

The Relationship Between Physicians' Self-Reported Target Fasting Blood Glucose Levels and Metabolic Control in Type 2 Diabetes

The QuED Study Group—Quality of care and outcomes in type 2 diabetes

THE QUED STUDY GROUP

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OBJECTIVE — To investigate the relationship between beliefs of physicians relative to intensive metabolic control in type 2 diabetes and levels of HbA_{1c} obtained in a sample of their patients.

RESEARCH DESIGN AND METHODS — Physicians' beliefs were investigated through a questionnaire sent to a sample of self-selected clinicians participating in a nationwide initiative aimed at assessing the relationship between the quality of care delivered to patients with type 2 diabetes and their outcomes. At the same time, physicians were asked to collect clinical data on a random sample of their patients, stratified by age (<65 vs. ≥65 years). Mean HbA_{1c} levels in the study population were thus evaluated according to target fasting blood glucose (FBG) used by their physicians.

RESULTS — Of 456 physicians, 342 (75%) returned the questionnaire. Among the responders, 200 diabetologists and 99 general practitioners (GPs) recruited 3,297 patients; 2,003 of whom were always followed by the same physician and 1,294 of whom were seen by different physicians in the same structure on different occasions. Only 14% of the respondents used target

FBG levels ≤6.1 mmol/l, whereas 38% pursued values >7.8 mmol/l, with no statistically significant difference between diabetologists and GPs. The analysis of the relationship between FBG targets and metabolic control, restricted to those patients always seen by the same physician, showed a strong linear association, with mean HbA_{1c} values of 7.0 ± 1.6 for patients in the charge of physicians pursuing FBG levels ≤6.1 mmol/l and 7.8 ± 1.8 for those followed by physicians who used target values >7.8 mmol/l. After adjusting for patients' and physicians' characteristics, the risk of having HbA_{1c} values >7.0% was highly correlated with physicians' beliefs. Patients followed by different physicians in the same unit showed a risk of inadequate metabolic control similar to that of patients followed by physicians adopting a nonaggressive policy.

CONCLUSIONS — Doctors adopt extremely heterogeneous target FBG levels in patients with type 2 diabetes, which in turn represent an important independent predictor of metabolic control. To improve patient outcomes, physicians-centered educational activities aimed at increasing the awareness of the potential benefits of a tight metabolic control in patients with type 2 diabetes are urgently needed.

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The recent results of the U.K. Prospective Diabetes Study (UKPDS) have confirmed, for type 2 diabetes, that intensive blood-glucose control substantially decreases the risk of developing complications of diabetes (1).

However, how this information translates into a balance among the need for improving metabolic control, the fear of unwanted hypoglycemic effects, and the burden imposed by more intense treatment is not clear. We studied this translation in the context of the QuED Project, a nationwide initiative aimed at assessing the relationship between the quality of

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A full list of investigators is listed in an appendix at the end of this article.

Abbreviations: DOC, diabetes outpatient clinic; FBG, fasting blood glucose; GP, general practitioner; OR, odds ratio; RC, reference category; UKPDS, U.K. Prospective Diabetes Study.

