Cross-sectional study of care, socio-economic status and complications in young French patients with type 1 diabetes mellitus

M Lièvre¹, M Marre², JJ Robert², G Charpentier³, F Iannascoli⁴, P Passa⁶, on behalf of the Diabetes, therapeutic Strategies and COmplications (DISCO) investigators

Summary

Objectives: To describe the present status of type 1 diabetes care in France and study the relations between clinical and socio-economic variables on one hand and disease management and prevalence of complications on the other hand.

Methods: A random sample of 365 French specialists in diabetes care performed a cross-sectional study and included consecutively 562 children aged 10-16 and 1691 adults aged 16-45, with more than 2 years of type 1 diabetes. The main outcome measures were the prevalence of complications (retinal, renal, lower-limb, cardiovascular, ketoacidosis); disease management parameters (blood pressure, HbA₁c, daily number of insulin injections, frequency of visits to a specialist in diabetes, membership of a patient association); socio-economic status as a score, and treatments received.

Results: Retinal complications were rare in children (0.7%) and common in adults (28.3%). 10.2% children and 15.2% adults had micro- or macro-albuminuria, 4.7% adults had plasma creatinine > 150 mmol/L. Only 15% children and 26% adults had HbA₁c < 7%, 86.7% children and 62.7% adults had blood pressure < 130/85 mmHg; 58% children and 80% adults had at least 3 daily insulin injections.

In adults, the risk of experiencing at least one complication was linked significantly with diabetes duration, HbA₁c, and socio-economic status. Age, sex, type of insulin therapy, tobacco consumption, and blood pressure control were not significant parameters. Ketoacidosis in the preceding year was only linked with HbA₁c and socio-economic status.

Conclusion: Although this sample of patients had overall a fair socio-economic status and were followed-up by specialists of diabetes care, metabolic and blood pressure control were not optimal. The care of French type 1 diabetics could probably be improved by a stricter control of glycaemia and blood pressure, and an earlier use of intensive insulin treatment, with a particular focus on adolescents and patients with the lowest socio-economic status.

Key-words: Type 1 diabetes · Socio-economic status · Cross-sectional study · Treatment · Complications.

Résumé

Étude transversale de la prise en charge, du statut socio-économique et des complications chez des jeunes diabétiques de type 1 français

Objectifs : Décrire la prise en charge du diabète de type 1 en France et étudier la relation entre les variables socio-économiques et la prise en charge et la prévalence des complications.

Méthodes : Un échantillon aléatoire de 365 spécialistes français du traitement du diabète a inclus consécutivement dans une étude transversale 562 enfants de 10 à 16 ans et 1691 adultes de 16 à 45 ans ayant un diabète de type 1 depuis plus de 2 ans.

Les principaux paramètres mesurés étaient la prévalence des complications (rétiniennes, rénales, des membres inférieurs, cardiovasculaires, épisodes d’acido-cétose) ; les paramètres de prise en charge (pression artérielle, HbA₁c, nombre d’injections quotidiennes d’insuline, fréquence des visites à un spécialiste du diabète, appartenance à une association de diabétiques) ; le statut socio-économique évalué par un score et les traitements reçus.

Résultats : Les complications rétiniennes étaient rares chez les enfants (0,7 %) et courantes chez les adultes (28,3 %). 10,2 % des enfants et 15,2 % des adultes avaient une micro ou une macro-albuminurie, 4,7 % des adultes avaient une créatinine plasmatique > 150 mmol/L. Seulement 15 % des enfants et 26 % des adultes avaient une HbA₁c < 7 %, 86,7 % des enfants et 62,7 % des adultes avaient une pression artérielle < 130/85 mmHg ; 58 % des enfants et 80 % des adultes se faisaient au moins 3 injections quotidiennes d’insuline.

Chez les adultes, le risque de souffrir d’au moins une complication était lié significativement à la durée du diabète, à HbA₁c et au statut socio-économique. L’âge, le sexe, le type d’insulinothérapie, le tabagisme et le contrôle de la pression artérielle n’intervenaient pas significativement. La survenue d’acido-cétose au cours de l’année précédente était seulement liée au taux d’HbA₁c et au statut socio-économique.

