

Clinical Experience with Insulin Detemir: Results from the Bangladesh Cohort of Global A_{1c}chieve Study

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Abstract

Objective: To present results from the Bangladesh cohort of the A_{1c}chieve study receiving insulin detemir (Levemir) ± oral anti diabetic drugs. **Methods:** Out of 1093 patients recruited from 49 sites in Bangladesh, 370 were initiated on insulin detemir (Levemir). Study visits were defined as baseline, interim (around 12 weeks from baseline) and final (around 24 weeks from baseline) visit. **Results:** Glycaemic control was poor in all the groups at baseline. In the entire cohort at 24 weeks, significant reductions from baseline were observed in mean HbA_{1c} (from 10.0 % to 7.2%, $p < 0.001$), FPG (from 10.5 to 6.7 mmol/L, $p < 0.001$) and PPPG (from 15.3 to 8.9 mmol/L, $p < 0.001$) levels. Overall 45.5% of the

participants achieved target HbA_{1c} level of < 7% after 24 weeks. The rate of all hypoglycaemic events in the entire cohort reduced from 1.34 (baseline) to 0.12 events/person year after 24 weeks of insulin detemir therapy ($p < 0.0001$). There was no clinically relevant change in body weight in insulin naïve or prior insulin users groups after 24 weeks of insulin detemir therapy. **Conclusions:** The current study suggests that insulin detemir may be considered as a safe and effective option for initiating insulin therapy for type 2 diabetes in Bangladesh.

Keywords: Type 2 diabetes mellitus, Levemir, Bangladesh.

(Birdem Med J 2013; 3(1):11-18)

Introduction

Type 2 diabetes mellitus (T2DM) has acquired the status of an epidemic worldwide with an exponential increase in the South Asian region. A threefold rise in prevalence rates is evident for urban population of Bangladesh during the last 5 years¹. T2DM constitutes 90%-95% of total diabetes in Bangladesh².

A recent systematic review on cardiovascular disease and diabetes in Bangladesh found evidence of a rising secular trend with T2DM in 5year intervals between 1995 and 2010 (T2DM = 3.8%, 5.3%, 9.0%). T2DM is higher in males (M vs. F: 7.0% vs. 6.2%) with a prevalence

of 5.1% in rural population as compared to urban population (10.2%), suggesting rising trend even in rural areas³.

Earlier Wild et al reported Bangladesh to have over 3 million people with diabetes in the year 2000 and projected it to increase by approximately 4 times (11 million) by the year 2030². The uncontrolled epidemic and increasing burden of T2DM in Bangladesh may be due to the progressive nature of the disease, different treatment demands at various stages⁴⁻⁷, increased life expectancy, physical inactivity, and poor awareness about healthy dietary habits and glycaemic control³.

Timely and effective use of anti-diabetic treatment may help reduce the burden of T2DM. Insulin is frequently reserved for a later stage of the disease and often prescribed for multiple Oral anti-diabetic drugs (OADs) failure cases. Although insulin is the most effective treatment for insulin deficient T2DM, with proven efficacy in lowering HbA_{1c}, there is strong resistance to introduce insulin at an earlier stage of the disease⁸. The American Diabetes Association (ADA) recommends early use of insulin when the required glucose levels are not achieved with lifestyle management and metformin monotherapy⁹. However, the recent position statement of the ADA and the European Association for the Study of Diabetes (EASD)

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Disclaimer : This study was funded by M/S Novo Nordisk Pharma Ltd.

