.1–21.1)	42.9 (41.7–44.1)	29.5 (28.4–30.6)
Treatment								
Diet only	7,023 (21.0)	44.9 (43.7–46.1)	52.2 (51.0–3.5)	17.1 (16.2–18.0)	40.2 (39.0–41.4)	13.5 (12.7–14.4)	26.3 (25.3–27.4)	19.7 (18.8–20.7)
Oral drugs	17,765 (53.1)	76.2 (75.6–76.8)	68.3 (67.6–69.0)	33.5 (32.8–34.2)	72.9 (72.3–73.6)	24.7 (24.1–25.4)	34.6 (33.9–35.3)	38.6 (37.9–39.4)
Insulin	8,665 (25.9)	80.3 (79.4–81.1)	66.6 (65.6–67.6)	36.4 (35.4–37.5)	77.4 (76.5–78.3)	29.0 (28.0–30.0)	35.9 (34.9–36.9)	42.2 (41.2–43.3)

Data are % (95% CI).

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024

aminations, total serum cholesterol, and microalbuminuria.

We considered all individuals who had a diabetologic consultation at least once in the follow-up period as cared for by a diabetes center, whereas those who had not were considered as cared for by a general practitioner only. To estimate the number of patients in the latter group who had contact with a general practitioner, they were linked to the drug prescription and laboratory test databases: 99.44% had at least one prescription (i.e., a contact with a general practitioner) in the study period.

Statistical analysis

The study population was followed up from 1 August 2003 to 31 July 2004. The proportion of individuals with diabetes receiving diabetes care procedures was estimated using a survival analysis based on Kaplan-Meier methods, where "survival" was defined as time from baseline to the date of the first laboratory test or examination. We considered as right-censored 428 individuals who died and 100 who moved out of Torino during the study period.

The relationship between indicators and explicative variables was investigated using a log-binomial regression model and is presented as prevalence rate ratio (PRR). The models included all the variables described above and the local health unit of residence. The models were fitted using PROC LIFETEST and PROC GENMOD by SAS (version 9.1).

RESULTS — We identified 33,453 individuals with diabetes residing in Torino as of 31 July 2003. The baseline characteristics are shown in Table 1. After 1 year, 71% of subjects had undergone an assessment of A1C, 65% had an assessment of lipids, only 31% had an assessment of microalbuminuria; 33% had undergone an ECG, and 25% had an eye screening test. However, only 35.8% had undergone a more comprehensive assessment (GCI). Sixty-eight percent of patients were seen at least once at a diabetes center. The process of care differed according to sociodemographic and clinical variables. There were almost no differences by sex, whereas all indicators showed large disadvantages among elderly individuals. Socioeconomic differences were modest. As for clinical variables, individuals with established CVD had a lower frequency for all indicators, with the exception of ECG. The most striking difference con-