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

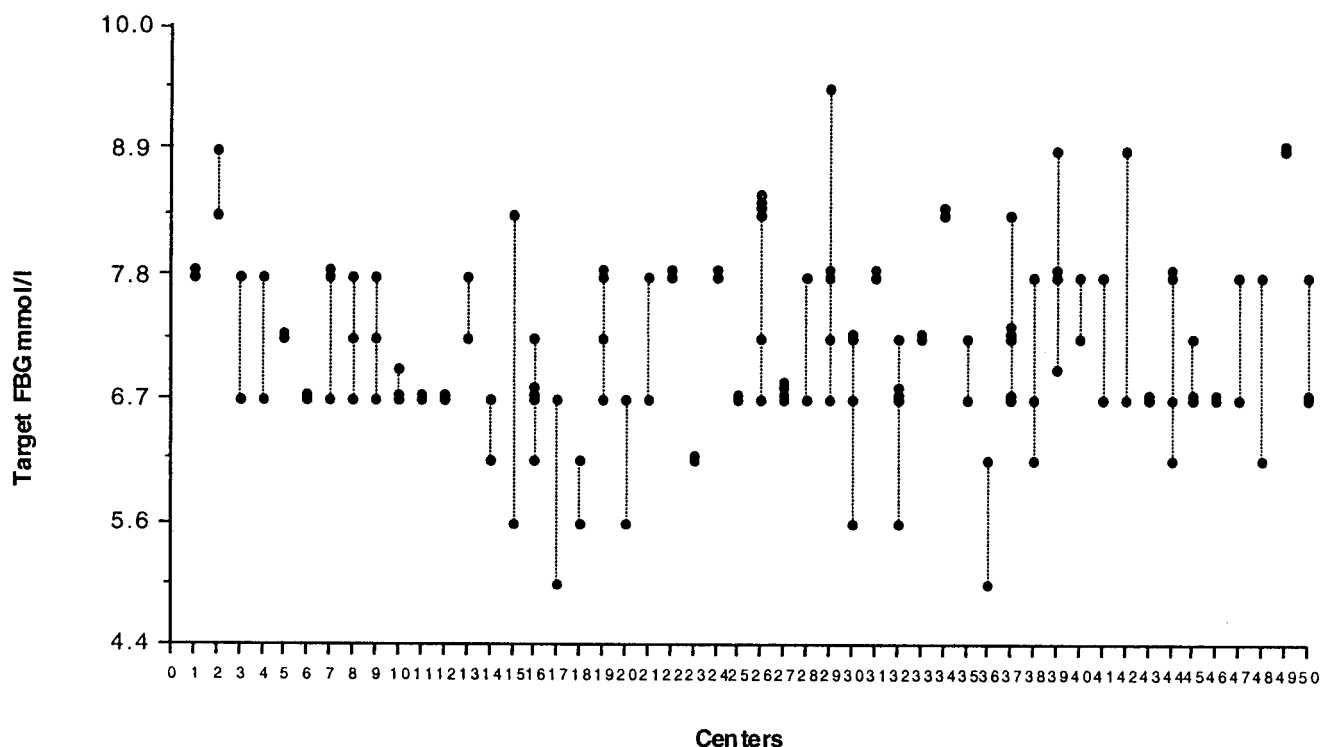


Figure 1—Target FBG values adopted by physicians practicing in DOCs in which patients may be seen by different physicians on different occasions.

care delivered to patients with type 2 diabetes and their outcomes in terms of clinical end points, quality of life, and utilization of resources (2). As an integral part of this project, we conducted a survey to investigate the relationship between target fasting blood glucose (FBG) levels adopted by Italian physicians and the level of metabolic control obtained in patients with type 2 diabetes in their charge.

RESEARCH DESIGN AND METHODS

Questionnaire

The physicians' survey was conducted between March and August 1998 through a questionnaire that included the following question: "For the average type 2 diabetic, what do you use as the target fasting blood glucose level for *your* patient?" We did not define the "average patient," because physicians' opinions are influenced by the reality of the patients they see in their practice and can therefore vary according to patient-case mix. This hypothesis could be tested by the concomitant complementary collection of data on real, not average, patients. Furthermore, an earlier

study suggests that physicians' beliefs, based on their practice rather than their knowledge, as measured with simulated cases, predict FBG values (3).

We also measured sociodemographic characteristics of the physicians (age, sex, and specialty).

Sampling of physicians

The questionnaire was sent by mail to all physicians participating in the QuED Project, a sample of 310 diabetologists practicing in 165 outpatient diabetes clinics, and 146 general practitioners (GPs). Physicians in all Italian regions were identified and selected according to their willingness to participate in the project. Two additional follow-up mailings were sent to initial nonrespondents.