Received: 12 October, 2012 **Accepted:** 12 December, 2012

also emphasizes on individualization of treatment goals. It suggests addition of basal insulin to metformin in patients with high baseline HbA_{1c} levels of e" 9%¹⁰. Basal insulin formulations try to restore the normal physiology, which is often impaired in diabetes. Developing therapeutic insulin, which can be injected with low frequency, especially once a day, with a similar and reproducible pharmacodynamic (PD) profile of normal basal insulin secretion is a challenge. Conventional basal insulin preparations (Ultralente and neutral protamine Hagedorn (NPH) insulin) lack of these desired properties^{11,12}. They are available as suspension and have pronounced peak effect and high variability, which is associated with nocturnal hypoglycaemia¹³⁻¹⁵. The above deficiencies with conventional human insulin have led to the development of insulin analogues¹⁶. Insulin detemir, a long acting basal insulin analogue, has a deletion of the terminal B chain amino acid (B30), and a fatty acid side chain (myristic acid) attached at B29 position. These changes facilitate dihexameric complexes to form in the injection depot of detemir and also enable binding with albumin. Thus PD profile of insulin detemir matches with that of endogenous basal insulin and is associated with fewer shortcomings than traditional insulin i.e. pronounced peak effect, increased risk of hypoglycaemic events, substantial within-patient variability, shorter duration of action and the potential need for multiple daily dosing^{17,18}. Many randomized controlled trials (RCTs) have shown that use of insulin detemir significantly reduces HbA_{1c} and blood glucose levels and is associated with very low risk of hypoglycaemia^{8,19}. Real life clinical studies have also shown improvement in glycaemic control with reduced risk of hypoglycaemia and less weight gain, when insulin detemir has been used in combination with OADs²⁰. Data generated from observational studies can complement those from RCTs by providing an insight into how treatments perform in day to day practice in more clinically representative patient populations²¹.

A₁chieve was an observational study, designed to assess the real life safety and effectiveness of insulin analogues in large diabetic populations (more than 65,000 patients comprising of insulin naïve patients and prior insulin users from 28 countries)²². It is one of the largest observational studies on insulin therapy till date which also evaluated the effect of insulin analogs on

health related quality of life (HRQoL) scores in the patients; to assess their satisfaction with the analogues²³.

The safety and effectiveness of insulin detemir in the Bangladesh population is not well established as there is scant published data exploring the use of this analogue in routine clinical practice. Therefore, the objective of the present analysis was to evaluate the safety, effectiveness and HRQoL parameters of Bangladesh cohort, treated with insulin detemir.

Methods

Study design

A₁chieve was a 24-week international, prospective, multicenter, open labeled, non-interventional, observational study in people with diabetes who had started using basal insulin detemir (Levemir, Novo Nordisk, Denmark), bolus insulin aspart (NovoRapid, Novo Nordisk) and biphasic insulin aspart 30 or BIAsp30 (NovoMix 30, Novo Nordisk), alone or in combination with oral glucose lowering drugs (OGLDs). The study was carried out in 28 countries across four continents to evaluate the clinical safety and effectiveness of insulin analogues in routine clinical use.

Basal insulin detemir (Levemir) and other analogues were initiated based upon the discretion of the practicing physician and the participant. There were no defined study related procedures. Safety and efficacy was measured during the routine clinical practice. Study visits were defined as baseline, interim (around 12 weeks from baseline) and final (around 24 weeks from baseline) visit. The time period of 4 weeks prior to the baseline visit, was defined as a pre-study period. The data was collected from physicians' clinical notes, patient's recall and patient self-monitoring diary, and was then recorded in a standard case report (CRF).

Participants

The study was conducted in accordance with the principles of Declaration of Helsinki and good clinical practice guidelines. Ethics committee approval before study commencement, and signed informed consent from all participants prior to participation in the study was obtained. Inclusion and exclusion criteria were intentionally kept minimal in order to reflect the real life clinic practice. Patients were included only if they had never been treated with insulin detemir (Levemir) or if

they have started within 4 weeks prior to enrollment. Women who were pregnant, breast-feeding or had the intention of becoming pregnant were excluded. Patients were taken into the study upon providing a voluntary signed informed consent. However they were free to withdraw at any time during the course of the study. Safety events were reported according to the protocol.

Assessments and outcome measures

The primary objective of this study was to evaluate the clinical safety of analogues with respect to the number of serious adverse drug reactions (SADRs), including major hypoglycaemic events, between baseline and final visit. Secondary safety assessments were the change in number of hypoglycaemic events in the last 4 weeks before interim and final visits, compared with the last 4 weeks before baseline visit, the change in number of nocturnal hypoglycaemic events during these periods and the number of adverse drug reactions (ADRs) from baseline to final visit. Major hypoglycaemic events were defined as events with severe central nervous system symptoms, consistent with hypoglycaemia, for which the person was unable to self-treat, and accompanied by plasma glucose <3.1 mmol/L or 56 mg/dL, or reversal of symptoms after either food intake or glucagon or intravenous glucose administration. Minor hypoglycaemia was any event, with or without symptoms of hypoglycaemia, with a plasma glucose reading below 3.1 mmol/L or 56 mg/dL that the participant was able to self-treat. Nocturnal hypoglycaemia was defined as a symptomatic event consistent with hypoglycaemia that occurred during sleep between bedtime after the evening insulin injection and before getting up in the morning.

