ORIGINAL ARTICLE

Impact of an Inpatient Diabetes Consulting Service on Post Discharge Glycemic Control

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Received: June 28, 2019 Accepted: September 3, 2019 Published: October 2, 2019

Am J Hosp Med 2019 July;3(3):2019.009 https://doi.org/10.24150/ajhm/2019.009

Background: There is increasing prevalence worldwide of diabetes mellitus with associated increased healthcare costs. Professional societies have recommended dedicated inpatient glucose management systems in order to improve morbidity, mortality, and reduce readmission rates. Currently there is limited data available on the efficacy of a dedicated inpatient diabetes mellitus consulting team on post discharge glycemic control and frequency of hypoglycemia.
Methods: A retrospective chart review was conducted for all patients with diabetes mellitus admitted to the St. Mary's Hospital, Rochester MN between January – April 2014. Participants were divided based on whether they received a diabetes consult (DC) or not (NC). A follow-up survey was mailed at least 12 months after admission to determine frequency of post discharge hypoglycemia.
Results: 338 patients with diabetes mellitus were included in the final analysis. 236 (69.8%) were in the DC group and 102 (30.2%) in the NC group. Patients in the DC group were younger (61 ± 15 vs 68 ± 14; $p<0.01$), had a higher frequency of type 1 diabetes mellitus (13% vs 2%; $p<0.01$), and were more likely to have had hypoglycemia before admission (40% vs 9%; $p<0.01$). While there was significant improvement in glycemic control at 3 months post discharge in the DC group as noted by a decrease in HbA1c (-0.5% vs 0.06%; $p=0.04$), this was not sustained at 12 months (-0.1% vs -0.02%, $p=0.4$). Measurement of HbA1c at least twice after discharge was significantly higher in the DC group compared to the NC group (185 vs 80; $p<0.01$). Survey response rate was 28% after discharge. DC responders were more confident in knowing how to treat hypoglycemia (82% vs 55%; $p=0.02$) and successfully treating hypoglycemia without requiring help (89% vs 65%; $p=0.04$). There was no difference in frequency of self-reported hypoglycemia.
Conclusion: Inpatient diabetes consultation improves glycemic control at 3 months and confidence in treating hypoglycemia. Glycemic control, however, was not sustained at 6 and 12 months. A more structured intervention is likely required to sustain effects.

Keywords: inpatient, glucose, diabetes, post discharge, glycemic control

INTRODUCTION

Diabetes mellitus has been estimated to affect 30 million Americans in 2015 with an increasing prevalence every year [1]. In addition, patients with diabetes have up to a 3-fold increased risk of hospitalization [2]. The health care cost for a person with diabetes has been calculated to be 2.3 times higher than that of a person without diabetes [3]. The need for better systems of care has been increasingly recognized[4].

Inpatient diabetes consultation results in improved glycemic control [5], shorter hospital stay [6] and decreased hospital readmission [7]. Despite this, Wei et al [8] have previously shown that glycemic control does not improve post hospitalization and suggested it was a missed opportunity to implement better strategies for long term glycemic control. The Diabetes Consulting Service (DCS) in the inpatient setting at the Mayo Clinic frequently assists in the management of diabetic patients. The consultation addresses preadmission glycemic control, frequency of hypoglycemia at home, inpatient glycemic control, and discharge planning. Discharge planning involves incorporating glycemic control requirements during the hospital stay, prescribing discharge diabetes medications, and scheduling follow-up visits focused on post-discharge glycemic control. We hypothesized that the DCS would lead to improvement in glycemic control as measured by a reduction in HbA1c and a lower frequency of hypoglycemic events post discharge within a one-year period. Our primary aim was to determine if HbA1c was lower in patients receiving a DCS evaluation on post discharge. The secondary aim was to determine if there was a lower rate of self-reported hypoglycemia after discharge in patients receiving a DCS evaluation.