Table 2—PRRs for indicators of diabetes care process; 1 year of follow-up

	A1C	Cholesterol	Microalbumin	Diabetologist	Eye examination	ECG	GCI
Sex							
Women	1	1	1	1	1	1	1
Men	1.01 (1.00–1.02)	0.99 (0.97–1.00)	1.04 (1.01–1.08)	1.01 (1.00–1.02)	1.05 (1.01–1.09)	1.08 (1.04–1.11)	1.02 (1.00–1.05)
Age (years)							
21–44	1	1	1	1	1	1	1
45–54	0.99 (0.95–1.03)	1.11 (1.05–1.17)	0.98 (0.91–1.06)	1.08 (1.04–1.13)	0.96 (0.87–1.07)	1.48 (1.31–1.68)	1.03 (0.96–1.11)
55–64	1.08 (1.04–1.12)	1.21 (1.15–1.27)	1.05 (0.98–1.13)	1.15 (1.11–1.20)	0.98 (0.89–1.07)	1.81 (1.60–2.04)	1.10 (1.03–1.18)
65–74	1.11 (1.08–1.15)	1.28 (1.22–1.35)	0.95 (0.88–1.02)	1.17 (1.12–1.21)	0.91 (0.83–1.00)	1.94 (1.73–2.18)	1.04 (0.98–1.11)
≥75	0.96 (0.93–1.00)	1.01 (0.96–1.06)	0.56 (0.52–0.61)	0.97 (0.93–1.01)	0.55 (0.50–0.61)	1.55 (1.38–1.74)	0.62 (0.57–0.66)
Education							
High	1	1	1	1	1	1	1
Medium	1.05 (1.03–1.07)	1.04 (1.01–1.07)	1.02 (0.97–1.07)	1.08 (1.05–1.10)	1.11 (1.04–1.18)	1.16 (1.10–1.23)	1.05 (1.00–1.10)
Low	1.04 (1.02–1.06)	1.00 (0.98–1.03)	0.98 (0.94–1.03)	1.11 (1.08–1.13)	1.08 (1.01–1.15)	1.18 (1.12–1.25)	1.00 (0.96–1.05)
Income							
High	1	1	1	1	1	1	1
Medium-high	1.04 (1.02–1.06)	1.05 (1.02–1.07)	1.12 (1.06–1.19)	1.09 (1.06–1.12)	1.06 (0.99–1.14)	1.17 (1.10–1.23)	1.10 (1.05–1.16)
Medium-low	1.03 (1.02–1.06)	1.04 (1.01–1.07)	1.12 (1.06–1.18)	1.10 (1.07–1.13)	1.12 (1.04–1.20)	1.19 (1.13–1.26)	1.13 (1.07–1.18)
Low	1.01 (0.99–1.03)	0.99 (0.96–1.02)	1.07 (1.01–1.13)	1.09 (1.06–1.12)	1.05 (0.98–1.13)	1.16 (1.09–1.23)	1.04 (0.98–1.09)
CVD							
No	1	1	1	1	1	1	1
Yes	0.93 (0.91–0.95)	0.99 (0.97–1.01)	0.80 (0.77–0.84)	0.92 (0.90–0.94)	0.86 (0.82–0.91)	1.34 (1.30–1.39)	0.84 (0.81–0.87)
Treatment							
Diet only	1	1	1	1	1	1	1
Oral drugs	1.74 (1.70–1.79)	1.35 (1.31–1.38)	1.97 (1.86–2.08)	1.83 (1.77–1.89)	1.84 (1.72–1.97)	1.36 (1.30–1.42)	1.98 (1.88–2.08)
Insulin	1.84 (1.79–1.89)	1.35 (1.31–1.39)	2.18 (2.05–2.31)	1.98 (1.92–2.04)	2.11 (1.97–2.27)	1.42 (1.36–1.50)	2.21 (2.09–2.34)

Data are PRRs (95% CI). PRRs are adjusted for all variables and for local health unit of residence.

Table 3—*PRRs for some indicators of diabetes care process after 1 year of follow-up adjusted for diabetologist consultation*