Effectiveness of therapy was determined from the change in HbA_{1c}, fasting plasma glucose (FPG), postprandial plasma glucose (PPPG) and body weight between baseline and interim and final visits, and change in systolic blood pressure (SBP) and lipid profile at final visit. In addition, the effect of insulin analogue therapies on HRQoL of the participants was also evaluated.

HRQoL was measured using the EQ-5D questionnaire and EQ visual analogue scale (EQ VAS) at baseline and after 24 weeks of therapy with insulin analogues. EQ VAS included a rating for an individual's current state, measured by a standard vertical 20 cm scale with score ranging from 0 (worst imaginable health) to 100

(best imaginable health). EQ-5D questionnaire consisted of five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) which was scored as 1, 2 or 3 depending on the level of severity. These different dimensions were converted to a single utility value, anchored by '1.00' representing full health and '0.00' representing the state 'dead'.

Participants were recruited between January 2009 and June 2010 and a total of 66,726 people were included in the study⁷. In this paper, we present the results of analysis conducted on the data of participants from the Bangladesh, treated with Insulin detemir (Levemir, Novo Nordisk, Denmark).

Statistical Analysis

The sample size calculation for the entire global cohort was based on the number of patients (60,000) exposed for 6 months required to confirm a frequency of e^{-15} events/100,000 patient-years of any one SADR, including major hypoglycaemic events, at the 95% confidence level. Statistical analyses were performed for the entire cohort and for the entire cohort classified as insulin-naïve or prior insulin users. Descriptive statistics were used to summarise continuous variables and frequency tables (number and percentage) were used for discrete variables. All statistical analyses were two-sided, with 5% significance level, unless otherwise stated. For the change in hypoglycaemia from baseline, the percentage of patients reporting at least one event was analysed using Fisher's exact test. The change from baseline in HbA_{1c}, FPG, PPPG, SBP, body weight, blood lipids and HRQoL was analysed using a paired t-test using baseline and end-of-study values. Data analyses were performed by Novo Nordisk using SAS (Version 9.1.3).

Results

A total of 370 patients participated in the study. The participant characteristics for the entire cohort divided as insulin-naïve and prior insulin users are shown in the Table-I. Patients in the prior insulin user group had longer duration of diabetes than the insulin-naïve cohort (8.6 yrs vs. 6.3 yrs), had a higher BMI (26.4 kg/m² vs. 25.1 kg/m²) and increased body weight (68.0 kgs vs 65.2 kgs). Baseline HbA_{1c} was almost similar in both the cohorts (10.1% vs 10.0%). Also, the age was same in prior insulin users and insulin naïve cohorts (50.4 yrs vs. 50.1 yrs).

Table I*Baseline characteristics of the Bangladesh cohort*

	Entire cohort 370	Insulin naïve 272	Prior insulin users 98
N (%)			
Sex, M/F† (%)	200 (54.1)/ 170 (45.9)	153 (56.3)/ 119 (43.8)	47 (48.0)/ 51 (52.0)
Age (yrs)	50.2 (11.2)	50.1 (11.5)	50.4 (10.4)
Duration of diabetes (yrs)	6.9 (5.3)	6.3 (5.3)	8.6 (5.0)
Bodyweight (kgs)	66.0 (9.5)	65.2 (8.8)	68.0 (11.0)
BMI‡ (kg/m ²)	25.4 (3.4)	25.1 (3.2)	26.4 (3.8)
HbA _{1c} (%)	10.0 (1.2)	10.0 (1.2)	10.1 (1.0)

†-Male/female; ‡- body mass index; Data expressed in Mean (Standard deviation) for all variables except N and Sex

