Impact of 2011 Flood Disaster in Thailand on Glycemic Control in Patients with Diabetes Mellitus

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Background: *Diabetes mellitus (DM) is a chronic disease for which continuation of medication, either by oral or injection form, is needed. Severe flooding occurred during September 2011 to December 2011 in Thailand. Thirteen million people were affected, which might lead to poor control of plasma glucose in diabetic patients.*
Objective: *To study the effect of the flood on glycemic control in patients with diabetes mellitus.*
Material and Method: *Patients with DM, who had blood chemistry data before, during and up to 6 months after the 2011-flood disaster in Thailand, were included. Medical records and blood chemistry data were reviewed. Telephone interview method was used to assess the effect of the flood on their lifestyles, food and medications.*
Results: *300 patients were included. Only 57 patients (19%) had a shortage of medications during the flood. In the subgroup of patients taking all medications (n = 243), mean fasting plasma glucose significantly increased during the flood (153 vs. 142 mg/dL, p-value <0.001). As compared to baseline data, lower mean body weight during the flood (67.7 vs. 68.5 kg, p-value = 0.022) and higher HDL level were also found (50.8 vs. 44.7 mg/dL, p-value <0.001) during flood. In the subgroup of patients with a shortage of medications (n = 57), worsening of plasma glucose control (184 vs. 156 mg/dL, p-value = 0.014) and HbA1c (8.66 vs. 8.09%, p-value = 0.043) was seen during the flood. No significant changes in other lipid profiles were seen in this subgroup. Resumed plasma glucose control was found in 3-6 months after the flood.*
Conclusion: *The 2011-flood in Thailand caused increased plasma glucose levels among DM patients during the flood, but better control of other metabolic profiles were seen in those diabetic patients who were able to continue taking medications.*

Keywords: *flood, plasma glucose, diabetes mellitus, lipid, natural disaster*

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Diabetes mellitus (DM) is one of the common chronic diseases for which lifestyle modification and medication are needed to control the level of plasma glucose. Being a major chronic disease, diabetes seems to be one of the leading causes of mortality and is a public health burden[1]. The increasing incidence of diabetes worldwide has been strongly linked to westernized dietary patterns, physical inactivity, and increasing rates of obesity and metabolic syndrome[2]. A survey in 19,997 Thai participants, aged 45 to 80 years, during 2004 to 2006 reported diabetic prevalence of 16%[3].

Floods are the most frequent natural disaster and the leading cause of death from natural disasters in the United States, accounting for 40% of all natural disaster damage and injury[4]. In Thailand, floods are also the most common natural disaster. Future climate scenarios indicate a projected increase in the frequency of extreme precipitation events and consequently increased risk of flood[5].

Severe flooding occurred during September, 2011 to December, 2011 in Thailand. Sixty-five of 77 provinces were declared flood disaster zones. Thirteen million people were affected[6]. Some of the impacts of this flood disaster were migration, shortage of food and the transportation problems. Lifestyles were modified, which might have a positive effect on glycemic control. Studies have shown that lifestyle modification through exercise, diet, and change way of living is important to control glucose levels. However, some patients faced shortage of medications and increased stress, which might result in poor glycemic control. A study in a UK city showed that glycemic control deteriorated in diabetic patients following the floods[7].

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In developing countries where resources, public education and disasters' preparation are different from in the developed countries, the effect of natural disasters on health problems might be different. The purpose of the study was to evaluate the effect of the 2011 flood disaster on glycemic control in patients with diabetes mellitus.

Material and Method

Patients with DM who were treated at Thammasat University Hospital's outpatient clinic during the 2011 flood were studied. Only patients who had the results of plasma glucose tests 6 months before (March, 2011 to August, 2011), during the flood (September, 2011 to December, 2011) and within 6 months after the flood (January, 2011 to June, 2011) were included. At each 3-month visit, patients would be examined by doctors. Body weight and blood chemistries, including fasting plasma glucose, hemoglobin A1C (HbA1c), and lipid profiles, were measured. Each patient would receive a telephone interview from a trained internal medicine resident asking about the effects of the flood on lifestyle and history of taking medication. Data about baseline characteristics of patients, diabetic medication, body weight and blood chemistries were studied and compared between before-during the flood and before-after the flood using paired t-test.