	A1C	Cholesterol	Microalbumin	Eye examination	ECG	GCI
Sex						
Women	1	1	1	1	1	1
Men	1.00 (0.99–1.01)	0.98 (0.97–1.00)	1.04 (1.01–1.07)	1.05 (1.01–1.09)	1.06 (1.03–1.10)	1.02 (0.99–1.05)
Age (years)						
21–44	1	1	1	1	1	1
45–54	0.99 (0.96–1.02)	1.09 (1.03–1.14)	0.96 (0.90–1.04)	0.94 (0.85–1.04)	1.41 (1.24–1.60)	1.01 (0.94–1.08)
55–64	1.02 (1.00–1.05)	1.14 (1.09–1.20)	0.99 (0.93–1.05)	0.93 (0.85–1.01)	1.67 (1.49–1.88)	1.03 (0.97–1.10)
65–74	1.04 (1.01–1.06)	1.19 (1.14–1.25)	0.89 (0.83–0.95)	0.85 (0.78–0.93)	1.78 (1.59–2.00)	0.97 (0.92–1.04)
≥75	1.01 (0.99–1.04)	1.03 (0.98–1.08)	0.59 (0.55–0.64)	0.58 (0.52–0.64)	1.55 (1.38–1.75)	0.66 (0.61–0.70)
Education						
High	1	1	1	1	1	1
Medium	1.02 (1.01–1.03)	1.01 (0.99–1.03)	0.99 (0.94–1.03)	1.07 (1.00–1.14)	1.11 (1.05–1.17)	1.01 (0.97–1.05)
Low	1.00 (0.99–1.01)	0.97 (0.95–0.99)	0.93 (0.89–0.98)	1.03 (0.97–1.10)	1.12 (1.07–1.18)	0.95 (0.91–0.99)
Income						
High	1	1	1	1	1	1
Medium-high	1.00 (0.99–1.02)	1.01 (0.99–1.04)	1.08 (1.02–1.14)	1.01 (0.94–1.08)	1.12 (1.06–1.18)	1.05 (1.01–1.10)
Medium-low	1.00 (0.99–1.01)	1.01 (0.99–1.03)	1.07 (1.02–1.13)	1.06 (0.99–1.13)	1.14 (1.08–1.20)	1.07 (1.02–1.12)
Low	0.99 (0.98–1.01)	0.97 (0.95–1.00)	1.03 (0.98–1.09)	1.00 (0.93–1.08)	1.12 (1.06–1.19)	0.99 (0.95–1.05)
CVD						
No	1	1	1	1	1	1
Yes	0.98 (0.97–0.99)	1.02 (1.01–1.04)	0.85 (0.81–0.89)	0.90 (0.85–0.95)	1.39 (1.35–1.44)	0.89 (0.86–0.93)
Treatment						
Diet only	1	1	1	1	1	1
Oral drugs	1.17 (1.14–1.19)	1.09 (1.06–1.11)	1.38 (1.31–1.46)	1.41 (1.31–1.51)	1.08 (1.03–1.13)	1.37 (1.30–1.44)
Insulin	1.16 (1.14–1.19)	1.05 (1.03–1.08)	1.46 (1.38–1.55)	1.54 (1.43–1.65)	1.08 (1.03–1.13)	1.45 (1.38–1.53)
Diabetologist consult						
No	1	1	1	1	1	1
Yes	2.51 (2.44–2.58)	1.86 (1.82–1.91)	3.20 (3.02–3.39)	2.42 (2.28–2.58)	2.07 (1.98–2.16)	3.34 (3.17–3.53)

Data are PRRs (95% CI). PRRs are reciprocally adjusted for all variables and for local health unit of residence.

cerned the treatment of diabetes, which was strongly related to process indicators; for all of the assessments considered, their frequency was lowest among patients receiving diet-only treatment and highest among those treated with insulin (Table 1).

Table 2 reports the results of the multivariate models. Slight sex differences in favor of men were present for eye examination, ECG, and GCI. The effect of age differed between measures; A1C and cholesterol assessments increased with age up to the 65- to 74-year age class and decreased in the ≥75-year age-group. Microalbuminuria and eye examination showed no difference up to the 65- to 74-year age-group and dropped sharply in the last age class. ECG increased with age and only decreased slightly in the oldest age-group. GCI showed mild differences up to the 65- to 74-year age class and decreased sharply in the ≥75-year age class. Socioeconomic differences were absent or low and, if present, favored the disadvantaged social group. Subjects with previous CVD had a greater prevalence of cardiac tests, but poorer performance for typical diabetes screening tests, especially GCI. The strong association between severity of disease and the whole set of indicators was confirmed.

Table 3 shows the effect of introducing the diabetologist consultation into the multivariate model of Table 2. Although PRRs for almost all indicators remained unchanged, differences by type of treatment were considerably reduced, and the diabetologist consultation emerged as the strongest independent predictor of a better screening process.

