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Impact of intervention on metabolic outcomes among dropouts with type 2 diabetes

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ABSTRACT

Purpose: The aim of this study was to evaluate the effect of an individual intervention given by health care professionals to dropouts with type 2 diabetes (T2D) on their metabolic profile.
Materials/methods: In 2010, we identified 356 T2D dropouts in Vantaa Health Centre, Finland. At the baseline visit the participants' status was assessed including laboratory tests. Diabetes counseling was given, and drug treatment was enhanced when needed. The follow-up visit was performed 13 to 30 months later including the same assessments as performed at the baseline visit. The dropouts who attended the follow-up visit formed the study group. One third (n = 115) of the dropouts participated in the follow-up visit.
Results: The study participants (mean age 61.4 years) were older than the non-participants (mean age 58.5 years) (p = 0.009). After the intervention the proportion of participants with hemoglobin A1c $\geq$ 9% (75 mmol/mol) decreased from 15.5% to 5.2% (p = 0.004). Improvements were also observed in general in hemoglobin A1c, from 6.6% (49 mmol/mol) to 6.3% (45 mmol/mol) (p = 0.001), in total cholesterol, from 4.9 mmol/l to 4.5 mmol/l (p = 0.011), in low-density lipoprotein cholesterol, from 2.9 mmol/l to 2.6 mmol/l (p = 0.015) and in diastolic blood pressure, from 90 mmHg to 84 mmHg (p = 0.001).
Conclusions: Dropouts with T2D were difficult to bring back to the public health care system, especially men under the age of 60 years. Dropouts who participated in the intervention showed improvements in several metabolic outcomes.

Key messages

– Dropouts with T2D are difficult to bring back to diabetes care.
– Men younger than 60 years seem to be at high-risk to drop out from public diabetes care.
– An individual intervention improved several metabolic outcomes.

1. Introduction

Globally, the burden of type 2 diabetes (T2D) is increasing [1]. The general treatment goal is to prevent acute complications, reduce the risk of long-term diabetic complications including micro- and macro-vascular complications as well as to ensure an optimal quality of life [2]. Treatment of T2D involves both lifestyle modifications and drug treatment.

A proportion of the patients with T2D does not attend diabetes clinics as prescribed by the health care personnel. The underlying reasons for dropout differ, e.g. long distance to the clinic, multi morbidity, treatment goals requiring lifestyle changes, patients' age and gender [3,4]. Potentially, these dropouts are exposed to an increased risk for diabetic complications further influencing their quality of life and increasing the costs of diabetes treatment for society.

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In the public primary health care center of the city of Vantaa, Finland, we investigated the phenomenon of dropout. In 2009, every tenth patient with T2D was a 'dropout' from the public primary diabetes care system [5]. Among these patients, the level of hemoglobin A1c (HbA$_{1c}$) was satisfactory whereas low-density lipoprotein (LDL) cholesterol and blood pressure (BP) were non-optimal [5]. Our aim was to attach these dropouts back to the diabetes care system and enhance their treatment when needed. The purpose of this study was to evaluate the effect of a 'real-life' intervention given by health care professionals to the dropouts with T2D on their metabolic profile.

2. Methods

2.1. Study population

A detailed description of the patients with T2D, who were dropouts from diabetes care within the public primary health care system, has been published recently [5]. Briefly, we identified dropouts with T2D aged 18–80 years from diabetes care in public primary health care by using computer aided search from an electric patient record system (Finstar) in the Eastern districts of the city of Vantaa, Finland. Patients fulfilled the criteria for dropout, if they during the years 2005–2009 had an ICD-10 code including an E11 code or if they used T2D specific medication and they had not contacted the public primary health care system during the year 2009. All together, we were able to identify 356 dropouts (10.3% of patients with T2D in Eastern Vantaa). Trained diabetes nurses contacted and interviewed the dropouts by telephone, and invited them to a baseline outpatient and laboratory visit within the public health care system. Of the contacted dropouts, 66.3% (of whom 60.6% were men and 39.4% were women) came to the baseline visit and 84.8% (of whom 58.9% were men and 41.1% women) had laboratory tests taken.

The follow-up visit took place 13 to 30 months after the baseline visit either as a visit to a trained diabetes nurse or to a general practitioner at the primary health care center. Those dropouts, who came to the follow-up visit, composed the study group in this present study (n = 115). Fig. 1 shows the study flowchart.