Conclusion : Bien que ces patients aient joui d’un statut socio-économique favorable et aient été suivis par des spécialistes du diabète, le contrôle métabolique et celui de la pression artérielle n’étaient pas optimaux. Le traitement des diabétiques de type 1 français pourrait probablement être amélioré par un contrôle plus strict de la glycémie et de la pression artérielle et un usage plus précoce de l’insulinothérapie intensive, avec une attention particulière portée aux adolescents et aux patients ayant le statut socio-économique le plus défavorable.

Mots-clés : Diabète de type 1 · Statut socio-économique · Étude transversale · Traitement · Complications.
Type 1 diabetes affects between 140,000 and 170,000 persons in France [1, 2], but little is known of the current therapeutic management of these patients. Yet during the last ten years, several randomised controlled trials have given results that justified changing type 1 diabetes management [3-5]. We have undertaken a cross-sectional study to make an update of the situation and study the influence of several clinical and socio-economic variables on disease management and prevalence of complications.

Patients and methods

Recruitment procedures

We sought participation of a random sample of physicians drawn from a list of 1940 French specialists in diabetes care, endocrinology, internal medicine and paediatrics. Randomisation was performed by the coordinating center and stratified on the type of practice (private, hospital, or both). The randomisation list was ordered and the physicians who refused to participate were replaced by the first physicians of the list who had not yet been contacted. Those who agreed or did not answer were contacted by telephone for further information about the study and were asked to include 5 to 10 consecutive patients between September 15 and October 31, 2002.

Patients

Patients aged 10 to 45 years with type 1 diabetes of at least 2 years in duration who accepted to answer questions regarding their socio-economic situation were eligible for the study.

Study variables

Complications were coded with increasing scores according to presence and severity of retinal (0-3), renal (0-4), cardiovascular (0-1), lower limb complications (0-3), and hospitalisation for ketoacidosis during the preceding year (0-1). The sum of all complication scores formed a global complication score (see annex 1).

Ideal disease management included blood pressure < 130/85 mmHg [6], HbA1c < 7%, adjusted on local laboratory values, with 6% as the reference upper limit of normal [7], at least 3 daily insulin injections, 2 1 visit to a specialist in diabetes care during the preceding year, membership of a patient association. Each disease management goal scored 1 if not reached and 2 if reached, resulting in a global disease management score of 5 (worst management) to 10. Severe hypoglycaemic episodes were defined as those requiring hospitalisation or help from another person.

Patient socio-economic status was scored from 4 (unemployed blue-collar worker or first-job seeker living alone, with less than secondary school education level) to 9 (active white-collar not living alone, with a university education level). For children, employment status was that of their parents.

Current treatments were recorded.

Statistics

At least 2000 patients were needed to allow the determination of a 30% prevalence of any variable with a 95% confidence interval [28%; 32%]. Separate analyses were done for children (aged < 16) and adults. Logistic regression analyses were used to study the relationship between complications and various parameters. Exponentiation of the regression coefficients resulted in odds ratios (OR), which are presented with their 95% confidence interval.

Quality control

Quality checks were performed on all entered data, queries were sent to investigators, and a random sample of 79 centres having included 581 patients were submitted to site visits.

Results

Recruitment

Of 1146 specialists who were invited 484 (42.3%) accepted to participate, and 365 eventually included 2253 eligible patients (30 diabetologists, 228 endocrinologists, 29 specialists in internal medicine, and 78 paediatricians). These specialists worked in the public (38.9%), private (31.5%) or in both (29.6%) sectors. Most children (84.5%) were recruited by paediatricians. The characteristics of the 562 children and 1691 adults included are given in (Tab I). Overall, the included population had a fair socio-economic status. All but 2 children scored 7 or 8 (mean score of 7.5 ± 0.5). Only 1.1% adults scored 4 or 5, and 0.7% had the maximum score
Table I
Characteristics of the patient population. Quantitative parameters are described as mean ± standard deviation. Children are patients 10-16 years old.