Sampling of patients

All patients with type 2 diabetes were considered eligible for this project, irrespective of age, duration of diabetes, and treatment. In diabetes clinics, patients were sampled by using random lists, stratified by patient age (<65 or ≥65 years). Each center was asked to recruit at least 30 patients, whereas GPs only enrolled those patients for whom they were primarily responsible for diabetes care.

All data concerning general medical history and specific diabetes history were collected by the patients' physicians by using study forms specifically developed by the scientific committee.

For all clinical variables, the last value in the previous 12 months was requested. Episodes of hypoglycemia requiring medical attention during the previous year were also investigated. Because normal ranges for HbA_{1c} varied in the different centers, the percentage change with respect to the upper normal value (actual value/upper normal limit) was estimated and multiplied by 6.2. This allowed us to standardize HbA_{1c} values with respect to a normal value of 6.2, thus making possible a direct comparison with the results obtained in the UKPDS trial.

Setting

All Italian citizens are covered by government health insurance and are registered with a GP. On average, 1,000 (500–1,500) patients are registered with each GP; 15–45 of patients registered with each GP are expected to have diabetes. Primary care for diabetes is provided by GPs and diabetes outpatient clinics (DOCs). DOCs are usually staffed by dia-

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Table 1—Patient characteristics according to the target FBG values pursued by the physician

Patient characteristics	Target FBG levels				P*
	≤6.1 mmol/l	6.11–6.7 mmol/l	6.71–7.8 mmol/l	>7.8 mmol/l	
Sex					0.3
Male	161 (57)	325 (56)	480 (53)	115 (51)	
Female	121 (43)	251 (44)	421 (47)	112 (49)	
Age (years)	63 ± 12	63 ± 10	63 ± 10	64 ± 11	0.08
Duration of diabetes (years)					0.03
<5	90 (32)	165 (29)	236 (27)	55 (25)	
5–10	85 (31)	173 (31)	257 (29)	53 (24)	
>10	104 (37)	228 (40)	393 (44)	116 (51)	
BMI (men)					0.3
<25	38 (24)	88 (28)	114 (24)	34 (30)	
25–27	26 (16)	68 (22)	104 (22)	28 (24)	
>27	94 (60)	156 (50)	253 (54)	53 (46)	
BMI (women)					0.6
<24	17 (14)	44 (18)	75 (18)	24 (22)	
24–26	18 (15)	40 (17)	71 (17)	13 (12)	
>26	83 (71)	158 (65)	268 (65)	70 (66)	
Treatment					0.003
Diet only	46 (17)	91 (16)	132 (15)	49 (22)	
Oral agents	188 (68)	351 (63)	573 (61)	124 (56)	
Insulin only	28 (10)	74 (13)	117 (13)	22 (10)	
Insulin plus oral agents	12 (5)	41 (8)	95 (11)	26 (12)	
Blood pressure (mmHg)					
Systolic	146 ± 18	143 ± 19	143 ± 18	144 ± 19	0.2
Diastolic	83 ± 9	82 ± 8	83 ± 8	83 ± 9	0.1
HbA _{1c} (%)	7.0 ± 1.6	7.3 ± 1.5	7.5 ± 1.6	7.8 ± 1.8	0.0001
Patients/year with severe hypoglycemic episodes	17 (6.6)	16 (3.1)	30 (3.5)	4 (1.9)	0.03
Total cholesterol (mmol/l)	5.5 ± 1.0	5.6 ± 1.2	5.6 ± 1.1	5.6 ± 1.1	0.7
Triglycerides (mg/dl)	166 ± 91	163 ± 111	165 ± 90	162 ± 86	1.0
No. of diabetes complications					0.2
0	213 (76)	396 (69)	639 (71)	151 (67)	
1	51 (18)	134 (23)	177 (20)	51 (22)	
≥2	18 (6)	46 (8)	85 (9)	25 (11)	
No. of comorbid conditions					0.001
0	54 (19)	161 (28)	246 (27)	49 (22)	
1	106 (38)	208 (36)	311 (34)	68 (30)	
2	73 (26)	120 (21)	231 (26)	58 (25)	
≥3	49 (17)	87 (15)	113 (13)	52 (23)	

Data are n (%) or means ± SD. * χ^2 for categorical variables and one-way analysis of variance for continuous measures.