2.2. Measurements

At the baseline visit the following characteristics were recorded: age, gender, height, weight, BP, duration of T2D, signs of proteinuria and/or retinopathy, and diabetes medication as well as marital status, occupation and comorbidities based on ICD-10 diagnoses. Further, at baseline the following laboratory tests were performed HbA$_{1c}$, total cholesterol, LDL −cholesterol, high-density lipoprotein (HDL) −cholesterol and triglycerides. Of the dropouts, a detailed description of the baseline characteristics of the dropouts with T2D has been published previously [5]. At the baseline visit the intervention was given in the following way: trained diabetes nurses counseled the participants individually aiming at better self-management behavior and if needed, the general practitioners of the health care center enhanced diabetes drug treatment.

At the follow-up visit the participants' weight; blood pressure and diabetes medication were recorded. Further, the participants were asked to visit the laboratory for the same laboratory tests as performed at the baseline visit.

The ethics committee of the Hospital District of Helsinki and Uusimaa, and the health authority of the Vantaa city have approved the study.

Statement of Informed Consent: This study is an observational retrospective register based cohort study based on an electric patient record system; we assessed the effects of the work performed by the community primary health care nurses and general practitioners. The investigators 'per se' did not contact the dropouts. According to the ethics committee of the Hospital District of Helsinki and Uusimaa, and the health authority of the city of Vantaa the patients do not need to have the Statement of Informed Consent.

2.3. Statistical analysis

Data are reported as percentage (number) or mean (standard deviations [SD]) or median (interquartile range [IRQ]). Percentage differences were tested using cross-tabulation and Chi-Square test or McNemar test. Comparisons were carried out by Mann-Whitney _U_ test or by independent samples T-test between the study participants and the non-participants. Comparisons were carried out by Wilcoxon signed rank test or paired samples T-test was used when comparing the results from the baseline and the follow-up visit. Statistical analyses were carried out using IBM SPSS, version 22.0 (IBM, Armonk, NY, USA). A p-value of less than 0.05 was considered statistically significant.

3. Results

About one third (n = 115) of the dropouts participated in the follow-up visit. The characteristics of the study participants and non-participants are presented in Table 1. For the classification of the dropouts' glycemic control (HbA$_{1c}$ level), the following
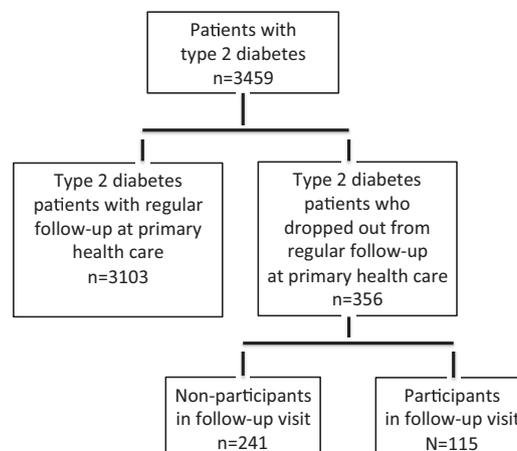

Fig. 1. Study flowchart.

Table 1
Baseline characteristics of the study participants and non-participants.

	Participants, N = 115			Non-participants, N = 241			P-value		
	All	Males	Females	All	Males	Females	All	Males	Females
Study subjects n, (%)	115 (100)	62 (53.9)	53 (46.1)	241 (100)	152 (63.1)	89 (36.9)			
Age, years	61.4 (9.4)	62.7 (8.2)	59.9 (10.5)	58.5 (10.0)	58.6 (9.2)	58.2 (11.2)	0.009	0.003	0.392
T2D duration*, years	6.0 (8.0)	7.0 (7.0)	4.5 (7.0)	5.0 (5.0)	5.0 (6.0)	6.0 (6.0)	0.276	0.027	0.374
BMI, kg/m^2	32.4 (6.2)	31.4 (5.8)	33.7 (6.6)	31.6 (6.6)	30.8 (5.9)	32.9 (7.5)	0.147	0.443	0.270
Hemoglobin A1c*, %	6.6 (1.7)	6.7 (1.5)	7.3 (2.1)	6.4 (1.9)	6.4 (1.8)	6.4 (1.8)	0.616	0.490	0.921
Total cholesterol*, mmol/l	4.7 (1.7)	4.5 (1.7)	5.0 (1.9)	4.8 (1.4)	4.7 (1.5)	5.0 (1.7)	0.856	0.435	0.832
LDL-cholesterol*, mmol/l	2.8 (1.3)	2.5 (1.3)	3.0 (1.5)	2.8 (1.4)	2.7 (1.3)	3.0 (1.4)	0.483	0.179	0.939
HDL-cholesterol*, mmol/l	1.2 (0.3)	1.3 (0.4)	1.2 (0.3)	1.2 (0.5)	1.2 (0.4)	1.4 (0.5)	0.339	0.058	0.336
Triglycerides*, mmol/l	1.8 (1.3)	1.5 (1.3)	1.8 (1.3)	1.6 (1.0)	1.6 (1.1)	1.6 (0.7)	0.416	0.673	0.095
Proteinuria n, (%)	25 (19.7)	19 (35.2)	6 (19.4)	33 (26.2)	18 (21.7)	15 (34.9)	0.607	0.082	0.144
Retinopathy n, (%)	25 (29.4)	19 (35.2)	6 (19.4)	33 (26.2)	18 (21.7)	15 (34.9)	0.607	0.082	0.144
Systolic BP, mmHg	147 (21.7)	144 (18.9)	151 (24.7)	145 (22.7)	146 (21.9)	144 (24.2)	0.571	0.632	0.218
Diastolic BP, mmHg	88 (10.8)	85 (9.9)	90 (11.5)	86 (12.4)	87 (12.3)	84 (12.4)	0.277	0.492	0.017