<table>
<thead>
<tr>
<th></th>
<th>Children 10-16 years (N = 562)</th>
<th>Adults 16-45 years (N = 1691)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (% males)</td>
<td>52.5</td>
<td>49.8</td>
</tr>
<tr>
<td>Age (years)</td>
<td>13.7 ± 1.9</td>
<td>31.6 ± 8.3</td>
</tr>
<tr>
<td>Diabetes duration (years)</td>
<td>5.6 ± 3.2</td>
<td>13.5 ± 8.7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>52.4 ± 12.7</td>
<td>68.1 ± 12.1</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>159.2 ± 11.7</td>
<td>169.1 ± 9.0</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>8.7 ± 1.6</td>
<td>8.2 ± 1.6</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>114 ± 12</td>
<td>123 ± 13</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>66 ± 9</td>
<td>73 ± 9</td>
</tr>
<tr>
<td>Current smoking (%)</td>
<td>6.4</td>
<td>26.8</td>
</tr>
</tbody>
</table>

(mean score 7.4 ± 0.9). Smoking was inversely correlated with the socio-economic score (p = 0.006).

Disease management and treatments

Disease management parameters are given in (Tab II). Only 15% children and 26% adults had HbA1c < 7% at the last measurement. Most children had a disease management score of 7 (25.2%), 8 (37.6%) or 9 (31.1%). Most adults had scores in the middle range (26.7% scored 7 and 37.5% scored 8) but, compared with children, more had lower scores and less had the highest scores. There was a non-significant trend (p = 0.053) toward an increase in disease management score according to the socio-economic score in adults (mean values 7.6, 7.8, and 7.9 for the 1st, 2nd and 3rd tertiles of socio-economic score), whereas no clear relationship of this kind was found in children (mean values 8.0, 8.2 and 8.0 respectively).

Table II
Disease management. Children are patients 10-16 years old. Intensive insulin therapy was defined as at least 3 daily insulin injections or the use of an insulin pump.

<table>
<thead>
<tr>
<th></th>
<th>Children (N = 562)</th>
<th>Adults (N = 1691)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c &lt; 7%</td>
<td>15.1%</td>
<td>26.4%</td>
</tr>
<tr>
<td>Blood pressure &lt; 130/85 mmHg</td>
<td>86.2%</td>
<td>62.7%</td>
</tr>
<tr>
<td>³ 3 insulin daily injections</td>
<td>58.0%</td>
<td>80.0%</td>
</tr>
<tr>
<td>Membership of a patient association</td>
<td>57.2%</td>
<td>23.5%</td>
</tr>
<tr>
<td>² 1 visit to a specialist during the preceding year</td>
<td>97.1%</td>
<td>76.8%</td>
</tr>
</tbody>
</table>

The modalities of insulin administration and corresponding HbA1c values are shown in (Tab III). HbA1c values decreased as the number of injections increased (with pump considered as the highest number of injections) in adults (p < 0.0001), but not in children. When three age groups were considered, HbA1c levels were correlated with the number of injections in children < 13 years and adults > 20 years, but not in adolescents aged 13-20 years, (p < 0.0001 for both age group and number of injections). Adults had lower HbA1c levels whatever the number of injections. Severe hypoglycaemia in the preceding year was reported by 14.6% children and 18.7% adults and was not related to HbA1c, nor to other studied parameters.

Two hundred twenty one adults (13.1%) used at least one antihypertensive drug (an ACE-inhibitor or angiotensin receptor antagonist in 87.8% cases). Sixty-two percent of treated patients were at blood pressure goal, whereas 78% of the 629 who were not at blood pressure goal received no treatment for hypertension. An ACE-inhibitor or an angiotensin-2 receptor antagonist was used in 39% adults with renal complications.

Complications

Complications were infrequent in children (Tab IV). In adults, the risk of having at least one complication was increased by 13.5% [11.1%; 16.0%] for 5 years of diabetes duration, by 25% [12.7%; 38.8%] for each 1% increase in HbA1c, and by 16% [0%; 29%] for each decrease in the socio-economic score by 1 point. Age, sex, number of insulin injections, smoking, and blood pressure control played no significant role. In children, HbA1c value (OR = 1.34 [1.14; 1.57] for 1% increase) was the only significant parameter. Most cardiovascular complications were observed in subjects older than 40.