The interactions between physician (diabetologist or general practitioner) and nearly all the variables considered were statistically significant ($P < 0.05$). Table 4 reports the results of multivariate models in patients cared for by a diabetes center ($n = 24,361$) and patients cared for by general practitioners ($n = 9,092$). On the whole, differences among the latter were much greater than those among the former, suggesting a more uniform diagnostic and screening approach at the secondary care level. The most striking differences regarded the type of treatment: differences between patients cared for by a diabetologist were largely inferior to those in patients cared for by general practitioners.

CONCLUSIONS — The first important conclusion that can be drawn from our work is that a low-cost surveillance program to monitor the quality–of–diabetes care process is feasible. Using routinely collected administrative data, we were able to monitor prospectively, at the population level, several indicators that are used internationally to assess the process of care (3,14–16) and, consequently, to identify some strengths and weakness of the care system.

On the basis of this set of indicators, the present study shows that there are considerable opportunities for improving the management of diabetes, particularly in elderly patients and in those with less severe forms of the disease. A recent survey in >100 Italian diabetes outpatient clinics (15) reported better performance for A1C (91.3%) and lipid measurements

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024

Table 4—*PRRs for indicators of diabetes care process, by diabetologist consultation at 1 year of follow-up*

	A1C		Cholesterol		Microalbuminuria	
	Yes	No	Yes	No	Yes	No
Sex						
Women	1	1	1	1	1	1
Men	1.00 (0.99–1.01)	1.02 (0.97–1.07)	0.98 (0.97–1.00)	0.98 (0.94–1.03)	1.03 (1.00–1.06)	1.10 (0.98–1.23)
Age (years)						
21–44	1	1	1	1	1	1
45–54	1.00 (0.97–1.03)	0.80 (0.70–0.91)	1.09 (1.04–1.15)	0.97 (0.84–1.12)	0.98 (0.91–1.06)	0.79 (0.63–0.98)
55–64	1.03 (1.00–1.05)	1.00 (0.89–1.12)	1.14 (1.08–1.19)	1.17 (1.03–1.33)	1.00 (0.93–1.08)	0.90 (0.74–1.09)
65–74	1.05 (1.02–1.07)	1.06 (0.95–1.18)	1.18 (1.12–1.23)	1.38 (1.23–1.56)	0.92 (0.85–0.98)	0.72 (0.59–0.88)
≥75	1.03 (1.00–1.06)	0.81 (0.72–0.91)	1.04 (0.99–1.09)	0.99 (0.87–1.12)	0.64 (0.59–0.69)	0.35 (0.28–0.43)
Educational level						
High	1	1	1	1	1	1
Medium	1.02 (1.01–1.04)	0.98 (0.91–1.05)	1.01 (0.98–1.03)	1.02 (0.95–1.09)	1.00 (0.96–1.06)	0.89 (0.77–1.02)
Low	1.01 (0.99–1.02)	0.93 (0.87–1.00)	0.97 (0.95–1.00)	0.94 (0.88–1.00)	0.95 (0.90–1.00)	0.89 (0.77–1.03)
Income						
High	1	1	1	1	1	1
Medium-high	1.00 (0.99–1.02)	1.00 (0.93–1.07)	1.02 (1.00–1.04)	0.99 (0.93–1.06)	1.11 (1.04–1.17)	0.97 (0.84–1.13)
Medium-low	1.00 (0.99–1.02)	0.98 (0.91–1.06)	1.01 (0.99–1.04)	0.99 (0.92–1.06)	1.10 (1.04–1.17)	0.90 (0.77–1.05)
Low	0.99 (0.98–1.01)	0.93 (0.85–1.01)	0.98 (0.96–1.01)	0.88 (0.82–0.96)	1.07 (1.00–1.13)	0.85 (0.71–1.01)
CVD						
No	1	1	1	1	1	1
Yes	0.99 (0.97–1.00)	0.90 (0.84–0.96)	1.03 (1.01–1.05)	1.01 (0.96–1.07)	0.88 (0.84–0.92)	0.70 (0.60–0.82)
Treatment						
Diet only	1	1	1	1	1	1
Oral drugs	1.07 (1.05–1.09)	2.28 (2.12–2.45)	1.04 (1.02–1.07)	1.27 (1.21–1.34)	1.19 (1.12–1.25)	2.73 (2.34–3.18)
Insulin	1.06 (1.05–1.08)	2.61 (2.41–2.82)	1.02 (0.99–1.04)	1.20 (1.12–1.28)	1.23 (1.16–1.30)	3.74 (3.17–4.41)