METHODS

After approval from the Mayo Clinic Institutional Review Board, a retrospective electronic search utilizing Mayo Clinic Life Sciences System Advanced Cohort Explorer (a search engine) of all inpatient admissions with a listed diagnosis of "diabetes mellitus" (either on the medical record or by International Confederation of Disease (ICD)-9 coding) from January 1, 2014 to April 30, 2014 was conducted. Participants had previously provided research authorization. Demographic, clinical, and laboratory data were extracted from the electronic medical record. Subjects were divided into two groups based on whether they received a diabetes consultation during the admission (DC) or did not receive diabetes consultation during admission and within one year after discharge (NC). On receiving a DCS referral, patients were evaluated by a practitioner from the DCS team (endocrinologist, nurse practitioner or physician assistant). A diabetes educator also was consulted and provided tailored and individualized education based on the discharge treatment regimen decided upon. Topics reviewed also included frequency of self-monitoring blood glucose, goal blood glucose concentrations, insulin dose titration (if applicable), and hypoglycemia management and prevention.

Glomerular filtration rate was calculated by the modification of diet in renal disease equation (MDRD) [9]. A self-administered hypoglycemia survey (previously described [10]) was mailed to all included subjects to determine frequency and severity of hypoglycemia after discharge. This survey also assessed fear of hypoglycemia [11], confidence in diabetes self-care[12], health related quality of life [13], and general anxiety disorder [14].

Subjects were excluded if age <18 years, death within one year of admission,

admission duration <48 hours, no follow-up HbA1c at least 3 or more months after discharge, steroid-induced hyperglycemia that resolved once discharged, received an islet transplant within one year of discharge or received a diabetes consult on a subsequent admission within one year of discharge.

Statistical Analysis

Categorical variables were reported as percentages and analyzed with Pearsons' Chi squared or Fisher's exact test when applicable. Continuous variables were expressed as mean with standard deviation (SD) when normally distributed and subjected to the two-sample t-test. Continuous variables with a non-Gaussian distribution were reported as median with interquartile range (25^{th} – 75^{th} IQR) and analyzed with non-parametric testing (Wilcoxon rank sum test). Differences with a significance level p <0.05 were considered to be statistically significant. Multivariate analysis with baseline characteristics, medication changes, and readmission rates were used to determine factors influencing access to medical care on follow-up. Statistical analysis was performed using JMP statistical package.

RESULTS

774 charts were reviewed with 336 included for final analysis (Figure 1). 234 (70%) received a DC during their hospitalization and 102 (30%) did not (NC).

Clinical Characteristics (Table 1)

The DC group was younger (61 ± 15 vs 68 ± 14; p<0.01), had a higher frequency of type 1 diabetes mellitus (13% vs 2%; p<0.01), was more likely to have preadmission hypoglycemia history documented (95% vs 48%; p<0.01) and also more likely to have had hypoglycemia before admission (40% vs 9%; p<0.01). Diabetes consultation was requested more frequently by non-medical services (DC 34% vs NC 14%; p<0.01) and in subjects using injectable therapy including the insulin pump (61.8 vs 38%; p<0.01). There were no differences in sex, ethnicity, frequency of co-morbidities, BMI, or renal function including use of dialysis.

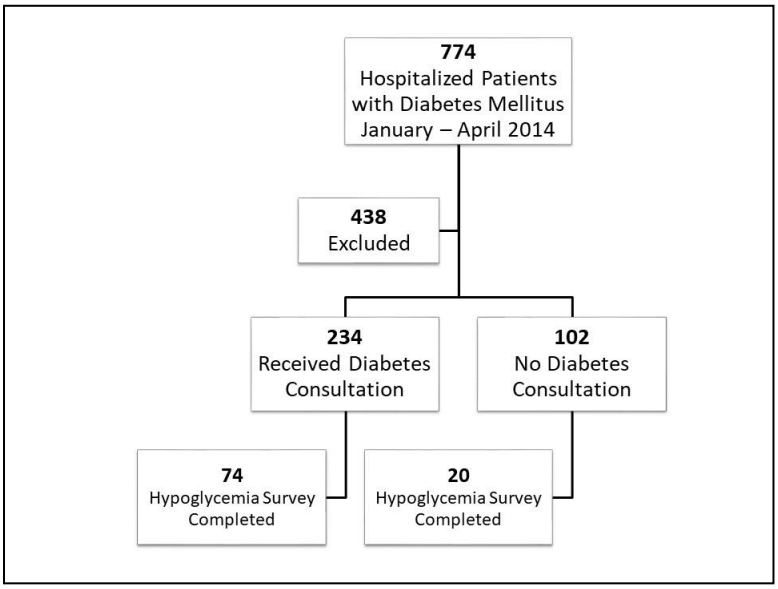

Figure 1. Cohort of Patients with Diabetes Mellitus admitted from January – April 2014

