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Prospective analysis of principles and frequency of self-adjustment of insulin dose in people with diabetes type 1 before and after participation in a diabetes treatment and teaching programme

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ABSTRACT

Objective: Insulin dose self-adjustment is an essential part of intensified insulin therapy – nowadays the routine treatment of type 1 diabetes (DM1). The aim of this study was to evaluate principles and frequency of insulin dose self-adjustments in people with DM1 before and one year after participating in a structured diabetes treatment and teaching programme (DTTP) and to determine to which extent the patients followed the way they had been trained.

Methods: 72 people with DM1 were interviewed before participation in our inpatient (32/72) or outpatient (40/72) DTTP. Sixty-six participants (91.7%) were followed up after one year. The number of adaptations of the insulin dose by the patients was recorded from 28 days of the patients' diary. The ability to find the correct dose was tested using five different examples.

Results: Metabolic control improved significantly after one year (7.9 ± 1.0 to $7.5 \pm 0.8\%$, $p = 0.004$). The participants performed 86.0 ± 37.1 insulin dosage adaptations per 28 days before the DTTP. After one year the frequency increased significantly to 99.1 ± 30.7 per 28 days ($p = 0.011$). Before the DTTP, 42 of 72 patients (58.3%) adjusted their insulin dose to correct high blood glucose levels by adjustment rules (factor for correction or correction scheme) and 20 of 72 people (27.8%) by personal experience/feeling. One year after the DTTP, 73% (48/66) used adjustment rules.

Conclusions: After participating in an structured education programme, patients adjusted their insulin dosage more frequently. Metabolic control improved despite the fact that many patients did not strictly apply the rules they had been trained for.

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Abbreviations: DM1, diabetes mellitus type 1; DTTP, diabetes treatment and teaching programme; HbA_{1c}, glycated haemoglobin

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1. Introduction

In people with diabetes mellitus type 1 (DM1), participation in a structured diabetes treatment and teaching programme (DTTP) for intensive insulin therapy is associated with improved metabolic control and quality of life, decreased frequency of hospitalization and less hypoglycaemia [1–6]. However, how is this achieved? Many studies evaluated metabolic control following DTTP in DM1. The core of DTTP is insulin dose self-adjustment, recognition of carbohydrate containing nutrients and estimation of the carbohydrate content as well as the influence of exercise on blood glucose [7,8]. The NICE guideline recommends offering all adults with DM1 a DTTP to enhance skills for the self-management of insulin therapy [9]. Insulin dose self-adjustment includes three basic elements: (i) meal-related insulin dose, (ii) insulin doses for correction (reduced or increased) according to current blood glucose and (iii) reduction/increase of insulin dose because of planned physical activity, stress or illness. The aim of such DTTP is that people with DM1 adjust their insulin dose according to the needs of their daily life. However, there are no data reporting how patients adjust their insulin under “real life” conditions on the long run.

A cross-sectional study on people with DM1 showed that although all people with DM1 were provided a factor for correcting high blood glucose levels, only half of the patients adjusted their insulin dose by applying the complex rules trained in the treatment and education programme [10]. 44% adjusted their insulin dose by personal experience or feeling. However, people adjusting their insulin dose based upon feeling did not show worse metabolic control. The same result was shown in a cross-sectional study on people with type 2 diabetes [11].

In this trial, we investigated people with current diabetes problems (e.g. insufficient metabolic control, high frequency of hypoglycaemia or marked blood glucose fluctuations) participating in a DTTP. Therefore, the aim of the study was to evaluate principles and frequency of insulin dose self-adjustment in people with DM1 before and directly after as well as one year after participation in a DTTP in an outpatient and inpatient setting.

2. Research design and methods

2.1. Participants and study setting

We recorded current principles and frequency of insulin dose self-adjustment in people with DM1 in an university department of endocrinology and metabolic diseases over one year (01/08/2012 to 31/07/2013). All patients, who participated in an outpatient or inpatient DTTP for people with DM1 and intensive insulin therapy or continuous subcutaneous insulin infusion (insulin pump therapy) [7] during the investigation period, were interviewed before (T0), immediately after (T1) and one year after participation in a DTTP (T2). Inclusion criteria were as following: people with DM1 of at least 6 months

and intensive insulin therapy or insulin pump therapy. All people who were not able to adjust their insulin dose by themselves (e.g. by caregivers) or did not understand German language were excluded. All participants signed an informed consent. The study was approved by the Ethics Committee of the Jena University Hospital (number 3492-06/12).

2.2. Descriptive and metabolic data

Clinical and laboratory data were drawn from the electronic patient record EMIL® [12] and collected on the day of each visit (T0, T1 and T2) of the individual patient.

HbA_{1c} was measured using high-performance liquid chromatography (TOSOH-Glykohaemoglobin-Analyzer HLC-723 GhbV, TOSOH CORPORATION, Tokyo, Japan) with a normal range of 5.0–6.2%. HbA_{1c} was adjusted according to the mean normal value of healthy people (5.05%, 32 mmol/mol) of the Diabetes Control and Complications Trial [13].

Three to six months prior to study entry, patients were instructed to document all episodes of hypoglycaemia as well as the 10 g carbohydrate portions in their diaries. Frequency of non severe hypoglycaemia was recorded from the patients' diary at T0 and T2. Non severe hypoglycaemia was defined as a status with typical symptoms (e.g. sweating, lose concentration, feeling shaky) disappearing quickly after carbohydrate intake or a status without typical symptoms and plasma glucose ≤ 3.9 mmol/l [14]. Severe hypoglycaemia was defined as necessity of glucagon injection or intravenous glucose injection [15].

People participated in the DTTP because of a diabetes-specific problem (insufficient metabolic control (high HbA_{1c}), frequent non severe or severe hypoglycaemic events, blood glucose fluctuations, checking of insulin-to-carbohydrate ratio and factor for correction, changing of insulin type). After one year (T2) an experienced diabetes educator (GK) in collaboration with a physician and the respective patient assessed whether the problem was solved.

Social status was gathered from all participants by a validated questionnaire at T0 [16]. Social status, ranging from a minimum of 3 to a maximum of 21 points, was composed of education, highest professional position and household net income.

2.3. Knowledge about adjustment of insulin dose

To check the patients ability to adjust the insulin dose correctly, five different calculation examples were used. Participants had to calculate the insulin dose from a given and their own insulin-to-carbohydrate ratio, resp. factor for correction and target value at T0, T1 and T2. For example: insulin-to-carbohydrate ratio is “2 units of insulin for every 10 grams of carbohydrates”, factor for correction is “1 unit lowers plasma glucose by 3.0 mmol/l” and the target value is 6.0 mmol/l. You want to eat 50 grams of carbohydrates and your current blood glucose is 12.0 mmol/l. How many units of insulin would you have to inject? (The correct answer is 12 units of insulin.)

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