Data are PRRs (95% CI). PRRs are reciprocally adjusted for all variables and for local health unit of residence.

(70.3%), but the same low rate of microalbuminuria tests (44.0%) was found. Regarding similarity in Europe, in the European core indicators project (16) annual A1C testing ranged from 51% (Ireland) to 99% (France and the Netherlands), lipid measurements ranged from 45% (Ireland) to 99% (the Netherlands), and microalbuminuria testing ranged from 25% (Finland) to 97% (the Netherlands). However, these surveys refer either to patients cared for by diabetes clinics or to selected cohorts and not to the general population of individuals with diabetes. Only a few cross-sectional studies in Europe provide insight into the care process at the population level. In a U.K. population of patients with diabetes, 92% had an A1C recorded within the past 15 months and 87% had a serum cholesterol concentration recorded, whereas the test rate for microalbuminuria was at 39% and retinal screening was 60% (8). Our results are very similar to those reported in the U.S. for Medicare beneficiaries at the end of the 1990s for three quality measures: annual A1C testing, biennial eye examination, and biennial lipid profile (4).

These levels of care are not shared by the whole of the population with diabetes, with elderly patients being the most disadvantaged. The abnormal fall in the quality of care among elderly patients, which has also been reported in some studies (10) but not in others (4), could be attributable to several factors, including greater difficulty in accessing health services and competing comorbidities that can lead to a less "aggressive" approach to the disease. On the other hand, we found no difference in the quality of care by socioeconomic position and only a very slight advantage among men. These are original findings as almost all studies, both in Europe and in the U.S., have constantly shown lower quality of care and higher risk of complications from diabetes among women and among individuals of low socioeconomic status (5–8,10,18). However, these findings are not unexpected as they are in line with previous studies showing substantial equity in the outcomes of care among individuals with diabetes residing in Torino (12,19), adding convincing evidence that these patients receive clinical follow-up and care irrespective of their socioeconomic status, a fairly uncommon situation (20). The paradoxical excess of risk in high-income groups could be due to a more frequent recourse to private specialists (not recorded in NHS administrative databases).

Regarding clinical determinants, there is an unequivocal relationship between severity of diabetes and intensity of care, whereas, paradoxically, a previous cardiovascular event reduces the attention to diabetes monitoring. It is plausible that because of the presence of cardiovascular complications, the interference of another specialist, less sensitive to this issue, diminishes the intensity of diabetes screening.

However, consistently with other studies (1,21), the strongest predictor and effect modifier of the quality of care is the diabetologist. Patients cared for at a diabetes center are more likely to be monitored according to guidelines than patients who are only cared for by other physicians. Our results highlight a severity-of-disease effect, especially among patients not cared for by diabetologists. In primary care, general practitioners are more likely to realize the need for screening when they care for a patient taking

