ORIGINAL RESEARCH

Time and Costs of Insulin Treatment in the Care of Newly Registered Type 2 Diabetes Patients in Diabetes Clinics Across Japan (JDDM 22)

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Abstract
Aims: To study the time and costs of insulin treatment of newly registered outpatients with Type 2 diabetes mellitus (T2DM).
Methods: In total, 355 patients with T2DM were registered on their first visit to one of 11 diabetes clinics across Japan. Of these, 313 were not being treated with insulin (the non-insulin group), whereas 42 were (the insulin group). In the insulin group, 26 were already on insulin at the first visit, whereas 16 were started on insulin after their first visit. The time and costs involved in the care were recorded over the following 5 months.
Results: In the first 3 months, considerable time was expended in both groups, with the time spent by physicians a little (but significantly) longer for the insulin group. The total time expended by all care providers was approximately 1.3-fold greater for the insulin compared with the non-insulin group. The total cost and total cost/min for the insulin group was almost twice that for the non-insulin group. Over the 5-month period, mean HbA_{1c} in the non-insulin group improved from 8.0% to 6.5%, with 72% achieving a glycemic target of $HbA_{1c} \leq 6.5\%$. In contrast, in the insulin group, mean HbA_{1c} improved from 9.4% to 7.6%, with only 39% achieving the target. There were no reports of major hypoglycemic events in either group and body mass index remained stable.
Conclusions: The insulin therapy for T2DM can be achieved safely and effectively at outpatient clinics, even though it requires considerably more time and resources than non-insulin therapy.

Keywords: insulin therapy, care delivery, Type 2 diabetes, patient education, economics

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Introduction

Diabetes mellitus (DM) is a chronic disease that currently affects 7.4 million people in Japan, and its prevalence is increasing.[1] Considerable mortality,[2,3] morbidity,[4,5] and costs[6,7] are associated with the condition. For example, the annual medical expenditure for diabetes care in Japan in 2007 was estimated to be more than 1,100 billion yen, which represented approximately 5% of Japan's healthcare costs, and the rise in expenditure for diabetes care was higher than that for any other disease. Each year, more than 10,000 DM patients start on hemodialysis and approximately 3,000 patients become blind. Stricter glycemic control is key in preventing the microvascular complications of diabetes and in reducing the risk of macrovascular diseases.[8–13] Because of progressive deficits in insulin secretion, approximately half the patients with DM require insulin therapy to achieve good glycemic control.[11,13,14] However, a delay in starting insulin is often reported.[15–17] For example, Kobayashi et al reported that the hypoglycemic effect of insulin therapy was proportional to basal HbA_{1c} at the time of initiation of insulin and any delay in starting insulin resulted in disappointing outcomes.[18] There are several reasons why starting on insulin may be delayed. First, patients are often reluctant to start insulin injections. Second, clinicians may be reluctant to start insulin therapy because it is a time-consuming process and they may lack appropriate resources.

Insulin is usually started on an inpatient basis or on an outpatient basis in secondary care. However, most patients are seen at the primary care level and it is reasonable that insulin therapy has expected to be initiated at the site of the clinical practice because of social and economic considerations. The present study was conducted to provide baseline information regarding the time and human resources required to start insulin therapy in diabetes clinics, as well as to provide relevant economic data.

Patients and Methods
Study setting and patient selection

Eleven diabetes clinics with practicing diabetologists participated in the present study. The clinics were located across Japan and the study period was March–November 2003. A total of 355 new patients with Type 2 DM were registered at their first clinic visit and followed for 5 consecutive months. Of these patients, 313 who were not on insulin were defined as the non-insulin group, whereas the 42 who were on insulin were defined as the insulin group. Twenty-six patients were on insulin at the time of their first visit to the clinic, whereas the remaining 16 patients in the insulin group started on insulin therapy after their first clinic visit. The initiation of insulin was done on outpatient basis at each clinic.

At the time of the first clinic visit, each new patient completed a form that recorded background information and behavior, as described previously.[19] After plasma glucose, HbA_{1c}, and urinalysis examinations, patients were interviewed by a Certified Diabetes Educator (CDE) nurse to confirm the history and lifestyle information recorded on the form. The CDE nurse gave this information to a physician, along with the glucose, HbA_{1c}, and urinalysis results for that day. The physician met the patient, assessed the state of the disease, the patient's lifestyle, and his/her knowledge of the disease, and then offered advice. At the end of the consultation, the physician arranged for the patient to have a one-on-one education session with a dietician or nurse on either the same day or at the next visit. When and to whom education had been delivered was assessed by a physician after consideration of glycemic control, lifestyle, obesity, and the stages of change according to the transtheoretical model.[20] Plasma glucose and HbA_{1c} (as determined by HPLC and expressed as a JDS value which is equivalent to (NGSP value—0.4)) were measured onsite at each visit, or each month, for every DM patient.