Blood glucose values and Insulin dose

Treatment with insulin detemir (Levemir) for 24 weeks led to significant improvement in the magnitude of glycaemic control. In the entire cohort, the mean reduction in HbA_{1c} was 2.8 %, while mean reductions in FPG and PPPG were 3.8 mmol/L and 6.4 mmol/L respectively. These parameters also showed reductions of similar extent in the insulin naïve patients and prior insulin users. In the entire cohort, 45.5% of the participants achieved target HbA_{1c} level of < 7% after 24 weeks of insulin detemir (Levemir) therapy. At end of

study, 45.2% of insulin naïve and 46.3% of prior insulin users reached target HbA_{1c} level of <7% following insulin detemir(Levemir) treatment (Table-II).

In the insulin-naïve cohort, total daily insulin dose at 24 weeks had been titrated up to 15.9 ± 5.1 U/day. In prior insulin users, pre-analogue insulin dose was 30.3 ± 14.0 U/day, total starting insulin dose was 21.9 ± 7.4 U/day and at 24 weeks was 19.8 ± 6.5 U/day. Furthermore, the pattern of OGLDs use in the patients also changed during 24 weeks of the study. Use of sulfonylurea (SU)

Table II*Effectiveness of insulin detemir (Levemir) in controlling hyperglycaemia*

		Full cohort(n=370)	Insulin naïve(n= 272)	Prior insulin(n=98)
HbA _{1c} (%)	N	315	236	79
	Baseline	10.0 (1.2)	10.0 (1.2)	10.1 (1.0)
	24 weeks	7.2 (1.1)	7.2 (1.1)	7.3 (1.1)
	Change	-2.8 (1.2)**	-2.8 (1.2)**	-2.8 (1.2)**
Proportion with HbA _{1c} <7%	Baseline	1.1	1.1	1
	24 weeks	45.5	45.2	46.3
Fasting plasma glucose (mmol/l)	N	339	249	90
	Baseline	10.5 (1.6)	10.6 (1.7)	10.4 (1.5)
	24 weeks	6.7 (0.8)	6.7 (0.8)	6.8 (0.9)
	Change	-3.8 (1.7)**	-3.9 (1.7)**	-3.6 (1.5)**
Post prandial plasma glucose (mmol/l)	N	339	249	90
	Baseline	15.3 (2.1)	15.3 (2.1)	15.4 (2.0)
	24 weeks	8.9 (1.2)	8.9 (1.2)	9.1 (1.3)
	Change	-6.4 (2.1)**	-6.4 (2.2)**	-6.3 (1.9)**

Data expressed in Mean (Standard deviation) for all variables unless mentioned otherwise * p<0.05, ** p<0.001 compared to baseline

Table-III*Hypoglycaemia and effect of insulin detemir(Levemir) on body weight*

Percent with event / event per person-year		Entire cohort	Insulin naïve	Prior insulin
Overall Hypoglycaemia [§]	Baseline	10.3 / 1.34	3.3 / 0.43	29.6 / 3.85
	24 wks	0.6 / 0.12	0.4 / 0.10	1.1 / 0.14
	Change	-9.7**	-2.9*	-28.5**
Minor Hypoglycaemia [§]	Baseline	28.6 / 3.71	3.3 / 0.43	28.6 / 3.71
	24 wks	1.1 / 0.14	0.4 / 0.10	1.1 / 0.14
	Change	-27.5**	-2.9* ^a	-27.5**
Major Hypoglycaemia [§]	Baseline	0.3 / 0.04	0	1.0 / 0.13
	24 wks	0.00 / 0.000	0	0.00 / 0.000
	Change	-0.3		-1.0
Nocturnal Hypoglycaemia [§]	Baseline	6.5 / 0.84	1.8 / 0.24	29.6 / 3.85
	24 wks	0.3 / 0.04	0.4 / 0.05	0.00 / 0.000
	Change	-6.2**	-1.4	-29.6**
Body weight (kg)	N	335	245	90
	Baseline	66.0 (9.7)	65.2 (9.0)	68.0 (11.2)
	24 wks	65.8 (9.6)	65.1 (8.8)	67.9 (11.2)
	Change,	-0.1 (1.1)*	-0.1 (1.1)	-0.1 (1.2)

§- Patients experiencing at least one episode of hypoglycaemia. * $p < 0.05$, ^a $p = 0.02$, ** $p < 0.0001$ compared to baseline

increased from 64.3% at baseline to 74.3% at 24 weeks. However, the use of metformin decreased from 45.6 % at baseline to 30.6% at the end of the study period. Thiazolidinediones (TZDs) use also decreased from 23.1% to 9.7 % during the study.