Results

There were 300 patients included. Baseline characteristics of the patients are presented in Table 1. Mean age of patients was 64 years old. Most patients (90%) were independent. Almost half (46%) of the patients had insulin treatment at baseline. During the flood (September, 2011 to December, 2011), food shortage was found in 16% of patients and 19% of the patients had shortage of some or all diabetic medication. In the subgroup of patients who continued all diabetic medication, higher plasma glucose was found during the flood (153 vs. 142 mg/dL, *p*-value <0.001) and 3 months (149 vs. 142 mg/dL, *p*-value = 0.022)) after the flood as compared to baseline data (Table 2). However, overall better plasma glucose control, measured by HbA1c was observed during the flood (7.73 vs. 7.9%, *p*-value = 0.055), and up to 6 months after the flood (7.68 vs. 7.9%, *p*-value = 0.036). As compared to baseline levels, higher HDL was also found during the flood (50.8 vs. 44.7 mg/dL, *p*-value <0.001) and up to 6 months after the flood (52 vs. 44.7 mg/dL, *p*-value = 0.002). Body weight was lower during the flood as compared to baseline (67.7 vs. 68.5 kg, *p*-value = 0.022). The trend of these changes was similar in those who had oral medication or insulin treatments.

In contrast, in the subgroup of patients who had a shortage of some or all diabetic medication during the flood, worsening of plasma glucose control (184 vs. 156, *p*-value = 0.014) and HbA1c (8.66 vs. 8.09, *p*-value = 0.043) was seen during the flood. However plasma glucose levels returned to baseline at 3 months after the flood or when they took all medication again (Table 2). No significant changes in other lipid profiles were seen in this subgroup.

Discussion

During September, 2011 to December, 2011; there was severe, widespread flooding in Thailand and 65 of 77 provinces were declared flood zone disaster areas. As a result, thirteen million people were affected. Because of the rather long duration of flooding, many people needed to abandon their residences and vehicles and migrated to unaffected areas. The cost of commodities including food, facilities and accommodations were higher than those in normal situations. Some areas had shortages of food and drinking water. Lifestyles of patients in the flooding area were changed drastically, or in some cases, totally. The study showed that patients with DM had higher plasma glucose level as compared to baseline during the flood. However, in the subgroup of those without any shortage of medication, better metabolic profiles were seen, i.e. slightly lower HbA1c (0.17-0.22%), lower body weight (0.8 kg), higher HDL (6.1-7.3 mg/dL),

Table 1. Baseline characteristics of diabetic patients in this study

Baseline characteristics	n=300
Mean age (years, range)	64 (20-90)
Male sex, n (%)	111 (37%)
Status, n (%)	
- independent	270 (90%)
- partial dependent	24 (8%)
- dependent	6 (2%)
Hypertension, n (%)	213 (71%)
Hyperlipidemia, n (%)	213 (71%)
Coronary artery disease, n (%)	15 (5%)
Old cerebrovascular disease, n (%)	9 (3%)
Diabetic control, n (%)	
- diet control	12 (4%)
- oral diabetic medication	150 (50%)
- insulin +/- oral diabetic medication	138 (46%)