Each clinic had, on average, 1.7 diabetologists, 4.5 nurses, 2.2 dietitians, and 4.1 clerks, and seven of the clinics also had one technician. At least three of the staff at each clinic were CDEs. Consultations with physicians required a prior appointment in six of the clinics, but not in the other five. The clinics saw an average of 60 patients/day and 840 DM patients/month. Six of the clinics provided free group education sessions outside consulting hours.

Collection of data regarding time and cost

During the study period, the time expended by the clinic for each visit was recorded using a form that documented the time taken by physicians for each

consultation, by nurses to interview the patients and perform laboratory examinations, by dietitians to provide dietary counseling, and by nurses to provide patient education. The sum of the times taken for each of these steps was defined as total care time, whereas the sum of the times to provide dietary counseling and patient education (carried out by a nurse) was defined as education time. Only the time for counseling delivered on a one-on-one basis was measured. The fees charged by each of the clinics each month were determined on the basis of reimbursement claims during the study period.

The study protocol was approved by the ethical committee of the JDDM. All registered patients were informed about the study and consented to being observed during their visit.

Statistical analysis

Data are expressed as the mean ± SD. In univariate analyses, Student's t-test for continuous data and Pearson's χ^2 test for categorical data were used to determine differences in means and proportions. Pearson's correlation coefficient was used to measure the association between two variables. $P < 0.05$ was considered significant. All statistical analyses were performed using SPSS software (SPSS Japan, Tokyo, Japan).

Results

Clinical characteristics of the patients

The clinical characteristics of the patients in the insulin and non-insulin groups are given in Table 1. In the non-insulin group, 40% of patients were newly diagnosed, compared with 24% in the insulin group. The proportion of smokers in both groups was 44%.

The mean age of patients in the insulin group was less than that of patients in the non-insulin group ($P < 0.05$). The average duration of diabetes in the non-insulin and insulin groups was 4.8 and 9.2 years, respectively ($P < 0.0001$). Within the insulin group, the average duration of diabetes for those already on insulin and those starting insulin after their first clinic visit was 11.7 and 4.4 years, respectively. The mean HbA$_{1c}$ level in the non-insulin and insulin groups was 8.0% and 9.3%, respectively ($P < 0.01$). Mean body mass index (BMI) was smaller and systolic blood pressure was significantly lower in the insulin group compared with the non-insulin group. However, there was no significant difference in total cholesterol levels between the two groups.

Time use during clinic visits

Patients in the insulin group visited the clinic more frequently than did patients in the non-insulin group.

Table 1. Clinical characteristics of patients with and without insulin therapy.

Characteristics	Non-insulin group	Insulin group		
		All patients	Ongoing insulin therapy	Insulin therapy initiated
n	313	42	26	16
Sex (male/female)	197/116	21/21	14/12	7/9
Age (years)	57.5 ± 12.3	51.7 ± 16.1‡	54.0 ± 15.9	47.5 ± 16.0*
Duration of diabetes (years)	4.8 ± 5.9	9.2 ± 11.4‡	11.7 ± 12.6‡	4.4 ± 6.4
HbA$_{1c}$ (%)	8.0 ± 2.0	9.3 ± 2.9†	9.3 ± 2.4†	9.5 ± 3.6
SBP (mmHg)	136 ± 22	128 ± 27‡	130 ± 27	124 ± 25
DBP (mmHg)	79 ± 13	76 ± 12	74 ± 13	79 ± 10
BMI (kg/m^2)	24.2 ± 3.6	23.0 ± 3.5	22.7 ± 2.9	23.4 ± 4.4
Tchol (mmol/l)	5.5 ± 1.2	5.6 ± 1.1	5.7 ± 1.2	5.6 ± 1.0
Smokers (%)	44	44		
Newly diagnosed patients (%)	40	24‡		
Combination of diseases (%)				
DM alone	47	59		
HT	25	12		
HL	14	17		
HT+HL	14	12		

Notes: Data are the mean ± SD. ‡$P < 0.05$, †$P < 0.01$, *$P < 0.0001$ compared with the non-insulin group.
Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; DM, diabetes mellitus; HbA$_{1c}$, glycated hemoglobin; HL, hyperlipidemia; HT, hypertension; SBP, systolic blood pressure; Tchol, total cholesterol.

There was no significant difference in the number of visits for patients in the insulin group who were already on insulin at the time of their first visit and those who started on insulin after their first visit (Table 2).