Results are presented as mean (SD) unless otherwise stated as *. Percentage differences were tested using cross-tabulation and Chi-Square test. Comparisons were carried out by Mann-Whitney *U* test (T2D duration, BMI, hemoglobin A1c and lipids) and by independent samples T-test (age, systolic and diastolic BP). P-values are between all participants vs non-participants, between males participants vs non-participants, and between females participants vs non-participants.
*Median (interquartile range).
T2D = type 2 diabetes; BMI = body mass index; LDL = low density lipoprotein; HDL = high density lipoprotein; BP = blood pressure; SD = standard deviation.

grouping was used HbA$_{1c}$ < 7% (53 mmol/mol), HbA$_{1c}$ 7–9% (53 mmol/mol to 75 mmol/mol) and HbA$_{1c}$ ≥ 9% (75 mmol/mol). No differences were observed between the participants and the non-participants in HbA$_{1c}$ levels. The non-participants were prescribed sulfonylureas/glinides more often than the participants (p = 0.040), but no significant differences were observed in relation to prescription of other diabetes drugs. There were no differences in marital status, occupation nor in comorbidities between the participants and the non-participants.

The effect of the intervention on BMI, HbA$_{1c}$, lipids and BP is presented in Table 2. At the baseline visit 15.5% of the participants had HbA$_{1c}$ ≥ 9% (75 mmol/mol) and the corresponding percentage at the follow-up visit was 5.2% (p = 0.004). During the follow-up period more participants were prescribed metformin (67.0% vs 83.5%, p < 0.001), basal insulin (8.7% vs 20.9%, p < 0.001) and DPP4 inhibitors (3.5% vs 30.4%, p < 0.001) compared with the situation at baseline. The prescription of sulfonylureas/glinides decreased significantly (24.3% vs 13.9%, p = 0.004). More information on the changes in diabetes drug treatment as a consequence of the intervention is presented in Supplementary material, Table 1.

4. Discussion

According to our study findings, it was possible to bring back only one third of the dropouts with T2D to the diabetes treatment system. Especially, dropouts under 60 years of age were difficult to

bring back. However, those who participated and who were successfully brought back to the system, showed improvements in HbA$_{1c}$ level, total and LDL-cholesterol, and diastolic BP. In addition, female participants showed improvements on triglycerides and systolic BP after the intervention.

Previous studies focusing upon the phenomenon of T2D dropouts have focused primarily on relapse prevention or characterization of the dropouts, less on the possibility to bring them back to the health care system. To the best of our knowledge, studies assessing feasibility and possibility to bring back dropouts with any chronic disease to the public health care system are rare. According to our study findings, dropouts with T2D were challenging to bring back to the health care system: even though the diabetes nurse invited them personally, only one third attended the follow-up visit 13–30 months after the baseline visit. The non-participants were younger than the participants supporting findings from previous communal based studies among dropouts [4–7]. We did not observe any differences in sex, duration of T2D or BMI between the participants and non-participants. These findings are in line with most previous studies on diabetes dropouts [3,5,6,8–10]. Further, we did not find any differences between the groups in HbA$_{1c}$, lipids, BP, signs of nephropathy or retinopathy, comorbidities, occupation or marital status. Previous study findings focusing upon these aforementioned factors have been inconsistent [10]. In relation to diabetes medication, we observed that the non-participants were more often prescribed

Table 2
Effect of intervention on BMI, hemoglobin A1c, lipids and BP among the study participants.