Hypoglycaemia

At baseline, overall 38 hypoglycaemic events (1.34 events/person year) were observed in 38 (10.3%) individuals of the entire cohort. After 24 weeks of therapy, overall only 3 (0.12 events/person year, $p < 0.0001$) events of hypoglycaemia occurred in 2 (0.6%) patients. A remarkable reduction in overall hypoglycaemic events was observed in the prior insulin users from 3.85 events/person year at baseline to 0.14 events/person year at 24 weeks ($p < 0.0001$). There was also a significant reduction in the rate of hypoglycaemia in insulin naïve patients from 0.43 events/person year to 0.10 events/person year ($p = 0.02$). Minor hypoglycaemic events in the entire cohort decreased significantly from 3.71 events/person year to 0.14 events/person year following treatment with insulin detemir (Levemir). Nocturnal hypoglycaemia was also

significantly reduced following treatment with insulin detemir (Levemir) and was prominent in prior insulin users where it fell from 3.85 events/person year to 0.0 events/ person year (Table-III).

Body weight and Blood Pressure

Following treatment with insulin detemir (Levemir) for 24 weeks, there was no clinically relevant change in body weight in insulin naïve, or prior insulin users groups (Table-III). Total cholesterol level for the entire cohort decreased significantly from 6.2 ± 1.5 mmol/L to 4.3 ± 0.2 mmol/L after 24 weeks of therapy. There was a mean reduction of 5.0 mm Hg in the SBP of the entire cohort from 128.7 ± 13.1 mm Hg at baseline to 123.7 ± 6.4 mm Hg at 24 weeks ($p < 0.001$). The reduction in SBP following insulin detemir (Levemir) therapy was higher in prior insulin users compared to insulin naïve patients.

Quality of Life:

a. Entire cohort

A significant improvement was seen in the HRQoL (as measured by EQ VAS scale i.e. on a scale 0-100) from 56.1 points at baseline to 83.0 points at 24 weeks ($p <$

0.001). Improvement in other dimensions of quality of life was also evident from baseline to 24 weeks.

b. Insulin-naïve or insulin experienced populations

An increase in HRQoL score (as measured by EQ VAS scale) was seen in both the insulin naïve and prior insulin users group. In the EQ-5D score, insulin naïve patients had an improvement of 0.189 points while prior insulin users reported a change of 0.170 points.

Discussion

The present subgroup analysis was carried out to assess the safety, effectiveness and change in HRQoL parameters in Bangladeshi A_1c study participants treated with insulin detemir (Levemir). Results showed that the HbA_{1c} levels reduced from 10% at baseline to 7.2% at 24 weeks of therapy in the entire cohort. Interestingly, similar extent of reduction in HbA_{1c} was observed in insulin naïve and prior insulin users (i.e. reduction by 2.8% in both the groups).

In addition, clinically significant reductions in FPG and PPPG values were observed in the entire cohort. Although effectiveness of insulin detemir (Levemir) in controlling the blood glucose of insulin naïve patients could have expected, its effect in insulin experienced patients was not entirely anticipated. Our observations are consistent with that of PREDICTIVE study where there was marked decrease in HbA_{1c} , fasting blood glucose (FBG) and within-patient variability in FBG in the subgroups who had switched to detemir plus OADs from older basal insulins (NPH or glargine) plus OADs²⁴. In the entire cohort, 45.5 % of patients reached target levels of $HbA_{1c} < 7\%$, within the span of 24 weeks following insulin detemir (Levemir therapy). However, a study by Hermansen et al, had reported that 70% of insulin naïve type 2 diabetics achieved target levels of HbA_{1c} following 24 weeks of insulin detemir therapy²⁵. The lower percentage of Bangladeshi patients achieving HbA_{1c} target levels could possibly be due differences in healthcare practices, food and lifestyle patterns. Overall, the analysis suggests that type 2 diabetics in Bangladesh achieve good glycaemic control with insulin detemir (Levemir), similar to other populations receiving this drug.