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024

Table 4—*Continued*

Eye examination		ECG		GCI	
Yes	No	Yes	No	Yes	No
1	1	1	1	1	1
1.04 (1.00–1.09)	1.06 (0.95–1.19)	1.05 (1.02–1.09)	1.14 (1.05–1.24)	1.02 (099–1.04)	1.08 (0.98–1.20)
1	1	1	1	1	1
1.02 (0.92–1.15)	0.61 (0.48–0.77)	1.33 (1.17–1.52)	1.79 (1.28–2.50)	1.04 (0.96–1.12)	0.74 (0.60–0.91)
0.99 (0.89–1.10)	0.71 (0.58–0.87)	1.56 (1.38–1.77)	2.33 (1.71–3.18)	1.06 (0.99–1.13)	0.86 (0.71–1.03)
0.90 (0.82–1.00)	0.71 (0.58–0.87)	1.65 (1.46–1.86)	2.65 (1.95–3.60)	1.00 (0.94–1.07)	0.79 (0.66–0.96)
0.66 (0.59–0.74)	0.30 (0.24–0.38)	1.47 (1.29–1.66)	2.06 (1.51–2.80)	0.71 (0.66–0.77)	0.33 (0.27–0.41)
1	1	1	1	1	1
1.05 (0.98–1.13)	1.17 (0.99–1.37)	1.08 (1.02–1.15)	1.26 (1.10–1.44)	1.01 (0.97–1.06)	0.98 (0.86–1.12)
1.01 (0.95–1.09)	1.16 (0.98–1.36)	1.10 (1.04–1.16)	1.27 (1.11–1.44)	0.96 (0.92–1.00)	0.93 (0.81–1.07)
1	1	1	1	1	1
0.99 (0.92–1.07)	1.11 (0.94–1.31)	1.11 (1.05–1.18)	1.16 (1.02–1.32)	1.07 (1.02–1.13)	0.95 (0.82–1.09)
1.06 (0.98–1.14)	1.07 (0.90–1.27)	1.14 (1.07–1.21)	1.15 (1.01–1.30)	1.09 (1.04–1.15)	0.95 (0.82–1.10)
1.01 (0.93–1.09)	0.96 (0.80–1.16)	1.13 (1.06–1.20)	1.07 (0.93–1.22)	1.02 (0.96–1.07)	0.86 (0.73–1.02)
1	1	1	1	1	1
0.93 (0.88–0.99)	0.79 (0.68–0.92)	1.37 (1.33–1.43)	1.53 (1.41–1.67)	0.91 (0.88–0.95)	0.74 (0.64–0.85)
1	1	1	1	1	1
1.22 (1.14–1.32)	1.97 (1.71–2.27)	1.03 (0.98–1.09)	1.21 (1.11–1.32)	1.19 (1.13–1.25)	2.80 (2.42–3.23)
1.29 (1.20–1.40)	2.75 (2.35–3.22)	1.03 (0.98–1.09)	1.20 (1.07–1.34)	1.24 (1.17–1.30)	3.68 (3.15–4.30)

insulin. Patients receiving diet treatment and, to a lesser extent, those taking pills are perceived as being at lower risk or sometimes are completely forgotten. Treatment seems to be a reminder of the disease and of the need for clinical assessment. The severity-of-disease effect is almost absent among patients cared for by diabetologists. Moreover, there is no difference by age among patients cared for by diabetologists, except for the oldest age class, whereas among patients who are only cared for by general practitioners, there is a linear inverse association with age and an impressive fall in the quality of care among elderly patients.

The main strength of our study is that, through record linkage between several data sources, we included about 80% of the entire population with known diabetes (12) and were able to monitor the care process longitudinally at the population level and at very low cost. Most studies assessing quality of care are based on either selected populations or on more or less large samples, a condition that makes replication difficult and costly, reduces the feasibility of continuous monitoring of care, and delays or invalidates timely interventions to improve it.

Our study has several limitations that could affect the results. Available administrative databases do not provide information on whether risk control targets have been met. We were only able to monitor when laboratory tests were performed but have no information about their results. This aspect is relevant because it has been pointed out that better process indicators do not always guarantee better intermediate outcomes (22,23). However, previous analysis conducted in the same area as our study convincingly highlighted the role of secondary care on hard end points such as mortality (24) and hospital admission (2). A second limitation is the lack of information about some relevant screening procedures such as blood pressure measurement, BMI determination, foot examination, and duration of disease, not recorded in administrative databases; the latter, however, should not affect adherence to guidelines. As a proxy of disease severity we used only insulin treatment and CVD; thus, some residual confounding related to diabetes complications or comorbidities can persist, and, furthermore, the accuracy of our conclusions could be affected by not accounting for physician-level variation (both general practitioner and diabetologist) by multilevel modeling (25); unfortunately, an identification key to link physicians with patients was not available. Finally, because Torino is an urban area in Northern Italy and residents have easy access to health services, we cannot assume that our results can be generalized to rural areas or to other regions.