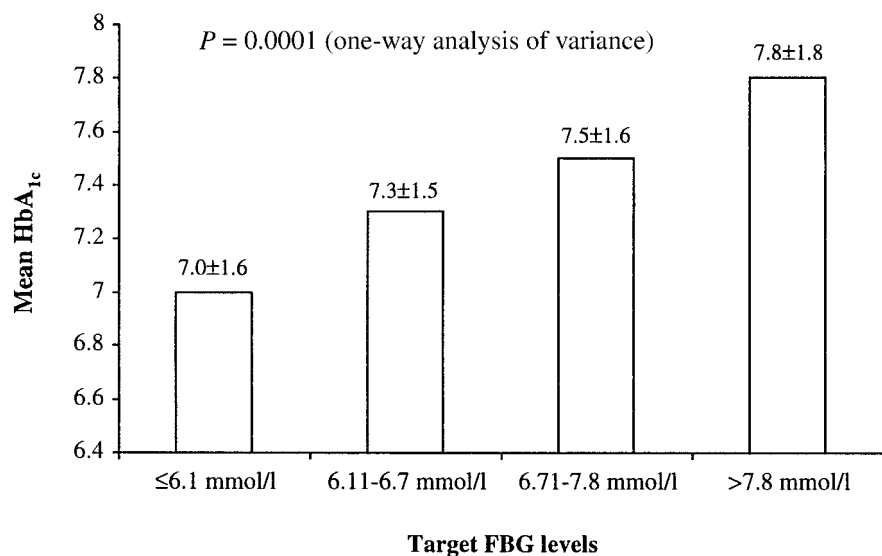
betologists, internists, and/or endocrinologists; other specialists (ophthalmologists, cardiologists, etc.) may also practice part-time in the clinic. In some DOCs, patients are always cared for by the same diabetologist/internist, whereas in other centers, patients can be seen by different physicians on different occasions. Patients can choose between the two health-care systems according to their preferences or can be referred to DOCs by their GPs.

Statistical analysis

Patient characteristics and physician responses were compared using χ^2 statistics

for categorical variables and one-way analysis of variance for continuous variables. The relationship between physicians' goals and metabolic control was restricted to those patients always seen by the same physician and was estimated using the Spearman' rank correlation. The linearity of the increase in the percentage of patients with HbA_{1c} levels >7.0% across the four physicians' target categories was tested by the Mantel-Haenszel χ^2 for trend. To control simultaneously for the possible confounding effect of the different variables, the risk of having HbA_{1c} values >7.0% was estimated by a

multiple logistic regression analysis with backward variable selection (4). The association between physician and patient characteristics and outcome was expressed in terms of odds ratios (ORs), along with 95% CIs. Covariates considered for the analysis included the following: physician age ≤40 (reference category [RC]), 41–45, 46–50, or >50 years; physician sex (male [RC] versus female); physician specialty (diabetologist [RC], internist, endocrinologist, other); health-care setting (diabetes clinic versus general practice); target FBG value ≤6.1 (RC), 6.11–6.7, 6.71–7.8, or >7.8



No. of patients	232	485	769	202
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Figure 2—HbA_{1c} mean values (± SD) in the study population according to FBG values pursued by participating physicians.

mmol/l); patient age ≤55 (RC), 56–64, 65–74, ≥75 years; patient sex (male [RC] versus female); duration of diabetes (<5, 5–10, >10 years [RC]); diabetes treatment (diet only [RC], oral agents, insulin only, insulin plus oral agents); number of diabetes complications (none [RC], one, two, or more than two); and comorbidity (no comorbid condition [RC], one, two, three, or > three comorbid conditions).