The UK prospective diabetes study (UKPDS), had shown that that every 1.0% reduction in HbA_{1c} is associated with a 43% reduction in the risk of amputation or death from peripheral vascular disease, a 37%

reduction in microvascular disease, and a 16% reduction in heart failure^{23,26}. Various population-based studies conducted in Bangladesh at different times have revealed an increasing trend of diabetes prevalence in rural and urban populations. Data from the Bangladesh Institute of Research and Rehabilitation for Diabetes, Endocrine, and Metabolic Disorders (BIRDEM) patient registry has shown that Bangladeshis are developing T2DM at an earlier age than in the past. Moreover, the INTERHEART Study- a global case-control study of risk factors for acute myocardial infarction (MI)- reported that the mean age of MI among Bangladeshis (51.9 years) was 6 years lower than the non-South Asians (58.8) and the lowest among all South Asians²⁷. Therefore, nearly 3% reduction in HbA_{1c} levels achievable with insulin detemir (Levemir) in this at-risk population may translate into possible clinical benefits in terms of significant reductions in diabetes related complications if the patients sustain on this treatment.

Intensive insulin therapy while improving glycaemic control is associated with increased risk of hypoglycaemia, leading to significant morbidity and mortality particularly in elderly or frail type 2 diabetics²⁸. Insulin detemir is well tolerated in patients with T2DM, and episodes of major hypoglycaemia have been documented in less than 10% of patients who receive the drug²⁹. In our study, the incidence of major hypoglycaemia following use of insulin detemir was absent at 24 weeks. Moreover, the incidence of nocturnal hypoglycaemia also reduced from 0.84 events/person-year at baseline to 0.04 events/person-year at 24 weeks. In the German cohort of Predictive study, major hypoglycaemic episodes had been significantly reduced by 55% and 51% respectively in prior NPH and glargine insulin users who switched to insulin detemir³⁰. An earlier study has shown that the incidence of nocturnal hypoglycaemia with bed time insulin detemir was 50% lower than with bed time NPH³¹. Results from a recent trial revealed that in comparison to NPH, the risk of hypoglycaemia at any time of day was 47% lower with insulin detemir while the risk of nocturnal hypoglycaemia was 55% lower²⁵. The PREDICTIVE BMI study, which was a 26-week, randomized, controlled trial of 277 overweight or obese adults with uncontrolled T2DM, revealed that the incidence of hypoglycaemia was lower in patients who had received insulin detemir compared to NPH insulin³².

In our study, the risk of hypoglycaemia was markedly reduced with insulin detemir (Levemir) possibly due to lower intra individual variability in blood glucose.

No clinically significant change in the body weight was observed at 24 weeks of insulin detemir (Levemir) therapy. Weight gain is usually a matter of concern for type 2 diabetic patients on insulin therapy³³. The use of insulin detemir is not associated with weight gain possibly due to factors like decreased hypoglycaemic episodes with less defensive eating, minimal adipogenesis and reduction in appetite⁸.

The safety related findings of the present study carry more significance as have been obtained during routine clinical practice and are more realistic than those observed within the controlled environment of clinical trials. The low incidence of hypoglycaemia and no significant change in weight therefore suggests that Bangladeshi diabetics can tolerate insulin detemir (Levemir) therapy satisfactorily. Furthermore, for long term therapy of such patients, insulin detemir may present itself as a safe yet effective alternative to other insulins including NPH and glargine, due to lower risk development of breast and prostatic cancers^{34,35}.

Conclusion

The results of the subgroup analysis suggest that significant improvement in glycaemic control is possible in Bangladeshi type 2 diabetic patients with the use of insulin detemir (Levemir). Moreover, such improved control of blood glucose can be achieved with reduced risk of hypoglycaemia and weight gain. Therefore, insulin detemir (Levemir) may be considered as a safe and effective option for initiating as well as intensifying insulin therapy for T2DM in Bangladesh.

Acknowledgements

We are thankful to Novo Nordisk for financial assistance and WorkSure Medpharma Consultancy Pvt. Ltd. for providing medical writing support.

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