The relation between disease management parameters and the global complication score was tested in an age-
Discussion

Although prevalence is much less informative than incidence in the search for links between risk factors and disease complications, type 1 diabetes is a favourable situation in this regard. In fact, the main complications of type 1 diabetes such as retinopathy and nephropathy are permanent, and disease duration is known precisely. In addition, the age-limit for the population was low, early mortality was not likely to have induced a selection bias.

Although our socio-economic score included a limited number of variables and has not been validated, it was well correlated with smoking, that has been shown to be strongly linked with socio-economic status [8]. We used a direct estimate of socio-economic status, in contrast with most other studies, in which socio-economic status was derived from a deprivation score attributed to the subject residence area [9-11].

Patient population

Between 1.3% and 1.6% of the French type 1 diabetic patients were recruited by a random sample of specialists in diabetes care. This population can therefore be expected to be representative of the type 1 diabetic patients who are followed-up by specialists regularly. We did not include however the most deprived diabetic patients, because they do not consult a specialist regularly, which explains the fairly good socio-economic status of our population. We also included by protocol a relatively young population, which results in a short diabetes duration in adults (mean 13.5 years, minimum 0, maximum 40 years). These two selection bias probably explain the relatively low prevalence of complications in our patients.

Disease management

Comparing our results with those of a similar cross-sectional study performed in France in 1998 by Charbonnel et al. [12], it seems that the proportion of type 1 diabetics who receive at least 3 daily insulin injections has increased dramatically, from 54.5% to 80% in our study. Glycaemic control, however, does not seem to have improved in parallel with the number of injections: in 1998, 32% patients had HbA1c < 7.5%, and only 26% adults had HbA1c < 7% in our study. The correlation between the intensity of insulin treatment and HbA1c found in adults was expected from the results of controlled trials [3], although Charbonnel et al. [12] did not find any difference in glycaemic control between patients receiving 1 or 2 injections daily and those who had more than 3 injections daily. The absence of such a correlation and the higher HbA1c levels in adolescents have already been observed [13-15] and confirm that specific problems exist in this age group. Only one in seven children and one in four adults were at HbA1c ADA's goal, although there is ample evidence that improved glycaemic control reduces microvascular complications in type 1 and type 2 diabetes [3, 4, 15, 16]. In our study, an increase in HbA1c was in fact very significantly and independently linked with the prevalence of complications. Fear of hypoglycaemia may be a reason for not intensifying insulin therapy, although we found no correlation between the frequency of severe hypoglycaemia and HbA1c or a higher number of insulin injections. In adults, the simultaneous decrease in

Table IV
Complications. Children are patients < 16 years old. Renal failure is defined as plasma creatinine $^{2}$ 150 nmol/L. Isolated microalbuminuria: urinary albumin 20 to 199 mg/L. Isolated macroalbuminuria: urinary albumin 200 mg/L. End stage renal failure: haemodialysis or renal transplantation. Cardiovascular complications: myocardial infarction, stroke, coronary or carotid artery revascularisation. Lower limb complications: foot ulcer, amputation, leg revascularisation. *: at least 1 episode having required hospitalisation