The time spent by physicians consulting with patients was longer for the insulin group than the non-insulin group, especially for patients who started insulin therapy after their first visit. The times spent by nurses conducting interviews and performing laboratory examinations was nearly the same between the two groups during the first month. The time spent on patient education was significantly longer for patients starting insulin than for those already on insulin or not taking insulin. The mean total care time in the first month was significantly longer for patients in the insulin than the non-insulin group (138 vs. 100 min, respectively). The total care time tapered during the study period, but was still longer by approximately 12 min for the insulin group than the non-insulin group at the end of the 5-month period.

In the first month, dietary counseling was delivered to 33% and 43% of patients in the non-insulin and insulin groups, respectively (Table 3). The counseling time was longer for patients in the non-insulin group than for those in the insulin group. Nurses provided counseling to 46% and 71% of patients in the non-insulin and insulin groups, respectively, during the first month, and the time spent with patients in the insulin group was much longer than that spent with patients in the non-insulin group throughout the study period.

Table 2. Time use during monthly clinic visits for patients in the insulin and non-insulin groups.

	Time (months)				
	1	2	3	4	5
No. visits/month					
Non-insulin group	1.6 ± 0.8	1.5 ± 0.7	1.3 ± 0.5	1.2 ± 0.4	1.2 ± 0.4
Insulin group	$2.2 \pm 1.4^\dagger$	$1.9 \pm 1.1^*$	1.4 ± 0.6	1.3 ± 0.7	$1.5 \pm 0.7^\dagger$
Ongoing therapy	2.1 ± 1.4	1.9 ± 1.0	1.6 ± 0.8	1.4 ± 0.8	1.5 ± 0.6
Therapy initiated	2.3 ± 1.0	1.9 ± 1.0	1.3 ± 0.5	1.2 ± 0.4	1.4 ± 0.8
Physician time (min)					
Non-insulin group	20.5 ± 10.9	11.3 ± 8.9	7.6 ± 5.7	7.1 ± 5.9	7.1 ± 6.7
Insulin group	$28.1 \pm 18.2^*$	$17.2 \pm 13.2^\dagger$	$9.7 \pm 5.6^*$	8.9 ± 5.5	$9.5 \pm 6.8^*$
Ongoing therapy	26.3 ± 19.9	15.0 ± 11.4	9.3 ± 5.2	8.6 ± 5.5	7.5 ± 4.2
Therapy initiated	36.2 ± 18.1	20.8 ± 15.5	10.6 ± 6.5	9.3 ± 5.9	11.4 ± 8.9
Time spent performing interviews and examinations (min)					
Non-insulin	56.2 ± 38.4	21.0 ± 18.1	17.8 ± 15.9	16.4 ± 14.6	15.5 ± 13.7
Insulin	$92.2 \pm 53.0^\dagger$	$38.6 \pm 32.2^\dagger$	21.6 ± 17.7	23.7 ± 24.5	28.5 ± 30.4
Ongoing therapy	86.4 ± 56.8	45.3 ± 37.3	24.9 ± 19.2	23.5 ± 17.3	32.8 ± 35.5
Therapy initiated	109.0 ± 46.5	36.6 ± 26.5	17.8 ± 15.9	25.2 ± 32.3	24.5 ± 25.0
Time spent educating patients (min)					
Non-insulin	23.7 ± 30.1	18.8 ± 25.5	10.6 ± 17.9	6.3 ± 13.1	4.5 ± 11.2
Insulin	$40.8 \pm 42.9^*$	23.7 ± 36.4	7.8 ± 11.0	7.8 ± 17.9	5.6 ± 13.0
Ongoing therapy	27.8 ± 32.9	18.7 ± 36.2	4.4 ± 7.5	4.3 ± 11.0	1.3 ± 5.6
Therapy initiated	64.8 ± 47.7	35.2 ± 34.7	13.9 ± 13.8	13.5 ± 25.2	11.0 ± 17.3
Total care time (min)					
Non-insulin	100.0 ± 60.7	51.1 ± 35.2	36.0 ± 24.7	29.7 ± 20.9	27.1 ± 19.8
Insulin	$137.8 \pm 78.5^\dagger$	63.9 ± 48.2	34.6 ± 18.0	36.2 ± 28.1	$39.1 \pm 33.6^*$
Ongoing therapy	104.3 ± 66.3	62.3 ± 55.9	35.1 ± 18.4	35.2 ± 24.0	41.9 ± 37.7
Therapy initiated	152.8 ± 66.2	71.6 ± 43.4	32.7 ± 16.9	39.6 ± 32.9	39.1 ± 33.8
Waiting time (min)					
Non-insulin	65.8 ± 49.8	58.5 ± 43.6	43.2 ± 30.6	45.1 ± 34.4	44.7 ± 33.5
Insulin	$94.1 \pm 76.5^*$	65.8 ± 52.3	$62.4 \pm 43.0^\dagger$	46.5 ± 37.9	$59.1 \pm 44.3^*$
Ongoing therapy	99.2 ± 91.0	67.3 ± 56.2	70.8 ± 50.4	54.0 ± 43.3	64.2 ± 51.1
Therapy initiated	84.5 ± 38.4	63.4 ± 46.8	47.2 ± 17.2	29.6 ± 19.5	52.6 ± 34.7

Notes: Data are the mean $\pm$ SD. $^*P < 0.05$, $^\dagger P < 0.01$ compared with the non-insulin group. The time spent educating patients is the sum of the time spent providing dietary counseling and education by nurses.