To estimate the fraction of the total number of patients with HbA_{1c} levels >7.0% that would have been avoided if all physicians had adopted an aggressive policy (i.e., target FBG ≤6.1 mmol/l), we also estimated the adjusted individual and summary attributable risks from the logistic regression (5).

RESULTS — Of the 456 physicians who received the questionnaire, 342 (75%) responded (221 physicians from DOCs and 121 GPs). The response rate was 83% for GPs and 71% for physicians from DOCs.

Of the respondent physicians, 69% were men; the median age was 45 years (range 25–70). In diabetes clinics, 31% of the physicians were diabetologists, 23% were internists, 30% were endocrinologists, and 16% were from other specialties. Among the GPs who responded to

the questionnaire, 8% had some training in diabetology, 9% had some training in internal medicine, 3% had some training in endocrinology, 51% had some training in other specialties, and 29% had no further training.

Among the responders, 43 (21 diabetologists and 22 GPs) who initially adhered to the project subsequently withdrew for organizational or personal reasons and therefore did not recruit any patients. The remainder of respondent physicians enrolled 3,297 patients, 2,003 of whom were regularly seen by the same physician and 1,294 of whom were followed by more than one physician.

Overall, 14% of the physicians stated that they pursued, for an average patient with type 2 diabetes, an FBG value ≤6.1 mmol/l, 30% had a target between 6.11 and 6.7 mmol/l, 18% had a target between 6.71 and 7.8 mmol/l, and 38% had a target >7.8 mmol/l. No statistically significant differences in beliefs emerged by physicians' characteristics (age, sex, specialty, and setting of care). In particular, the proportion of physicians pursuing strict metabolic control (i.e., FBG levels ≤6.1 mmol/l) was 16% among GPs and 13% among physicians practicing in DOCs ($\chi^2_{3df} = 3.92; P = 0.27$).

The analysis of physicians' beliefs in diabetes centers in which patients are seen by different physicians showed great

variability, even within individual centers. In fact, the target FBG adopted by different physicians within the same unit varied up to a maximum of 2.8 mmol/l (Fig. 1).

Patients' characteristics according to target FBG levels pursued by their physicians are reported in Table 1. Doctors who adopted a less aggressive policy tended to see subjects with longer duration of diabetes, with multiple comorbid conditions, and who were treated more often with insulin alone or in combination. The analysis of the relationship between FBG targets and metabolic control, restricted to those patients always seen by the same physician, showed a strong linear association (Spearman's rank correlation = 0.22; $P = 0.0001$), with HbA_{1c} values 7.0 ± 1.6 for patients in the charge of physicians pursuing FBG levels ≤6.1 mmol/l and 7.8 ± 1.8 for patients followed by physicians who used target values >7.8 mmol/l (Fig. 2). Along the same line, the proportion of patients with HbA_{1c} levels >7.0% in the four physicians' target categories were 41.8, 51.1, 55.7, and 64.4%, respectively (χ^2 for linear trend = 23.6; $P = 0.001$).

As expected, the proportion of patients experiencing one or more episodes of hypoglycemia requiring medical attention in the previous year was significantly higher among patients followed by physicians pursuing strict metabolic control (Table 1).

Patients seen by more than one physician tended to be slightly younger and had shorter duration of diabetes (Table 2). In patients seen by more than one physician, HbA_{1c} levels (7.7 ± 1.8) closely resembled those observed in patients followed by physicians who adopted a non-aggressive policy (i.e., target FBG >7.8 mmol/l; HbA_{1c} = 7.8 ± 1.8).