Table 1. Clinical Characteristics of Participants

Variable	DCS Consult (*n*= 234)	No DCS Consult (*n*=102)	*p* value
Age (years)	61 ± 15	68 ± 14	<0.01
Sex (M/F), *n*	129/105	52/50	0.48
Ethnicity (*n*, %) Caucasian African Asian Hispanic Other	 220 (94) 6 (2.4) 4 (1.7) 1 (0.4) 3 (1.3)	 86 (84) 4 (3.9) 2 (2.0) 4 (3.9) 5 (4.9)	0.05
DM (*n*, %) Type 1 Type 2 Surgical	 30 (13) 198 (85) 6 (3)	 2 (1.9) 99 (97) 1 (1)	<0.01
Hypoglycemia[#] (*n*, %) None Any Severe Not documented	 114 (49) 94 (40) 13 (5) 13 (5)	 37 (36) 9 (9) 3 (3) 56 (52)	<0.01
Reason for Admission (*n*, %) Cardiac Medical Cardiac Surgery General Surgery Psychiatric	 37 (16) 112 (48) 6 (3) 4 (30) 9 (4)	 17 (17) 69 (68) 2 (2) 14 (14) 0 (0)	<0.01
DM related admission (*n*, %)	37 (16)	15 (15)	0.80
Co-morbidities (*n*, %) HTN CAD CVA CKD	 180 (77) 94 (40) 23 (10) 80 (34)	 84 (82) 41 (41) 16 (16) 41 (41)	 0.30 0.94 0.12 0.24
Admission DM medications (*n*, %) None Oral hypoglycemic Non-insulin injection 1-2 insulin injections/day ≥3 insulin injections/day Insulin pump Oral + insulin Oral + non-insulin injections Oral + non-insulin + insulin injections	 30 (13) 61 (26) 0 (0) 30 (13) 56 (24) 14 (6) 41 (18) 1 (0.4) 1 (0.4)	 27 (26) 37 (36) 0 (0) 15 (15) 14 (14) 1 (1) 8 (8) 0 0	<0.01

Family History for DM positive (*n*, %)	118 (55)	42 (43)	0.04

*median (25^{th} – 75^{th} interquartile range)
Any Hypoglycemia defined as at least one self-reported hypoglycemic event documented within 3 months prior to admission. Severe Hypoglycemic defined as at least one self-reported hypoglycemic event requiring assistance documented within 3 months prior to admission
DM – diabetes mellitus; HTN – hypertension; CAD – coronary artery disease; CVA – cerebrovascular accident; CKD – chronic kidney disease; BMI – body mass index; SBP – systolic blood pressure; GFR – glomerular filtration rate; HbA1c – hemoglobin A1c

Outcomes with or without DCS (Table 2)
While there was significant improvement in glycemic control at 3 months post discharge in the DC group as noted by a decrease in HbA1c (-0.5% vs 0.06%; p=0.04), this was not sustained at 12 months (-0.1% vs -0.02%, p=0.3)(primary aim). Measurement of HbA1c at least twice after discharge was significantly higher in the DC group compared to the NC group (185 vs 80; p<0.01). After controlling for other variables, DC (p<0.01) and admission HbA1c (p=0.01) were the only significant factors influencing obtaining at least 2 follow-up HbA1c after discharge.

Table 2. Differences in Clinical Parameters with and without the Diabetes Consultation Service