Table 3. Delivery rate and time spent providing dietary counseling and education by nurses.

	Time (months)				
	1	2	3	4	5
Dietary counseling					
Non-insulin (OGLAs+diet)					
Delivery rate	32.6%	37.7%	26.2%	16.3%	10.5%
Time (min)	46.0 ± 21.1	40.2 ± 22.0	33.0 ± 18.0	29.6 ± 13.5	25.7 ± 13.3
Insulin					
Delivery rate	43.2%	26.7%	15.4%	14.0%	5.1%
Time (min)	36.6 ± 19.4	36.1 ± 20.0	24.7 ± 8.1	25.0 ± 12.2	29.0 ± 8.5
Ongoing therapy					
Delivery rate	34.6%	23.1%	4.5%	12.5%	0.0%
Time (min)	32.2 ± 16.3	34.7 ± 16.4	18	25.3 ± 17.0	–
Therapy initiated					
Delivery rate	50.0%	37.5%	41.7%	21.4%	12.5%
Time (min)	49.3 ± 22.8	37.5 ± 24.6	26.0 ± 8.3	24.7 ± 9.0	29.0 ± 8.5
Nurse education					
Non-insulin (OGLAs+diet)					
Delivery rate	45.7%	18.9%	11.0%	10.5%	9.6%
Time (min)	19.3 ± 17.4	18.9 ± 13.4	17.2 ± 12.4	14.0 ± 8.2	18.6 ± 14.6
Insulin					
Delivery rate	70.5%[†]	44.4%[‡]	25.6%[†]	9.3%	17.9%
Time (min)	37.3 ± 26.4[‡]	31.3 ± 33.2	12.9 ± 8.3	47.3 ± 37.8[‡]	28.6 ± 17.4
Ongoing therapy					
Delivery rate	57.7%	26.9%	27.3%	4.1%	4.1%
Time (min)	28.9 ± 22.1	32.3 ± 42.7	13.1 ± 6.8	27	25
Therapy initiated					
Delivery rate	92.9%	68.8%	25.0%	14.3%	25.0%
Time (min)	47.0 ± 28.4[†]	30.7 ± 28.1	12.3 ± 12.7	57.5 ± 47.4	29.5 ± 19.9

Notes: Data are the mean ± SD. [†]$P < 0.01$, [‡]$P < 0.001$ compared with the non-insulin group. The delivery rate shows the percentage of patients in each group receiving dietary counseling and/or nurse education.
Abbreviation: OGLAs, oral glucose-lowering agents.

Patients who were starting insulin therapy after their first visit received more educational counseling from both the dietitian and nurse than did the other patients.

Economic data

Reimbursement for care is detailed in Table 4. These figures do not include charges for medications and insulin. The reimbursement for the insulin group was approximately twice that of the non-insulin group in every month of the study. Under the Japanese medical system, charges associated with the self-monitoring of glucose levels and nurse counseling were covered for the insulin group, but not for the non-insulin group. Therefore, the reimbursement for expenses in addition to examinations was considered as an insulin-related expense. The total fee divided by total care time for the insulin group was approximately twice that for the non-insulin group throughout the study period, except for the total fee/min in the first and second months.

Clinical outcomes

The mean HbA_{1c} level in the non-insulin group decreased from 8.0% at the first visit to 6.5% after 5 months, compared with a decrease in mean HbA_{1c} in the insulin group over the same time frame from 9.4% to 7.6% (Table 5). In the group of patients who started insulin therapy after their first visit, the mean HbA_{1c} level improved better than in the group of patients continuing with insulin therapy, although HbA_{1c} levels in the latter group after 5 months were still higher than in the non-insulin group. The proportion of patients in the non-insulin group who achieved an $HbA_{1c} \leq 6.5\%$ in the first month was 34%, which increased to 72% after 5 months (range 56%–88% across the 11 clinics). In comparison, 24% and 39% of patients in the insulin group achieved an $HbA_{1c} \leq 6.5\%$ after 1 and 5 months, respectively.

Blood pressure in the non-insulin group decreased significantly between the first visit and the fifth month,

Table 4. Reimbursement of costs for the care of diabetes with/without insulin therapy.

