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Blood sugar control among type 2 diabetic patients who travel abroad

A cross sectional study

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Abstract

The dose adjustment of anti-diabetic drugs during traveling abroad remains an important issue for the diabetic patients. However, there are few studies exploring the changes in blood sugar in patients with type 2 diabetes mellitus (T2DM) when traveling abroad. The study aimed to investigate the hypoglycemic episodes, sugar control, and associated factors during travel among patients with T2DM.

A questionnaire was administrated to T2DM patients visiting the family medicine clinic in a medical center from September 2016 to April 2017. The Chi-square test was used to examine the differences in risk factors of hypoglycemia between hypoglycemic group and non-hypoglycemic group. Multivariate logistic regression models were used to examine the risk factors for the hypoglycemia.

A total of 65 males and 74 females completed the questionnaire. The mean age was 59.3 ± 12.1 year olds, the mean BMI was 28.1 ± 5.9 kg/m^2, and the mean $HbA1_C$ was 7.4 ± 1.1%. There was 8.6% of diabetic patients reporting hypoglycemic episodes during travel. The hypoglycemic episodes were significantly related to the numbers of crossing time zones after adjusting for possible confounders. Only 21.6% of subjects told physicians their travel plan whereas two third of the physicians did not provide pre-travel consultation.

The hypoglycemic episodes sometimes occurred and were related to the numbers of crossing time zones in diabetic travelers. The proportion of pre-travel consultation was low in patients with T2DM. Besides, most of the physicians did not offer pre-travel education when patients mentioned their traveling plan. The willing and ability of physicians to offer the pre-travel diabetic education deserved further investigation.

Abbreviations: OADs = oral anti-diabetic agents, SMBG = self-monitoring of blood glucose, T2DM = type 2 diabetes mellitus.

Keywords: diabetic mellitus, travel

1. Introduction

The numbers of international travelers have been increasing rapidly in the last 50 years.[1] According to the tourism statistics, the total number of outbound trips of Taiwanese have reached 156 million in last decade,[2] while more than 1.32 billion people traveling around worldwide in 2017.[3]

The risks of travel-related illness vary according to the destination and person's habits and underlying diseases.[4] Travelers need to adapt jet lag and weather change as well as modification of the diet habit and life pace during abroad. These changes were stresses on health status for all travelers, and with more impact on the travelers with chronic illness.

Referring to chronic illness, during-travel labile blood sugar has been an important issue in diabetic patients. A meta-analysis in 2010 pointed out that the prevalence of diabetes in adults was estimated to be around 7.0% (6.1–7.9%).[5] And the number of patients of diabetes has increased from 108 million in 1980 to 422 million in 2014.[6] A study conducted in the travel clinic of the Public Health Service in Amsterdam has also proved that the number of diabetic travelers increases significantly from 2001 to 2011.[7] Thus, more and more patients with type 2 diabetes mellitus (T2DM) may encounter acute or chronic events associated with sugar control during their traveling. Besides, traveling involved time zone changes altered physical regulation as well as glycemic control.[8,9] How the anti-diabetic drugs were adjusted during traveling abroad has been widely discussed.[10–12] Previous studies pointed out that more than 95% of insulin-dependent diabetic patients searched for available pre-traveling consultation.[13] However, updated professional recommendations for pre-traveling diabetic patients are inadequate.[14]

There were limited studies to investigate the events of hypoglycemia in T2DM patients who travel abroad. This study aimed to explore the hypoglycemic episodes and sugar control during travel among T2DM patients. Also, the study examined

Editor: Daryle Wane.

C-WL and K-CH contributed equally to this work.

This work was partially supported by the Center for Disease Control, Taiwan (CL105037).

The authors have declared no conflicts of interest.

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Medicine (2019) 98:13(e14946)

Received: 13 November 2018 / Received in final form: 15 February 2019 / Accepted: 23 February 2019

http://dx.doi.org/10.1097/MD.0000000000014946

the factors involving in during-travel sugar control, focusing on pre-travel consultation of physician.

2. Method

2.1. Ethical statement

This was a retrospective observational study. The study protocol was approved by the National Center of Excellence for Clinical Trial and Research of the National Taiwan University Hospital (201611037RINA).

2.2. Setting

This study was conducted in the out-patient clinic at department of Family Medicine in medical centers of northern Taiwan during September 2016 to June 2017. Patients aged more than 20-year-old with the diagnosis of T2DM who had travel abroad was included. Patients who were unable or unwilling to complete the questionnaire were excluded.