	Before, n = 115			After, n = 115			P-value		
	All	Males, n = 62	Females, n = 53	All	Males, n = 62	Females, n = 53	All	Males	Females
BMI*, kg/m^2	32.4 (5.4)	33.5 (6.5)	32.9 (4.7)	32.2 (6.4)	30.4 (6.7)	34.4 (5.5)	0.339	0.183	0.975
Hemoglobin A1c*, %	6.6 (1.7)	6.7 (1.5)	6.4 (2.1)	6.3 (1.4)	6.4 (1.3)	6.2 (1.5)	0.001	0.013	0.023
Total cholesterol*, mmol/l	4.9 (1.1)	4.8 (1.1)	4.9 (1.2)	4.5 (1.1)	4.5 (1.1)	4.5 (1.1)	0.011	0.169	0.018
LDL-cholesterol*, mmol/l	2.9 (0.9)	2.8 (0.9)	3.1 (0.9)	2.6 (0.9)	2.6 (0.8)	2.7 (0.9)	0.015	0.305	0.012
HDL-cholesterol*, mmol/l	1.3 (0.3)	1.2 (0.3)	1.3 (0.4)	1.2 (0.3)	1.2 (0.3)	1.3 (0.4)	0.301	0.849	0.171
Triglycerides*, mmol/l	2.0 (1.2)	2.2 (1.4)	1.6 (1.2)	1.7 (1.3)	2.0 (1.9)	1.6 (1.0)	0.355	0.476	0.021
Systolic BP, mmHg	149 (22.1)	144 (21.3)	155 (22.1)	143 (20.3)	141 (16.6)	146 (23.9)	0.069	0.510	0.042
Diastolic BP, mmHg	90 (11.4)	86 (10.3)	94 (11.6)	84 (10.8)	82 (10.5)	86 (11.0)	0.001	0.036	0.015

Results are presented as mean (SD) unless otherwise stated as *. Comparisons were carried out by Wilcoxon signed rank test (BMI, hemoglobin A1c and triglycerides) and by paired samples T-test (total cholesterol, LDL-cholesterol, HDL-cholesterol, systolic and diastolic BP). P-values are between all participants vs non-participants, between males participants vs non-participants, and between females participants vs non-participants.
*Median (interquartile range)
BP = blood pressure; BMI = body mass index; LDL = low density lipoprotein; HDL = high density lipoprotein; SD = standard dev

sulfonylureas/glinides than the participants. Some studies have shown a low dropout rate in patients with insulin treatment [3,6]. Overall, the existing literature of T2D dropout is inconsistent partly explained by differences in defining dropouts', sample sizes and study designs [10].

After the intervention, the level of HbA_{1c} improved significantly, although the baseline level of HbA_{1c} was already at a satisfactory level. Importantly, a proportion of patient with high baseline HbA_{1c} levels showed marked improvements. The risk for any diabetes related complication increases notably when HbA_{1c} level is over nine per cent [11]. One explanatory factor for the improvement in HbA_{1c} is enhancements in diabetes medication: more prescriptions of metformin, basal insulin and incretin-based drugs were observed. In addition, the participants received counseling by the diabetes nurse for better self-management behavior and diabetes treatment. To achieve optimal HbA_{1c} level, both active self-management and tailored drug treatment are needed [12,13]. The present intervention also improved significantly the participants' lipid metabolism. A beneficial effect of the intervention was also seen in diastolic blood pressure. The intervention showed no effect on degree of adiposity.

According to Finnish Current Care Guidelines, patients with T2D should be treated holistically and the treatment targets should be individually tailored [2]. The holistic treatment includes evaluation and management of lifestyle factors, glycaemia, dyslipidemia, blood pressure and consideration for antiplatelet therapy [2]. With an optimal treatment of T2D it is possible to decrease the risk of micro- and macrovascular complications and mortality [14]. This kind of multifactorial treatment is also cost-effective [15].

4.1. Study limitations

We acknowledge some limitations to our study. Due to the nature of the dropout phenomenon the dropout rate was high and the dropouts in the present study had no control group. Some of those that we classified as dropouts may have their T2D treatment in the private sector or in the occupational health care setting. Further, all our participants were of European ancestry, which may influence the generalizability of the results. Data on dropouts' lifestyle factors, including physical activity, dietary or sleeping habits, smoking and alcohol consumption, as well as other medication than diabetes medication were not available. These factors may influence the results and should be addressed in future research.

4.2. Implication for clinical practice

It is important to identify diabetics dropouts with poor metabolic condition. Among those successfully brought back to diabetes care, intervention seems to improve metabolic outcomes.

5. Conclusions

The dropouts were challenging to bring back to diabetes care, especially men below 60 years of age. The dropouts who participated in the intervention showed improvements in HbA_{1c}, BP and lipid levels.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.advms.2017.05.003.

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