	Time (months)				
	1	2	3	4	5
Total fees/month (yen)					
Non-insulin (OGLAs+diet)	18885 ± 7214	10366 ± 5988	10798 ± 5089	10207 ± 4253	10433 ± 4606
Insulin	29660 ± 10968*	21697 ± 7507*	22933 ± 4886*	21654 ± 6234*	24012 ± 5538*
Ongoing therapy	27893 ± 11802	20819 ± 8720	24221 ± 4952	22942 ± 5818	24806 ± 4919
Therapy initiated	32941 ± 8646	23123 ± 4881	20572 ± 3926	19446 ± 6514	23019 ± 6247
Care fees/month (yen)					
Non-insulin (OGLAs+diet)	6173 ± 3970	5247 ± 4007	5977 ± 3880	5606 ± 3380	5532 ± 3455
Insulin	17135 ± 8806*	16371 ± 7005*	17619 ± 4017*	16575 ± 5253*	17765 ± 4906*
Ongoing therapy	15706 ± 9192	15168 ± 7982	18433 ± 3924	17444 ± 5329	18043 ± 4352
Therapy initiated	19791 ± 7646	18325 ± 4622	16127 ± 3873	15086 ± 4950	17418 ± 5651
Examination fees/month (yen)					
Non-insulin (OGLAs+diet)	13362 ± 5641	5799 ± 3485	5411 ± 2826	5164 ± 2207	5512 ± 2737
Insulin	12524 ± 4469	5326 ± 2608	5314 ± 2337	5079 ± 2059	6246 ± 2840
Ongoing therapy	12188 ± 5071	5651 ± 3186	5788 ± 2781	5499 ± 1614	6763 ± 3273
Therapy initiated	13150 ± 3133	4798 ± 1094	4445 ± 581	4360 ± 2565	5601 ± 2109
Total fees/min (yen/min)					
Non-insulin (OGLAs+diet)	250 ± 278	312 ± 352	469 ± 420	530 ± 515	583 ± 563
Insulin	303 ± 245	474 ± 264‡	887 ± 630‡	1108 ± 1164†	925 ± 539‡
Ongoing therapy	345 ± 295	478 ± 251	944 ± 731	956 ± 688	888 ± 475
Therapy initiated	225 ± 54	469 ± 293	783 ± 390	1368 ± 1704	971 ± 623
Care fees/min					
Non-insulin (OGLAs+diet)	77 ± 65	156 ± 201	269 ± 360	288 ± 350	307 ± 392
Insulin	172 ± 153‡	352 ± 221*	688 ± 484*	903 ± 1123*	690 ± 428*
Ongoing therapy	195 ± 184	340 ± 213	728 ± 554	748 ± 582	657 ± 398
Therapy initiated	129 ± 43	370 ± 239	615 ± 326	1168 ± 1693	732 ± 473

Notes: Data are the mean ± SD. †$P < 0.01$, ‡$P < 0.001$, *$P < 0.00001$ compared with the non-insulin group.
Abbreviation: OGLAs, oral glucose-lowering agents.

but remained the same in the insulin group. Although total cholesterol levels decreased between the first and fifth months in both groups, the decrease was only significant for the non-insulin group (Table 5). The proportion of patients who achieved their target systolic blood pressure increased in the non-insulin group over the 5 months of the study, but was unchanged in the insulin group (Table 5). The BMI after 5 months was nearly the same as that on the first visit for both groups.

Discussion

The present study has provided baseline data regarding the time and costs involved in the management of newly registered patients in diabetes clinics in Japan according to whether they are receiving insulin or non-insulin therapy. The time and resource utilization for patients receiving insulin therapy was approximately twice that for those receiving non-insulin therapy. In addition, patients receiving insulin therapy had

1.3-fold more clinic visits/month than patients not on insulin therapy. Compared with patients in the non-insulin group, the total time spent on patients who were either on insulin therapy at the time of their first clinic visit or who started insulin after their first visit was 1.4- and 1.7-fold greater, respectively, at the end of the first month. Although the time spent on patients in the insulin group decreased over the 5 months of the study, it remained consistently higher than that spent on patients in the non-insulin group (~4 min). Furthermore, the time physicians spent consulting with patients was 2.5 min longer for the insulin group after 4 months. In previous studies, it has been reported that approximately 7 min is spent seeing outpatients with DM treated with medication,[19,21] thus, in the present study having to spend an additional 2.5 min with patients in the insulin compared with the non-insulin group may place a further burden on physicians. The time spent by nurses providing patient education was also longer for the insulin group than the non-insulin

Table 5. HbA_{1c}, blood pressure, cholesterol values and body mass index for each month.