In summary, this study provides the first population-based data on quality in the diabetes care process in a large southern European cohort and indicates that, despite the increasing prevalence of diabetes and the widespread availability of up-to-date guidelines and screening procedures, a nonnegligible portion of the diabetic population still do not receive proper care. On the other hand, the good news is that there are no sex or social inequities in health care. Diabetes centers, although with several limitations, seem to perform screening regardless of the severity of disease or other conditions. Conversely, patients who are only cared for by general practitioners are at greater risk of receiving low-quality care, as the physicians may lack sufficient knowledge, decision support, or time to appropriately

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024

schedule their patients' annual control examinations. However, it must be highlighted that the purpose of a surveillance system is not to rank doctors but to provide evidence for improvement. Our findings suggest that care provided to patients with diabetes can be improved by increasing the intensity of disease management programs to foster greater participation by general practitioners, thus increasing knowledge and decision support and raising appropriateness. Moreover, an effort to improve diabetes care in elderly patients is a priority.

Acknowledgments— This study was supported by the 2006 Ministry of Health Research Program ex art.12 bis DL 299/99 ("Un metodo per presidiare l'equità nell'appropriatezza e nella continuità dei percorsi assistenziali") and by the Piedmont Region Ricerca Sanitaria Applicata 2007 (Un modelo per il monitoraggio della qualità dell'assistenza ai pazienti con diabete mediante sistemi informativi correnti).

No potential conflicts of interest relevant to this article were reported.