Variable	DCS Consult (*n*= 234)	No DCS Consult (*n*=102)	*p* value
DM Education provided[#] (*n*, %)	187 (80)	17 (17)	<0.01
Discharge medications different (*n*, %)	158 (68)	39 (38)	<0.01
Discharge DM medications (*n*, %)			<0.01
None	28 (12)	31 (30)	
Oral hypoglycemic	45 (19)	30 (29)	
Non-insulin injection	0 (0)	0 (0)	
1-2 insulin injections/day	44 (19)	16 (16)	
≥3 insulin injections/day	61 (26)	17 (17)	
Insulin pump	14 (6)	1 (1)	
Oral + insulin	41 (17)	7 (7)	
Oral + non-insulin injections	1 (0.4)	0 (0)	
Oral + non-insulin + insulin injections	0 (0)	0 (0)	
No. of hospital admissions one year post discharge*	2 (0-3)	1 (0-3)	0.15
Last DM medications (*n*, %)			<0.01
None	39 (17)	36 (35)	
Oral hypoglycemic	51 (22)	32 (31)	
Non-insulin injection	0 (0)	1 (1)	
1-2 insulin injections/day	31 (13)	13 (13)	
≥3 insulin injections/day	62 (27)	15 (15)	
Insulin pump	11 (5)	1 (1)	
Oral + insulin	38 (16)	3 (3)	
Oral + non-insulin injections	1 (0.4)	0 (0)	
Oral + non-insulin + insulin injections	1 (0.4)	1 (1)	
BMI (kg/m^2)			
On Admission	34 ± 11	33 ± 9	0.55
1 year	32 ± 8	33 ± 9	0.46
SBP (mmHg)			
On Admission	132 ± 23	133 ± 26	0.51

1 year	128 ± 21	132 ± 25	0.26
Weight (kg)			
On Admission	96 ± 30	92 ± 28	0.20
1 year	94 ± 29	92 ± 27	0.60
Creatinine (mg/dl)	1.4 ± 1	1.5 ± 1.6	0.23
GFR (ml/min/1.73m^2)	70 ± 35	70 ± 41	0.90
On Dialysis (%)	12 (5)	11 (11)	0.1
HbA1c (%)			
Baseline	7.8 ± 1.8	7.1 ± 1.8	<0.01
3 months	7.4 ± 1.6	7.1 ± 1.5	0.22
6 months	7.8 ± 1.8	6.7 ± 1.1	<0.01
12 months	7.8 ± 1.7	7.0 ± 1.2	<0.01
Change in HbA1c from baseline			
3 months	-0.5 ± 1.7	0.06 ± 1.3	0.04
6 months	-0.07 ± 1.7	0.2 ± 1.0	0.7
12 months	-0.1 ± 1.9	-0.02 ± 1.7	0.3

*median (25th – 75th interquartile range)
#DM Education provided defined as receiving diabetes education while hospitalized from a certified diabetes educator

Survey Responders (Table 3)

The self-administered postal survey was completed by 94 of 336 subjects (28% response rate). 79% of responders received diabetes consultation. There were no differences between responders and non-responders with respect to gender, preadmission hypoglycemia or co-morbidities. Responders were slightly older than non-responders (65 ± 13 vs 62 ± 16 years; p=0.05). 85% of responders had type 2 diabetes mellitus and 10% type 1 diabetes mellitus. Responders also had fewer admissions after discharge [1 (0-2) vs 2 (1-3); p<0.01) and better glycemic control at baseline (7.3 ± 1.9% vs 7.8 ± 1.4%; p=0.02) and at 3 months follow-up (6.8 ± 0.9% vs 7.6 ± 1.7%; p<0.01).

Table 3. Clinical Characteristics of Survey Responders vs Non-Responders

	Responders (n=94)	Non-Responders (n=242)	*p* value
Age (years)	65 ± 13	62 ± 16	0.05
Sex (M/F)	52/42	129/113	0.74
DM (*n*, %)			0.05
Type 1	9 (10)	23 (9)	
Type 2	80 (85)	217 (90)	
Surgical	5 (5)	2 (1)	
Reason for Admission (*n*, %)			<0.01
Cardiac	15 (16)	39 (16)	
Medical	40 (43)	141 (58)	
Cardiac Surgery	2 (2)	6 (2)	
General Surgery	36 (38)	48 (20)	
Psychiatric	1 (1)	8 (3)	
Hypoglycemia (*n*, %)			0.21
None	41 (44)	110 (45)	
Any	34 (36)	69 (29)	
Severe	2 (2)	14 (6)	
Not documented	17 (18)	50 (20)	
Co-morbidities (*n*, %)			
HTN	70 (75)	194 (80)	0.25