	Time (months)				
	1	2	3	4	5
HbA_{1c} (%)					
Non-insulin (OGLAs+diet)	8.0 ± 1.9	7.6 ± 1.7**	7.1 ± 1.3****	6.6 ± 1.0****	6.5 ± 1.0****
% Patients who achieved $HbA_{1c} \leq 6.5$%	34%	43%	51%	70%	72%
Insulin	9.4 ± 2.9†	8.8 ± 2.4¶	8.0 ± 1.7∬,**	7.6 ± 2.0†,**	7.6 ± 1.5∬,***
Ongoing therapy	9.2 ± 2.4	9.1 ± 1.8	8.1 ± 1.0	7.4 ± 1.2	7.7 ± 1.5
Therapy initiated	9.5 ± 3.6	8.5 ± 3.0	7.8 ± 2.5	7.9 ± 3.1	7.5 ± 1.6
% Patients who achieved $HbA_{1c} \leq 6.5$%	24%	22%¶	21%‡	39%‡	39%‡
SBP (mmHg)					
Non-insulin (OGLAs+diet)	136 ± 22	130 ± 21***	126 ± 21****	126 ± 20****	127 ± 21****
% Patients who achieved SBP $\leq$ 130 mmHg	46%	54%	62%	65%	62%
Insulin	128 ± 27‡	121 ± 18†	125 ± 16	127 ± 18	131 ± 22
Ongoing therapy	130 ± 27	123 ± 17	127 ± 16	129 ± 18	130 ± 18
Therapy initiated	124 ± 25	118 ± 20	122 ± 15	123 ± 18	132 ± 27
% Patients who achieved SBP $\leq$ 130 mmHg	57%	68%	70%	52%	58%
DBP (mmHg)					
Non-insulin (OGLAs+diet)	80 ± 13	76 ± 12***	74 ± 11****	73 ± 12****	74 ± 13****
Insulin	75 ± 12†	72 ± 11¶	75 ± 9	77 ± 9¶	74 ± 12
Ongoing therapy	74 ± 13	73 ± 11	76 ± 9	77 ± 9	74 ± 11
Therapy initiated	79 ± 10	71 ± 12	73 ± 10	76 ± 11	74 ± 14
Total cholesterol (mmol/L)					
Non-insulin (OGLAs+diet)	5.5 ± 1.2	5.3 ± 1.0*	5.1 ± 1.1***	5.2 ± 1.0***	5.3 ± 0.8*
Insulin	5.5 ± 1.2	5.3 ± 1.0	5.1 ± 1.1	5.2 ± 1.0	5.3 ± 0.8
Ongoing therapy	5.6 ± 1.2	5.1 ± 0.5	5.8 ± 0.9	5.6 ± 0.9	5.5 ± 0.7
Therapy initiated	5.5 ± 1.0	5.5 ± 0.6	4.8 ± 0.8	4.8	5.3 ± 1.2
BMI (kg/m^2)					
Non-insulin (OGLAs+diet)	24.2 ± 3.6	24.5 ± 4.6	23.9 ± 3.5	24.3 ± 3.8	24.0 ± 3.5
Insulin	23.0 ± 3.5	23.7 ± 4.2	23.6 ± 4.0	23.2 ± 3.7	23.6 ± 3.5
Ongoing therapy	22.7 ± 2.9	24.2 ± 4.1	23.8 ± 4.4	23.6 ± 3.6	23.8 ± 3.8
Therapy initiated	23.4 ± 4.4	22.6 ± 4.5	23.4 ± 4.0	22.6 ± 3.9	23.4 ± 3.4

Notes: Data are the mean ± SD. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ****$P < 0.00001$ compared with the first month; ¶$P < 0.05$, †$P < 0.01$, ‡$P < 0.001$, ∬$P < 0.00001$ compared with the non-insulin group.
Abbreviations: OGLAs, oral glucose-lowering agents; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index.

group, especially in the first 3 months. These data indicate that patients can become accustomed to administering insulin injections and self-monitoring glucose levels over a period of approximately 3 months, even though they are likely to need greater consultation than patients who are not on insulin throughout their treatment.

The total fee for the insulin group was approximately double (ie, 10,000 yen) that for the non-insulin group. However, the calculated fee for the insulin group included the costs of sensors and other equipment needed for glucose monitoring, as well as fees for the disposal of these medical devices, so that the actual fee for insulin care is only approximately half the reported fee. The additional costs in the insulin group were offset by reimbursements for education and support of insulin injections, and are thought to be reasonable considering the time expended on these patients, even though the costs remain higher than those in the non-insulin group.