Results of logistic regression showed that, after adjusting for physician and patient characteristics, target FBG levels still remained a strong predictor of metabolic control. In fact, the risk of HbA_{1c} levels >7.0% increased with the target FBG levels (OR = 1.5, 95% CI 1.1–2.1 for a target FBG of 6.11–6.7 mmol/l; OR = 1.7, 1.2–2.3 for a target FBG of 6.71–7.8 mmol/l; and OR = 2.9, 1.9–4.3 for a target >7.8 mmol/l). Neither physicians' characteristics nor the setting of care (GPs versus DOCs) were independent predictors of metabolic control. The estimation of attributable risks showed that 38% of the

Table 2—Patient characteristics according to diabetes care modalities

Patient characteristics	Single physician	Multiple physicians	P*
Sex			0.4
Male	1,092 (54.5)	685 (52.9)	
Female	910 (45.5)	609 (47.1)	
Age (years)	63 ± 10	62 ± 10	0.01
Duration of diabetes (years)			0.007
<5	548 (27.8)	416 (32.6)	
5–10	574 (29.1)	370 (29.0)	
>10	849 (43.1)	490 (38.4)	
BMI (men)			0.6
<25	280 (26.2)	188 (27.8)	
25–27	228 (21.4)	132 (19.5)	
>27	559 (52.4)	356 (52.7)	
BMI (women)			0.2
<24	160 (18.1)	121 (20.2)	
24–26	145 (16.4)	80 (13.4)	
>26	580 (65.5)	397 (66.4)	
Treatment			0.9
Diet only	321 (16.5)	204 (16.1)	
Oral agents	1,024 (61.9)	774 (61.2)	
Insulin only	246 (12.6)	171 (13.5)	
Insulin plus oral agents	175 (9.0)	115 (9.1)	
HbA _{1c} (%)	7.4 ± 1.6	7.7 ± 1.8	0.0001
Patients/year with severe hypoglycemic episodes	67 (3.6)	41 (3.4)	0.8
Blood pressure (mmHg)			
Systolic	144 ± 18	143 ± 19	0.1
Diastolic	83 ± 9	82 ± 9	0.07
Total cholesterol (mmol/l)	5.6 ± 1.1	5.6 ± 1.1	0.2
Triglycerides (mg/dl)	164 ± 97	160 ± 114	0.3
No. of diabetes complications			0.2
0	1,409 (70.4)	889 (68.7)	
1	417 (20.8)	303 (23.4)	
≥2	176 (8.8)	102 (7.9)	
No. of comorbid conditions			0.8
0	514 (25.7)	318 (24.6)	
1	698 (34.9)	474 (36.6)	
2	487 (24.3)	308 (23.8)	
≥3	303 (15.1)	194 (15.0)	

Data are n (%) or means ± SD. * χ^2 for categorical variables and one-way analysis of variance for continuous measures.

cases with HbA_{1c} levels >7.0% could be avoided if an aggressive policy (i.e., target FBG ≤6.1 mmol/l) was adopted by all physicians.

A final logistic regression analysis showed that patients followed by more than one physician had a two-fold risk of having HbA_{1c} levels >7.0% as opposed to those in the charge of a single physician adopting a target of ≤6.1 mmol/l (OR = 2.1; 95% CI 1.6–2.8). Overall, being followed by more than one physician or by one physician pursuing a target FBG >6.1 mmol/l accounted for 44% of the total cases with HbA_{1c} levels >7.0%.

CONCLUSIONS— In recent years, physicians' beliefs regarding tight metabolic control in patients with type 1 and type 2 diabetes have been investigated in a few studies (6,7), but their relationship to HbA_{1c} levels obtained in their patients has never been explored. Our data confirm the findings obtained in a study of a much smaller number of physicians, showing that physicians' beliefs in more aggressive management strategies will result in better clinical outcomes in terms of mean FBG values (3).

This study, conducted just before the results of the UKPDS were published,

provides important information about the prevailing opinions of Italian physicians relative to metabolic control in patients with type 2 diabetes. It shows that, in the absence of clear scientific evidence, physicians tended to pursue a nonaggressive policy, with a wide heterogeneity in target FBG level across and within centers. These findings are likely to be attributable to the different perception about the risk of hypoglycemia in an aged population and to the belief that even low levels of metabolic control could exert a positive effect in preventing complications of diabetes.