CAD	34 (36)	101 (42)	0.34
CVA	8 (9)	31 (13)	0.26
CKD	29 (31)	92 (38)	0.23
No. of hospital admissions one year postdischarge*	1 (0-2)	2 (1-3)	<0.01
Last DM medications (*n*, %)			0.70
None	17 (18)	58 (24)	
Oral hypoglycemic	28 (30)	55 (23)	
Non-insulin injection	0 (0)	1 (0.4)	
1-2 insulin injections/day	14 (15)	30 (12)	
≥3 insulin injections/day			
Insulin pump	19 (20)	58 (24)	
Oral + insulin			
Oral + non-insulin injections	3 (3)	9 (4)	
Oral + non-insulin + insulin injections	13 (14)	28 (12)	
	0 (0)	1 (0.4)	
	(0)	2 (0.8)	
HbA1c (*n*, %)			
Baseline	7.3 ± 1.9	7.8 ± 1.4	0.02
3 months	6.8 ± 0.9	7.6 ± 1.7	<0.01
6 months	7.4 ± 1.4	7.6 ± 1.8	0.30
12 months	7.4 ± 1.4	7.7 ± 1.7	0.12

Survey Responses (Table 4)

Responders who received diabetes consultation were younger (64 ± 14 vs 71 ± 11 years; p=0.05). Otherwise no differences were noted between DC and NC responders in gender, type of diabetes, diabetes related behavior (fingerstick glucose checks), health related quality of life or frequency of hypoglycemia. The DC responders were more likely to be seen by a healthcare provider at least every six months (82% vs 45%; p<0.01). There were no noted differences in the frequency of hypoglycemia or the total scores for avoidance of and anxiety related to hypoglycemia. DC responders, however, were more confident in knowing how to treat hypoglycemia (84% vs 58%; p=0.02) and successfully treating hypoglycemia without requiring help (89% vs 65%; p=0.04).

Table 4. Survey Responses

Question	**DC (n=74)**	**NC (n=20)**	***p* value**
Age (years)	64 ± 14	71 ± 11	0.05
Sex (M/F)	44/30	8/12	0.12
Diabetes Mellitus (n, %)			0.39
Type 1	9 (12)	0 (0)	
Type 2	61 (82)	19 (95)	
Surgical	4 (5)	1 (5)	
Duration of DM (years)	17 ± 13	13 ± 10	0.22
Management of DM (n, %)			
Lifestyle	53 (76)	17 (24)	0.49
Oral hypoglycemic agents	38 (54)	7 (39)	0.24
Insulin (fixed dose)			
Sliding-scale insulin	39 (56)	7 (39)	0.20

Non-insulin injectable	29 (41) 2 (3)	4 (22) 0 (0)	0.13 0.46
Fingerstick glucose frequency (n, %) Several times per day Once daily Several times per week Several times per month Never	 38 (51) 13 (18) 8 (11) 6 (8) 8 (11)	 7 (35) 5 (13) 1 (5) 2 (10) 4 (20)	0.55
Health Rating (n, %) Excellent Very Good Good Fair Poor	 0 (0) 13 (18) 28 (38) 21 (28) 8 (11)	 1 (5) 3 (15) 9 (25) 4 (20) 2 (10)	0.48
Frequency of moderate hypoglycemia* (n, %) Daily Weekly Monthly Rarely Never	 1 (1) 6 (8) 14 (19) 20 (27) 31 (42)	 0 (0) 1 (5) 5 (25) 8 (40) 5 (25)	0.57
Frequency of severe hypoglycemia[$] (n, %) Daily Weekly Monthly Rarely Never	 1 (1) 2 (3) 0 (0) 10 (14) 60 (81)	 0 (0) 0 (0) 2 (10) 3 (15) 14 (70)	0.12
Frequency of health care provider visits (n, %) Once per week Once per month Once every 6 months Once per year Less than once per year	 3 (4) 7 (10) 50 (68) 11 (15) 2 (3)	 2 (10) 1 (5) 6 (30) 8 (40) 2 (10)	<0.01
Frequency of ER visits (n, %) Once per week Once per month Once every 6 months Once per year Less than once per year	 0 (0) 1 (1) 3 (4) 8 (11) 58 (78)	 0 (0) 0 (0) 1 (5) 4 (20) 14 (70)	0.60
Health-related quality of life (EQ-5D)	7 ± 2	8 ± 2	0.52
GAD-7 Score	3 ± 5	2 ± 3	0.3
Confidence in Hypoglycemia (n, %) Recognition Treatment knowledge Successful treatment without help	 49 (67) 61 (84) 65 (89)	 13 (68) 11 (58) 13 (68)	 0.44 0.02 0.04