For most patients in Japan, insulin therapy had been initiated on an inpatient basis. However, in recent times it has become increasingly difficult for patients to afford hospital admission to start insulin therapy. The costs associated with starting insulin as an inpatient (5–7 days hospitalization) have

been reported to be fourfold greater in France[22] and 10-fold greater in Germany[23] compared with the costs of initiating insulin therapy on an outpatient basis. In these reports, equivalent glycemic control was achieved at 3 and 12 months, respectively,[22,23] and the authors concluded that the initiation of insulin therapy on an outpatient basis was as safe and effective as starting insulin as an inpatient, and that it was very cost-effective.[22,23]

In the present study, the HbA_{1c} improved from a mean of 9.4% to 7.6% in the insulin group, which was a slightly larger decrease than that seen in the non-insulin group (from 8.0% to 6.5%). There were no major hypoglycemic episodes recorded for any patient in either group in the present study. The BMI, which often increases in response to insulin therapy, did not increase in the present study, which is attributed to the quality of the self-care education provided by the CDE nurses and dietitians. However, the proportion of patients who achieved the glycemic goal (ie, $HbA_{1c} \leq 6.5\%$) was only 39% in the insulin group, compared with 72% in the non-insulin group. The basal HbA_{1c} in the group of patients who started insulin after their first clinic visit was as high as 9.5%, which reflects a delay in the initiation of insulin. It has been reported previously that the mean basal HbA_{1c} of patients who achieved $HbA_{1c} \leq 6.5\%$ after 12 months insulin was 7.5%.[18] The mean age of patients in the insulin group was less than that in the non-insulin group and stricter glycemic control was expected from the point of view of preventing DM-associated complications and health care expenditure. It has been reported previously that the total health care expenditure decreases following the initiation of insulin therapy, despite initial increased costs.[24]

Delays in initiating insulin therapy can be caused by several factors. First, patients are often reluctant to inject insulin. In addition, physicians may be reluctant to start insulin therapy because of concerns regarding patient acceptance of injections, a lack of nurses to provide patient education, and more complex and time-consuming difficulties in the medical management of insulin treatment.[15–17,25] Furthermore, many clinicians traditionally only consider initiating insulin therapy in T2DM patients after treatment with oral glucose-lowering agents has failed.[25] Many patients with T2DM are seen in primary care settings. When we weigh high priority against the need for tight glycemic control, it is evident that we need a more effective and efficient system in the community that can facilitate the initiation of insulin treatment earlier in those patients who require it by referring them to specialists and/or increasing the accessibility to CDEs.[16,17,26,27]

There are some limitations to the present study. First, the sample size was small in the insulin group. The physicians participating in the study are specialists and the proportion of newly registered patients a year in the insulin group is not so small compared to that of general physician's clinics. However, it is still too small to evaluate the effect of the severity of glycemic control, duration of diabetes and complications which are the factors that are considered to affect the time and costs of the treatment. In addition, the education program was not standardized and differed between clinics, such that a relatively large standard deviation was obtained for the time spent educating patients.

In conclusion, the titration and initiation of insulin therapy for T2DM patients can be achieved safely and effectively at outpatient clinics. Although insulin therapy requires much more time and resources than non-insulin therapy, the initiation of insulin therapy on an outpatient basis remains a cost-effective option. The initiation of insulin should not be delayed when it is needed.

Acknowledgement

Abbreviations

BMI, body mass index; CDE, certified diabetes educator; DM, diabetes; HbA_{1c}, glycated haemoglobin; JDDM, Japan Diabetes Clinical Data Management study group; OGLA, oral glucose-lowering agents.

Disclosure

patient consent prior to publication. Author(s) have confirmed that the published article is unique and not under consideration nor published by any other publication and that they have consent to reproduce any copyrighted material. The peer reviewers declared no conflicts of interest.