Table 2. Plasma glucose, body weight and lipid profiles of patients with DM

	Patients with continuing diabetic medications (n = 243)							Patients with diabetic-medication shortage during flood (n = 57)						
	Before flood	During flood	Before vs during flood *p*-value Risk difference (95%CI)	3 months after flood	Before vs 3 months after flood *p*-value Risk difference (95%CI)	6 months after flood	Before vs 6 months after flood *p*-value Risk difference (95%CI)	Before flood	During flood	Before vs during flood *p*-value Risk difference (95%CI)	3 months after flood	Before vs 3 months after flood *p*-value	6 months after flood	Before vs 6 months after flood *p*-value
Mean plasma glucose (mg/dL)	142	153	*p*<0.001 (4.6 to 15.9)	149	*p* = 0.022 (1.2to14.9)	144	*p* = 0.22	156	184	*p* = 0.014 (5.8 to 50.2)	157	*p* = 0.96	146	*p* = 0.32
Mean HbA1c (%)	7.90	7.73	*p* = 0.055	7.68	*p* = 0.036 (-0.4 to-0.01)	7.52	*p* = 0.002 (-0.5 to -0.1)	8.09	8.66	*p* = 0.043 (0.01 to 1)	8.45	*p* = 0.65	8.05	*p* = 0.87
Body weight (kg)	68.5	67.7	*p* = 0.022 (-1.5 to-0.1)	67.8	*p* = 0.56	68.5	*p* = 0.32	69.3	69	*p* = 0.40	68	*p* = 0.24	69	*p* = 0.42
Cholesterol(mg/dL)	166	167	*p* = 0.81	167	*p* = 0.86	165	*p* = 0.31	167	198	*p* = 0.13	170	*p* = 0.87	171	*p* = 0.83
Triglyceride (mg/dL)	143	116	*p* = 0.002 (-43 to -10)	127	*p* = 0.06	124	*p* = 0.55	179	157	*p* = 0.60	179	*p* = 0.13	182	*p* = 0.89
high-density lipoprotein (mg/dL)	44.7	50.8	*p*<0.001 (3.9 to 8.3)	52	*p* = 0.002 (1.9 to 8.1)	52	*p* = 0.027 (0.5 to 7.4)	42	50	*p* = 0.15	46	*p* = 0.96	48	*p* = 0.09
low-density lipoprotein (mg/dL)	96	92	*p* = 0.17	93	*p* = 0.447	86	*p* = 0.037 (-0.4 to-2.1)	94	100	*p* = 0.64	89	*p* = 0.91	84	*p* = 0.41

during the flood and up to 6 months after the flood. This may partly be explained by the effect of lifestyle modification. Glycated hemoglobin A1c is formed by irreversible nonenzymatic glycation. Its concentration reflects the average value of blood glucose over the last two or three months[8]. Lifestyle interventions have been shown to improve diabetic control, with a reduction in HbA1c of 0.44[9].

Since DM is one of the most common chronic diseases, most patients keep medications in hands to last for a few months. Thus, a shortage of medication occurred in only 19% of patients during the flood and almost all patients were able to continue all medications within 3 months after the flood. In patients with shortage of some or all diabetic medications during the flood, higher level of plasma glucose and HbA1c was found.

Ng et al studied the effect of extensive flooding in Hull on the glycemic control of patients with diabetes[7]. They found that glycemic control deteriorated in patients following the flood (HbA1c 7.6% before flood vs. 7.9% after flood, $p = 0.002$). The difference was mainly in insulin-treated patients and glycemic control was worst at 6 to 9 months following the event. However, the effect of the flood impacted people in Hull was longer than in our study, as houses were uninhabitable for many months and after a year there were still a significant number of people living in temporary accommodation. Another study showed an overall 0.1% rise in HbA1c taken 6-16 months after Hurricane Katrina, compared with readings on the same patients taken 6 months before[10]. Natural disasters can physically or psychologically affect diabetic patients, and the severity depends on the severity, type and length of disaster. Inui et al studied the effect of the Kobe earthquake on stress and glycemic control in patients with DM. They found an association between increased HbA1c and severity of earthquake, which might suggest the effect of chronic, life-threatening stress on the worsening of metabolic control in diabetic patients[11].

Our study showed slightly better control of metabolic profiles during the flood in diabetic patients who took medications. This might be, in part, explained by lifestyle modifications. However, in patients with a shortage of medications, worsening plasma glucose control was seen. This emphasized the necessity of continuation of diabetic medications. Despite the rather long duration and widespread impact of the 2011 flood in Thailand, relatively rapid recovery (within a few months after the flood) was seen, which explained the resumed plasma glucose control in 3 months after the flood even in those who had a shortage of medications.

There were a few limitations of the study. This study was a retrospective study. Most patients were independent and able to come to the hospital to get their refill of medications. Thus the results may not apply to dependent patients or patients in some more severe, unreachable flooded areas. Most patients who came to the hospital usually took good care of themselves, which may not represent all diabetic patients. However, this was the first study in Thailand looking for the effect of flooding on plasma glucose control in diabetic patients. Because of the 'El Nino' effect on global atmosphere, extreme weather events are predicted to occur more frequently. Preliminary data regarding the effect of natural disasters on health is necessary. Improvement in warnings, public education and preparation is important to handle extreme weather events[12]. More research in climate-health connection is still needed.