<table>
<thead>
<tr>
<th></th>
<th>Children (N = 562)</th>
<th>Adults (N = 1691)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background retinopathy</td>
<td>0.7%</td>
<td>16.6%</td>
</tr>
<tr>
<td>Proliferative retinopathy</td>
<td>0</td>
<td>8.0%</td>
</tr>
<tr>
<td>Blindness</td>
<td>0</td>
<td>3.7%</td>
</tr>
<tr>
<td>Isolated microalbuminuria</td>
<td>9.7%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Isolated macroalbuminuria</td>
<td>0.5%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Renal failure</td>
<td>0</td>
<td>2.0%</td>
</tr>
<tr>
<td>Cardiovascular complication</td>
<td>0</td>
<td>1.1%</td>
</tr>
<tr>
<td>Lower limb complication</td>
<td>0</td>
<td>2.0%</td>
</tr>
<tr>
<td>End stage renal failure</td>
<td>0</td>
<td>0.6%</td>
</tr>
<tr>
<td>Ketoacidosis in the preceding year</td>
<td>7.9%</td>
<td>5.7%</td>
</tr>
</tbody>
</table>
complication prevalence with HbA1c goal achievement and increase when insulin was injected at least three times daily suggest that intensive insulin therapy was proposed to patients as a response to the occurrence of a complication, in spite of being proposed a priori. All the parameters of our disease management score, except membership of a patient association, were independently linked to the number of complications in adults, which justifies our choice. HbA1c was the only disease management parameter correlated with complications in children, probably because children had a short exposition to diabetes, had an optimal frequency of specialised follow-up and are seldom truly hypertensive (although 23.8% were not at goal in our study). Finally, it must be stressed that antihypertensive drugs might have been underused in this population, since 78% of the 629 adults who were not at blood pressure goal received no treatment for hypertension. Although no adequate outcome study was performed in type 1 diabetic patients regarding the control of blood pressure, it is of note that the UK Prospective Diabetes Study demonstrated blood pressure control to be as efficient as glycaemic control for the prevention of microvascular complications in type 2 diabetes [17]. This result applies probably to type 1 diabetes because there is no compelling reason to consider that microvascular complication are radically different in type 1 and type 2 diabetes. ACE-inhibitors and inhibitors of angiotensin-2 receptors might also have been underused because only 39% patients with an increased urinary albumin excretion or renal failure were on these drugs, which have been proved beneficial in these patients [18, 19].

Role of socio-economic status

A non-significant link was found between socio-economic status and disease management. This is probably due in part to the above-mentioned selection bias that excluded the most deprived patients from the study population, and to the egalitarian nature of the French health care system (type 1 diabetes related expenses are totally reimbursed). Socio-economic status was nevertheless independently linked with the prevalence of complications in adults, even after adjusting for tobacco consumption, a risk factor correlated itself with socio-economic status. The dependence of ketoacidosis incidence during the preceding year on HbA1c and socio-economic status only suggests that individuals with a lower socio-economic status have more difficulties in adjusting the doses and the times of insulin injections than those with a higher status. Socio-economic status played no role in children, perhaps because parental employment status was only one of several factors of a global score the impact of which was attenuated because educational level was not relevant, no child lived alone and visits to a specialist were very regular.

In previous studies, metabolic control of diabetes was worse in patients with a lower socio-economic status than in more affluent ones [10, 11, 20, 21]. An increase in renal and retinal complications with higher deprivation status was found in several studies [9, 17, 22] and may be explained by a worse disease management. However, a study in Salford, UK, failed to show any difference in the prevalence of complications according to socio-economic status, although disease management was better in patients from more affluent areas [22]. Differences in lifestyle that we could not account for may explain the independent link between socio-economic status and the prevalence of complications.

In conclusion, the care of French type 1 diabetics could probably be improved by a stronger enforcement of the disease management strategies that were proved efficacious in randomised clinical trials: intensive insulin therapy before instead of after the occurrence of complications, strict control of glycaemia with a goal of maintaining HbA1c < 7%, more widespread use of antihypertensive drugs to maintain blood pressure < 130/85 mmHg and of ACE-inhibitors or angiotensin-receptor antagonists in patients with renal impairment [3-7, 17-19].

Our results also suggest that adolescents and patients with the lowest socio-economic status should receive particular attention.

Funding

The DISCO study was funded by Novo Nordisk France.

Competing interests

M Lièvre's institution received funds to run the study.

Annex 1: Complication score.

Retinal complications were coded 0 (absence), 1 (background retinopathy), 2 (proliferative retinopathy or history of panphotocoagulation) or 3 (blindness). Renal complications were coded 0 (absence), 1 (isolated microalbuminuria = urinary albumin 20 to 199 mg/L), 2 (isolated macro-albuminuria = urinary albumin > 200 mg/L), 3 (renal failure = creatinine 2 150 µmol/L), 4 (end stage renal failure = dialysis or transplantation).

Complications affecting the lower limbs were coded 0 (absence), 1 (passed or present foot ulcer, no amputation), 2 (revascularisation procedure), 3 (amputation). Cardiovascular complications (myocardial infarction, coronary artery or carotid revascularisation procedure, stroke), hospitalisation for ketoacidosis during the preceding year were coded 0 if absent, 1 if present. A global complication score was constructed by addition of all complication scores, that could go
from 0 (absence of complication) to 12 (most severe complication state).

References