On the other hand, differences in patient case mix can also be responsible for such variability. In fact, the less aggressive physicians were those seeing patients with longer duration of diabetes and multiple comorbid conditions. In this respect, their beliefs could reflect the tendency to tailor their policies to the individual patient, after a careful evaluation of the magnitude of benefit, potential inconvenience, and harm.

The study also offered the unique opportunity to match physicians' attitudes with the results obtained in their practices and to provide empirical confirmation of the UKPDS results. In fact, mean HbA_{1c} levels obtained in patients followed by physicians adopting an aggressive policy (i.e., target FBG ≤6.1 mmol/l) or a non-aggressive policy (i.e., target FBG >7.8 mmol/l) closely resemble those obtained in the intensive and control arms of the UKPDS.

The finding of the linear association between FBG target and HbA_{1c} values is of particular interest in light of the recent UKPDS results, showing a linear increase in the risk of complications as HbA_{1c} levels increase (8).

It is worth noting that the price paid for this difference in metabolic control is a more than three-fold increase in the risk of hypoglycemic episodes requiring medical intervention, a finding highly consistent with the existing literature (1).

Our study also shows the crucial role of physicians' attitudes and beliefs in determining patient outcomes. After adjusting for patient-case mix, the risk of poor metabolic control is strongly related to physicians' beliefs, and more than one-third of the cases with HbA_{1c} levels >7.0% can be attributed to physicians' FBG target. The fact that the FBG target chosen is not a generic indicator of better

quality of care, but a specific marker of physicians' attention to metabolic control, is confirmed by the lack of any difference in the control of other important risk factors such as blood pressure and lipid profile.

It is also important to note that, having taken physicians' average patient FBG target and patients' characteristics into account, no difference emerged between DOCs and general practice concerning metabolic control. These findings reinforce the concept that the involvement of GPs in diabetes care can represent a valid solution to the problem of the rising prevalence of the disease and the subsequent overcrowding in hospital clinics, provided that clear treatment goals are set.

On the other hand, the organization of DOCs with respect to patients' follow-up strongly influences the outcome. In our study, patients who were seen by different physicians on different visits clearly showed worse metabolic control. These findings emphasize the central role of the patient-physician relationship and of continuity of care but also document the lack of adoption of a common policy, even among physicians practicing in the same center. The high variability in the choice of FBG target across and within centers urgently calls for educational activities devoted to the diffusion and implementation of widely accepted evidence-based guidelines.

Finally, some of the potential limitations of our study must be discussed. First, physicians were selected according to their willingness to participate in the project. They could thus represent those clinicians, particularly among GPs, who were more interested in diabetes care and therefore did not reflect the general attitudes of Italian physicians. From this point of view, the problems documented in our study could be underestimated and the true variability in physicians' behavior and patients' outcomes could be even greater. The selection of the more motivated clinicians could also obscure any real difference in the outcome considered according to the setting of care (DOCs versus GPs). Nevertheless, our data, as they are, clearly show that by fixing adequate treatment goals, it is possible to substantially improve metabolic control in patients with type 2 diabetes, irrespective of the health-care setting.

The second point to be considered refers to the cross-sectional nature of our

study, correlating physicians' FBG target with a single HbA_{1c} value. However, the high number of structures involved, the large number of patients evaluated, and the consistency of our findings, even after having controlled the analysis for many potential confounders, make the possibility of spurious associations very unlikely. The relationship between physicians' beliefs, practice, and outcomes will be further explored during the longitudinal phase of this study, with the collection of data at 6-month intervals for a period of 5 years.

In conclusion, UKPDS results are expected to have a profound impact on clinical practice and patient outcomes. Nevertheless, our data show that the adoption of the new findings requires a major shift in physicians' attitudes and beliefs. It will thus be important to identify effective educational strategies to increase their awareness of the great potential for reducing diabetes morbidity and mortality.

The organization of many outpatient clinics also must be revised by allowing patients to have a regular health-care provider. Finally, the historical separation of primary care and specialty services must be lessened by the creation of patient management systems, in which the roles of the different professional figures are clearly defined.

APPENDIX

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