2.3. Questionnaire

A structured, 3-part questionnaire was developed by the study investigators. The questionnaire was pretested for face validity and content validity by a panel of 5 physicians who were all experienced in the clinical practice of travel medicine and diabetes mellitus. The first section collected the demographic data including sex, age, cigarette smoking, alcohol consumption, and exercise. Weight, height, and blood pressure were measured using a standard electronic scale of stadiometer and sphygmomanometer, respectively. Waist circumference was measured by the same operator. Serum glucose and lipid level were extracted from latest chart record. The second section investigated the disease status of T2DM, including duration of T2DM, drug compliance, and self-monitoring of blood glucose (SMBG). The third section targeted on the

1. traveling information: including departure date, traveling duration, destination, time zone across, diet and activity during traveling,
2. pre-travel behavior: including consultation with the primary care physician about abroad diabetic care, booking of diabetic diet before flight boarding, and medication preparation,
3. during-travel behavior: including drug compliance, episodes of hypoglycemia and management, SMBG, diet and exercise amount compared with baseline, causes of missed drugs, acute illness occurred during traveling.

All participants filled in the self-administrated, cross-sectional questionnaire.

2.4. Statistical analysis

For continuous variables, values were presented as mean ± standard deviation (SD). For categorical variables, values were presented as numbers and percentage. Chi-square test was used to examine the differences of risk factors of hypoglycemia between hypoglycemic group and non-hypoglycemic group. Multivariate logistic regression models were used to examine the association between the hypoglycemia episodes and the escalation of time zone crossed. Data management and statistical analyses were performed using SPSS software (21th version, SPSS Inc., Chicago, IL). A 2-tailed *P* value less than .05 was considered statistically significant.

Table 1

Baseline characteristics data among female and male diabetic patients.

	Female (N = 74)	Male (N = 65)	All N = 139
Age (y)	60.3 ± 10.9	58.1 ± 13.2	59.3 ± 12.1
WC (cm)	88.8 ± 16.0	93.3 ± 12.9	91.0 ± 14.7
BMI (kg/m^2)	28.2 ± 6.5	28.0 ± 5.3	28.1 ± 5.9
Height (cm)	155.9 ± 6.3	168.9 ± 6.7	162.0 ± 9.2
Weight (kg)	69.0 ± 18.1	80.5 ± 18.3	74.4 ± 19.0
Systolic BP (mmHg)	134.5 ± 15.5	139.3 ± 16.0	136.7 ± 15.8
Diastolic BP (mmHg)	78.1 ± 9.7	84.5 ± 11.3	81.1 ± 10.9
Fasting glucose (mg/dl)	144.4 ± 42.5	137.2 ± 38.0	140.8 ± 40.3
Hemoglobin A1c (%)	7.4 ± 1.1	7.3 ± 1.2	7.4 ± 1.1
T-CHO (mg/dl)	184.1 ± 39.5	167.3 ± 31.7	175.7 ± 36.5
Triglyceride (mg/dl)	157.8 ± 62.2	178.0 ± 131.6	168.0 ± 103.2
LDL-C (mg/dl)	109.4 ± 36.0	99.8 ± 26.6	104.4 ± 31.6
HDL-C (mg/dl)	46.7 ± 8.1	40.3 ± 6.3	43.4 ± 7.8
Smoke habit (%)	2 (2.7%)	17 (26.2%)	19 (6.6%)
Drink habit (%)	6 (8.1%)	18 (27.7%)	24 (8.3%)
Exercise habit (%)	50 (67.6%)	38 (58.5%)	88 (30.4%)
Days of abroad	11.3 ± 23.0	21.9 ± 34.5	16.3 ± 29.3
Number of time zone crossed	2.1 ± 3.6	2.2 ± 4.4	2.2 ± 4.0

For continuous variables, values are presented as mean ± standard deviation (SD). For categorical variables, values are presented as a number (per cent).
BMI = body mass index, BP = blood pressure, HDL-C = high density lipid cholesterol, LDL-C = low density lipid cholesterol, T-CHO = total cholesterol, WC = waist circumference.

3. Results

Total 139 T2DM travelers completed self-administrated questionnaire, including 65 males and 74 females. The mean age was 59.3 ± 12.1 year-old, the mean BMI was 28.1 ± 5.9 kg/m^2, the mean fasting glucose and HbA1C were 140.8 ± 40.3 mg/dl and 7.4 ± 1.1%, respectively. The average abroad days were 16.3 ± 29.3 days, and the median time zone crossed was 2.2 ± 4.0. Detailed descriptive statistics are shown in Table 1.