References

1. Verlato G, Muggeo M, Bonora E, Corbellini M, Bressan F, de Marco R. Attending the diabetes center is associated with increased 5-year survival probability of diabetic patients: the Verona diabetes study. Diabetes Care 1996;19:211–213
2. Giorda C, Petrelli A, Gnavi R, Regional Board for Diabetes Care of Piemonte. The impact of second-level specialized care on hospitalization in persons with diabetes: a multilevel population-based study. Diabet Med 2006;23:377–383
3. De Micheli A. Italian standards for diabetes mellitus 2007: executive summary Diabete Italia, AMD Associazione Medici Diabetologi, SID Società Italiana di Diabetologia. Acta Diabetol 2008;45:107–127
4. Arday DR, Fleming BB, Keller DK, Pendergrass PW, Vaughin RJ, Turpin JM, Nicewander DA. Variation in diabetes care among states: do patient characteristics matter? Diabetes Care 2002;25:2230–2237
5. Brown AF, Ettner SL, Piette J, Weinberger M, Gregg E, Shapiro MF, Karter AJ, Safford M, Waitzfelder B, Prata PA, Beckels GL. Socioeconomic position and health among persons with diabetes mellitus: a conceptual framework and review of the literature. Epidemiol Rev 2004;26:63–77
6. Bihan H, Laurent S, Sass C, Nguyen G, Huot C, Moulin JJ, Guegen R, Le Toumelin P, Le Clésiau H, La Rosa E, Reach G, Cohen R. Association among individual deprivation, glycemic control, and diabetes complications: the EPICES score. Diabetes Care 2005;28:2680–2685
7. Hippisley-Cox J, O'Hanlon S, Coupland C. Association of deprivation, ethnicity, and sex with quality indicators for diabetes: population based survey of 53 000 patients in primary care. BMJ 2004;329: 1267–1270
8. Van Der Meer JBW, Mackenbach JP. The care of diabetes: differences according to level of education. Health Policy 1999;46: 127–141
9. Lanting LC, Joung IMA, Mackenbach JP, Lamberts SWJ, Bootsna AH. Ethnic differences in mortality, end-stage complications, and quality of care among diabetic patients: a review. Diabetes Care 2005;28: 2280–2288
10. Alberti H, Boudriga N, Nabli M. "Damm sokkor": factors associated with the quality of care of patients with diabetes. Diabetes Care 2007;30:2013–2018
11. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27:1047–1053
12. Gnavi R, Karaghiosoff L, Costa G, Merletti F, Bruno G. Socio-economic differences in prevalence of diabetes in Italy: the population-based Turin study. Nutr Metab Cardiovasc Dis 2008;18:678–682
13. Bruno G, Karaghiosoff L, Merletti F, Costa G, Demaria M, Panero F, Segre O, Cavallo-Perin P, Gnavi R. The impact of diabetes on prescription drug costs: the population-based Turin study. Diabetologia 2008;51:795–801
14. De Beaufort CE, Reunanen A, Raleigh V, Storms F, Kleinbreil L, Gallego R, Giorda C, Midthjell K, Jecht M, De Leeuw I, Schiber E, Boran G, Tolis G. European Union diabetes indicators. Eur J Public Health 2003;13:51–54
15. Italian Association of Clinical Diabetologists. *Quality Indicators in Diabetes in Italy*. AMD, Roma, 2008
16. EuCID. *Final Report European Core Indicators in Diabetes Project, 2008*. Available from http://ec.europa.eu/health/ph_projects/2005/action1/docs/action1_2005_frep_11_en.pdf. Accessed 11 February 2009
17. Marinacci C, Spadea T, Biggeri A, Demaria M, Caiazzo A, Costa G. The role of individual and contextual socioeconomic circumstances on mortality: analysis of time variations in a city of north west Italy. J Epidemiol Community Health 2004;58:199–207
18. Gouni-Berthold I, Berthold HK, Mantzors CS, Böhm M, Krone W. Sex disparities in the treatment and control of cardiovascular risk factors in type 2 diabetes. Diabetes Care 2008;31:1389–1391
19. Gnavi R, Petrelli A, Demaria M, Spadea T, Carta Q, Costa G. Mortality and educational level among diabetic and non-diabetic people in the Turin Longitudinal Study: a 9 year follow-up. Int J Epidemiol 2004;33:864–871
20. Glazier RH, Bajcar J Kennie NR, Wilson K. A systematic review of interventions to improve diabetes care in socially disadvantaged populations. Diabetes Care 2006;29:1675–1688
21. Mc Allister FA, Majumdar SR, Eurich DT, Johnson JA. The effect of specialist care within the first year on subsequent outcomes in 24232 adults with new-onset diabetes mellitus: population-based cohort study. Qual Saf Health Care 2007;16: 6–11
22. Grant RW, Buse JB, Meigs JB. Quality of diabetes care in U.S. academic medical centers. Diabetes Care 2005;28:337–442
23. Mangione CM, Gerzoff RB, Williamsom DF, Steers N, Kerr E, Brown AF, Waitzfelder BE, Marrero DG, Dudley A, Kim C, Herman W, Thompson TJ, Safford MM, Selby J. The association between quality of care and the intensity of diabetes disease management programs. Ann Intern Med 2006;145:107–116
24. Bruno G, Merletti F, Biggeri A, Bargero G, Ferrero S, Pagano G, Cavallo-Perin P. Fibrinogen and AER are major independent predictors of 11-year cardiovascular mortality in type 2 diabetes: the Casale Monferrato study. Diabetologia 2005;48:427–434
25. Greenfield S, Kaplan SH, Kahn R, Ninomiya J, Griffith JL. Profiling care provided by different groups of physicians: effects of patient case-mix (bias) and physician-level clustering on quality assessment results. Ann Intern Med 2002;136: 111–121

Downloaded from http://diabetesjournals.org/care/article-pdf/32/11/1986/600737/zdc01109001986.pdf by guest on 24 May 2024