References

1. Ministry of Welfare, Japan, report of national survey of diabetes, 2007.
2. Tominaga M, Eguchi H, Manaka H, Igarashi K, Kato T, Sekikawa A. Impaired glucose tolerance is a risk factor for cardiovascular disease but not impaired fasting glucose. The funagata diabetes study. *Diabetes Care*. 1999;22:920–4.
3. Nakanishi S, Yamada M, Hattori N, Suzuki G. Relationship between HbA1c and mortality in a Japanese population. *Diabetologia*. 2005;48:230–4.
4. Kawasaki R, Wang JJ, Rochtchina E, et al. Cardiovascular risk factors and retinal microvascular signs in an adult Japanese population: the Funagata Study. *Ophthalmology*. 2006;113:1378–84.
5. Mayfield JA, Deb P, Whitecotton L. Work disability and diabetes. *Diabetes Care*. 1999;22:1105–9.
6. ADA. Economic consequences of diabetes mellitus in the US in 1997. *Diabetes Care*. 1998;21:296–309.
7. Brown JB, Nichols GA, Glauber HS, Bakst AW. Type 2 diabetes: incremental medical care costs during the first 8 years after diagnosis. *Diabetes Care*. 1999;22:1116–24.
8. The diabetes control and complication trial research group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977–86.
9. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes: (UKPDS 33). *Lancet*. 1998;352:837–53.
10. Shichiri M, Ohkubo Y, Kishikawa H, Wake N. Long-term results of the Kumamoto Study on optimal diabetes control in type 2 diabetic patients. *Diabetes Care*. 2000;23(Suppl 2):B21–9.
11. UKPDS Group. Glycemic control with diet, sulphonylurea, metformin, or insulin in patients with type 2 diabetes mellitus: progressive requirement for multiple therapies (UKPDS49). *JAMA*. 1999;281:2005–12.
12. Nathan DM, Cleary PA, Backlund JY, et al. Diabetes control and complication trial/epidemiology of diabetes interventions and complications (DCCT/EDIC) study research group. intensive diabetes treatment and cardiovascular disease in patients with type 1 diabetes. *NEJM*. 2005;353:2643–53.
13. Holman RR, Paul SK, Bethel MA, Matthews DR, Neil HA. 10-year follow-up of intensive glucose control in type 2 diabetes. *NEJM*. 2008;359:1577–89.
14. Wright A, Burden AC, Paisey RB, Cull CA, Holman RR; for the UK Prospective Diabetes Study Group. Sulfonylurea inadequacy: efficacy of addition of insulin over 6 years in patients with type 2 diabetes in the UK. Prospective Diabetes Study (UKPDS57). *Diabetes Care*. 2002;25:330–6.
15. Nichols GA, Koo YK, Shah SN. Delay of insulin addition to oral combination therapy despite inadequate glycemic control. Delay of insulin therapy. *Gen Int Med*. 2007;22:453–8.
16. Shah BR. Zinman B. Hux JE. Walraven CV. Laupacis A. Clinical inertia in response to inadequate glycemic control. *Diabetes Care*. 2005;28:600–6.
17. Calvert MJ, McManus RJ, Freemantle N. Management of type 2 diabetes with multiple oral hypoglycemic agents or insulin in primary care: retrospective cohort study. *Bri J Gen Prac*. 2007;57:455–60.
18. Kobayashi M, Yamazaki K, Kanatsuka A, JDDM group. CoDiC-based survrillance of clinical management of diabetes in Japan (2nd report); the present state of insulin therapy and glycemic control in Type2 diabetes. *Jpn J Diabet Mast Clin*. 2007;5:401–6. Japanese.
19. Oishi M, Yokoyama H, Abe N, et al. Time and cost involved in the care of newly registered patients with diabetes mellitus and other lifestyle diseases at diabetes clinics in Japan (JDDM4). *Diab Med*. 2007;24:1149–55.
20. Prochaska JO, Redding CA, Evers KE. The transtheoetical model and stages of change. Glanz K, Lewis FM, Rimer BK, editors. *Health Behavior and Health Education*. 2nd ed. San Francisco. Jossey-Bass; 1997:60–84.
21. Oishi M, Yokoyama H, Ikeda S. Cost and time for outpatient medical care for lifestyle disease—comparison between diabetes and hypertension and/or hyperlipidemia. *J Japan Diab Soc*. 2004;47:363–8.
22. Pengornis A, Millot L, the INNOV study group. Initiating insulin treatment in insulin-requiring type 2 diabetic patients: comparative efficiency and cost of outpatient and inpatient management. *Diabetes Metab*. 1998;24:137–42.
23. Müller UA, Müller R, Starrach A, et al. Should insulin therapy in type 2 diabetic patients be started on an out- or inpatient basis? results of a prospective controlled trial using the same treatment and teaching programme in ambulatory care and a university hospital. *Diabetes Metab*. 1998;24:251–5.
24. Rosenblum MS, Kane MP. Analysis of cost and utilization of health care services before and after initiation of insulin therapy in patients with type 2 diabetes mellitus. *JMCP*. 2003;9:309–16.
25. Tanenberg RJ. Transitioning pharmacologic therapy from oral agents to insulin for type 2 diabetes. *Curr Med Res Opi*. 2004;20:541–3.
26. Hayward RA, Manning WG, Kaplan SH, Wagner EH, Greenfield S. Starting insulin therapy in patients with type 2 diabetes, effectiveness, complications, and resource utilization. *JAMA*. 1997;278:1663–9.
27. Home PD, Boulton AJM, Jimenez J, Landgraf R, Osterbrink B, Christiansen JS. on behalf of the Worldwide initiative for diabetes education (WorldWIDE). Issues relating to the early or earlier use of insulin in type 2 diabetes. *Pract Diab Int*. 2003;20:63–71.