Only 21.6% of T2DM travelers told their primary care doctors about the traveling planning and asked for pre-travel consultation. Among these consultations, two third of the doctors did not educate the patient about the medication adjustment during abroad, and only 6.7% had offered certification of T2DM for the travelers. Moreover, only 3.6% of the 139 cases had booked diabetic meal before boarding on the flight.

There was 36.7% of the T2DM travelers increased food intake while 45.3% increased exercise during travel. Besides, there was 10.1% of the T2DM travelers took medications irregularly during the journey and 12.9% of the T2DM travelers checked SMBG. The prior experiences about pre-travel consultation and during-travel diabetic control are shown in Table 2.

There was 8.6% of the T2DM travelers experienced hypoglycemia symptoms during travel. The T2DM travelers tended to have hypoglycemia episode when crossing longer time zones though not statistically significant ($P = .050$). And most of the T2DM travelers experiencing hypoglycemia only took oral anti-diabetic agents (OADs) (91.7%). The patients with OADs had similar risk for hypoglycemia compared with insulin-dependent travelers. The analyses of hypoglycemia associated with traveling are shown in Table 3. During the pre-travel and during-travel health behaviors, time zone ≥6 hours (P value = .028) was significantly related with hypoglycemia episode. After adjusting with age, gender, and healthy behaviors, we found that there was a significant elevated risk of hypoglycemic episode with escalation of time zone crossed (Table 4).

Table 2

Prior experiences about pre-travel consultation and during-travel diabetic control.

	Female (N = 74)		Male (N = 65)		All N = 139	
	Yes	No	Yes	No	Yes	No
Consultation before traveling	14 (18.9%)	60 (81.1%)	16 (24.6%)	49 (75.4%)	30 (21.6%)	109 (78.4.7%)
Doctors had offered certification for diabetes	1 (7.1%)	–	1 (6.3%)	–	2 (6.7%)	–
Doctors had educated about the medication adjustment.	4 (28.6%)	–	5 (31.3%)	–	9 (30%)	–
Book diabetic meal before boarding on the flight	3 (4.1%)	71 (95.9%)	2 (3.1%)	63 (96.9%)	5 (3.6%)	134 (96.4%)
Food intake increased during travel	28 (37.8%)	46 (62.2%)	23 (35.4%)	42 (64.6%)	51 (36.7%)	88 (63.4%)
Exercise increased during travel	43 (58.1%)	31 (41.9%)	20 (30.8%)	45 (69.2%)	63 (45.3%)	76 (54.7%)
Taking medication irregularly during travel (N = 138)	7 (9.5%)	66 (89.2%)	7 (10.8%)	58 (89.2%)	14 (10.1%)	124 (89.2%)
Has experienced hypoglycemia during travel	5 (6.8%)	69 (93.2%)	7 (10.8%)	58 (89.2%)	12 (8.6%)	127 (91.4%)
Self-monitor serum glucose level during travel	7 (9.5%)	67 (90.5%)	11 (16.9%)	54 (83.1%)	18 (12.9%)	121 (87.1%)

Values are presented as a number (percent).

4. Discussion

The diabetic participants of this study were mostly in their middle age, and most of them would like to travel distant area with a longer period, especially in male group. However, only one-fifth of diabetic patients sought pre-travel consultation before going abroad. Moreover, only 3.5% of diabetic travelers booked diabetic meals for oneself. The results implied that most diabetic patients did not aware of the impacts of traveling on the chronic illness. Nassar et al, had also suggested that diabetic patients should consult their physician 4 to 6 weeks before traveling.[15] To improve the knowledge of the diabetic patients, the traveling preparation of diabetic care should be taken as 1 part of routine diabetic education.

Another important finding was that near two-third of the diabetic physicians did not offer pre-travel instruction when patients mentioned about their traveling plan. One study conducted by Burnett et al. with self-administered questionnaire pointed out that the insulin-dependent diabetic patients expected the pre-traveling consultation could be more available.[13] However, the rate of physician response toward diabetic traveling was relatively low. One of the probable explaination was that there were averaged 35.2 patients in a 3-hour clinic in this single medical center,[16] which means each patient only received 5 minutes or even less outpatient care on each appointment. Furthermore, there was no structured and routine seminars or conferences for general physician to improve their knowledge of pre-travel care.[17] As a consequence, general physicians were reluctant an unable to offer the pre-travel diabetic education. To figure out the exact cause of low consultation rate, the capacity and the capability for pre-travel diabetic care of the physicians may need further investigation in the future.