Conclusion

The effect of the 2011 flood in Thailand caused slightly increased plasma glucose levels in DM patients during the flood, but better control of other metabolic profiles were seen in patients taking medications.

What is already know on this topic?

A study in a UK city showed that glycemic control deteriorated in diabetic patients following the floods, however, there was very few information in developing countries.

What this study adds?

The 2011-flood in Thailand caused increased plasma glucose levels among DM patients during the flood, however slightly better control of metabolic profiles during the flood in diabetic patients who took medications was seen. This might be, in part explained by lifestyle modifications.

Acknowledgements

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Potential conflicts of interest

None.

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ผลกระทบของอุทกภัยครั้งรุนแรง พ.ศ. 2554 ในประเทศไทยต่อการควบคุมระดับน้ำตาลในผู้ป่วยเบาหวาน

ณัฏฐ์ชญาธิปก์ กิตติจำเริญ, พรภัทร ธรรมสโรช

ภูมิหลัง: *โรคเบาหวานเป็นโรคเรื้อรังที่จำเป็นต้องได้รับการรักษาด้วยการรับประทานยาหรือฉีดยาเบาหวาน เพื่อควบคุมระดับน้ำตาลในช่วงปี พ.ศ. 2554 เกิดอุทกภัยรุนแรงที่ครอบคลุมหลายจังหวัดทั่วประเทศไทยและส่งผลกระทบต่อการดำเนินชีวิตของประชาชนถึง 13 ล้านคน ซึ่งอาจส่งผลทำให้การควบคุมระดับน้ำตาลในผู้ป่วยเบาหวานแย่ลง*

จุดประสงค์: *เพื่อศึกษาผลกระทบจากอุทกภัยต่อการควบคุมระดับน้ำตาลในผู้ป่วยเบาหวาน*

วัสดุและวิธีการ: *ศึกษาในผู้ป่วยเบาหวานที่มีผลการตรวจเลือดก่อนระหว่างและหลังอุทกภัยครั้งรุนแรง (พ.ศ. 2554) ข้อมูลจากเวชระเบียนและผลการตรวจเลือดทางห้องปฏิบัติการจะถูกนำมาศึกษาผลของอุทกภัยต่อการดำรงชีวิตการเข้าถึงอาหารและยาจะได้รับการสอบถามโดยโทรศัพท์*

ผลการศึกษา: *ผู้ป่วยเบาหวานจำนวน 300 ราย เข้าร่วมการศึกษา ผู้ป่วยจำนวน 57 ราย (ร้อยละ 19) ขาดยาช่วงอุทกภัยในกลุ่มผู้ป่วยที่มี และรับประทานยาเบาหวาน (243 ราย) ระดับน้ำตาลขณะงดน้ำและอาหารสูงขึ้น อย่างมีนัยสำคัญทางสถิติช่วงอุทกภัย (142 เทียบกับ 153 มก./ดล., ค่า p-value น้อยกว่า 0.001) เมื่อเทียบกับข้อมูลก่อนอุทกภัย น้ำหนักตัวลดลง (68.5 เทียบกับ 67.7 กก., ค่า p-value = 0.022) และระดับไขมันเอชดีแอลสูงขึ้นอย่างชัดเจนช่วงอุทกภัย (44.7 เทียบกับ 50.8 มก./ดล., ค่า p-value <0.001) ในกลุ่มผู้ป่วยที่ขาดยาเบาหวาน (57 ราย) ระดับน้ำตาลสูงขึ้นชัดเจน (156 เทียบกับ 184 มก./ดล., ค่า p-value = 0.014) และไม่พบการเปลี่ยนแปลงระดับไขมันในกลุ่มนี้ การควบคุมระดับน้ำตาลกลับมาคงเดิมหลังผ่านช่วงอุทกภัยไปประมาณ 3 ถึง 6 เดือน*

สรุป: *อุทกภัยครั้งรุนแรงช่วงปี พ.ศ. 2554 ส่งผลให้ระดับน้ำตาลในผู้ป่วยเบาหวานสูงขึ้นแต่ระดับไขมันเอชดีแอลสูงขึ้นและน้ำหนักตัวลดลงในกลุ่มที่ไม่ขาดยาเบาหวาน*