Hypoglycemia is the most important concern of diabetic patient while traveling abroad. Both a large cohort study in 2009 and the substudy of the ACCORD trial found that the history of severe hypoglycemia was associated with a higher risk of cognitive impairment or dementia among diabetic patients.[18,19] Besides, hypoglycemia may also cause the immediate harm such as falls, traffic accidents, or other related injuries,[20] which may increase the risk during travel.

Hypoglycemia during traveling was around 10% to 14% in previous studies,[10,13] and was 8.6% in our study. Differed from previous studies mostly discussed hypoglycemia among insulin-dependent travelers, our study reported that the patients with OADs had similar risk for hypoglycemia compared with insulin-dependent travelers. Education for abroad hypoglycemia prevention is an important issue for both groups of diabetic patients.

There had been the consensus of time zone changes associated with glycemic labile.[9] In our study, we went further disclosing that the hypoglycemia risks were increased after more than 6 hours of time zone. The longer time zone crossed, the higher risk of hypoglycemia occurred, even in patients only with OADs. These results help physician rapidly screen the diabetic patients who had higher risk for hypoglycemia in clinical settings, and offer more intense instruction for diabetic care during long haul traveling.

Table 3

Hypoglycemia associated with traveling.

	Had hypoglycemia (n = 12)	No hypoglycemia (n = 127)	*P*
Consultation before traveling	5 (41.7%)	25 (19.7%)	.077
Doctors had offered certification for diabetes	0	2 (1.6%)	.661
Doctors had educated about the medication adjustment	2 (16.7%)	8 (6.3%)	.184
Number of time zone crossed			
Case number of crossing < 6 h time zone	8 (66.7%)	111 (87.4%)	
Case number of crossing ≥ 6 h time zone	4 (33.3%)	16 (12.6%)	.039
During-travel			
Irregular diet	2 (16.7%)	20 (15.7%)	.934
Decreased exercise	3 (25.0%)	24 (18.9%)	.610
Irregular medication	7 (58.3%)	39 (30.7%)	.052
Case number of using insulin	1 (8.3%)	16 (12.6%)	.666
Case number of using only OADs	11 (91.7%)	111 (87.4%)	.666

Values are presented as a number (per cent). Chi-square test was performed to test the differences of percentage between the hypoglycemic group and non-hypoglycemic group.

* Items with *P* value < .05.

Table 4

Odds ratio for hypoglycemia with escalation of crossing time zones, using multivariate logistic regression analyses.

	No time zones crossing (N = 59)	Time zones crossing (N = 60)
Model 1	1.00	1.11 (0.99–1.24)
Model 2	1.00	1.13 (1.00–1.28)*
Model 3	1.00	1.15 (1.01–1.31)*

Model 1: no adjustment.

Model 2: adjusted for age and gender.

Model 3: adjusted for age, gender, over exercise, and irregular medication.

* *P* < .05.

There were several limitations to our study. First of all, this study was conducted in a single medical center in northern Taiwan, and the patients were screened in several certain physicians' clinics. This might cause low diversity of both the patients and the educational setting in clinics. Furthermore, there was small sample size (N = 139) and 12 subjects experienced hypoglycemic episode during travel. Due to small sample size and inadequate statistical power, the exploration of confounding factors was limited and the extension of results to population was restricted. In addition, recall bias for the retrospective questionnaire should also be taken into consideration. Despite the above limitations, the pilot study raised important issues for diabetes travelers. Surprisingly, the rate of pre-travel consultation was low, the ability and willing of physicians for giving pre-travel consultation was poor whereas the self-reported episodes of hypoglycemia in T2DM was equal in OADs group and insulin group. Due to significantly increased risk of hypoglycemia after crossing time zone more than 6 hours, strengthen the pre-travel consultation for long haul travels in T2DM was needed.

5. Conclusion

There were risks for hypoglycemic events during abroad traveling even only using OADs, but the proportion of pre-travel consultation was low in patients with T2DM. Most of the physicians did not offer pre-travel education when patients mentioned about their traveling plan. The willing and ability of physicians to offer the pre-travel diabetic education deserved further investigation.

Author contributions

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