Fear of Hypoglycemia (n, %)			
Avoidance of hypoglycemia	11 ± 9	10 ± 8	0.83
Treating hypoglycemia without help	10 ± 3	8 ± 1	0.12
Anxiety about hypoglycemia	5 ± 6	6 ± 1	0.48

*Moderate hypoglycemia – Frequency over last 6 months characterized by significant dizziness, blurry vision, confusion, sweating, etc
$Severe hypoglycemia – Frequency over last 6 months requiring assistance from others
ER – emergency room

DISCUSSION

Inpatient diabetes consultation improves hyperglycemia, decreases hypoglycemia and subsequently reduces 30-day readmission rates, inpatient diabetes cost and improves transition of care and follow-up [15-17]. To our knowledge this is the first study that focused on the effect of inpatient diabetes consultation on glycemic control up to one year post discharge. We show that while there was a significant improvement in glycemic control at 3 months post discharge, this effect was lost at 6 and 12 months. However, access to medical care was significantly higher in the group that received diabetes consultation. In addition, those who received diabetes consultation while in hospital reported higher confidence in knowing how to treat hypoglycemia and successfully treating hypoglycemia compared to those who did not post discharge.

At least one quarter of hospital admissions have diabetes mellitus [18]. Diabetes mellitus is associated with higher length of stay, morbidity, health care cost and mortality[2-4,19]. Utilization of a diabetes consultation service has previously been shown to reduce 30-day readmission rates thus reducing overall health care cost and expenditure[17]. In Australia, the utilization of inpatient diabetes education was associated with improved glycemic control at 3 months post discharge[20]. This study, however, only included 67 patients with 'poorly controlled diabetes mellitus' (mean HbA1c on admission 10.45% or 90 mmol/mol). They showed a reduction in HbA1c by 1.5% at 3 months. While our study only shows a 0.4% reduction at 3 months, we included all patients with diabetes mellitus and thus a less dramatic effect was noted. However, the DC group on admission had worse glycemic control on admission (HbA1c 7.8% or 62 mmol/mol in DC vs 7.1% or 157 mmol/mol in NC, $p<0.01$) and were more likely to be on insulin indicating a more complicated patient group compared to the NC group. Discharged medications reflect intensification of the diabetes regimen in the DC group compared to the NC group (Table 1) which can also account for the improvement in glycemic control. Despite increased frequency of health care visits in the DC group, as reflected by more measurements of HbA1c post discharge, improvement in glycemic control was not sustained.

Hypoglycemia is increasingly recognized as a severe adverse event resulting in reduced quality of life [21]. HbA1c is a poor reflection of hypoglycemia and thus, in the absence of continuous glucose monitoring data, self-reported hypoglycemia can be used as a surrogate marker[10,21]. Fear of hypoglycemia has been associated with anxiety, avoidance behavior and past history of severe hypoglycemic events [21-23]. Despite having experienced severe hypoglycemia previously, patients with diabetes continue to

have low confidence in treating hypoglycemia [10]. Providing comprehensive, individualized education is of paramount importance in order to improve knowledge on how to treat and prevent hypoglycemia[24] which can hopefully translate to a better quality of life. We have shown that even after 12 months after their initial diabetes education consultation, knowledge and confidence in treating hypoglycemia persisted.

We failed to show sustained improvement in glycemic control, frequency of self-reported hypoglycemic events and readmission rates. This however can be explained by the discrepancy in the characteristics of the two groups. On admission, the DC group had worse glycemic control, a higher report of hypoglycemia and was more likely to be on more than 3 injections per day of insulin. A more intense diabetes medication regimen was consistent on discharge as well as on follow-up in the DC group. In fact, 35% of patients in the NC group had their medications discontinued by follow-up versus 17% in the DC group. This reflects that the DC group would require a higher intensity of follow-up and have a higher likelihood of hypoglycemia. The finding that complicated patients are more likely to obtain an inpatient diabetes consultation has been reflected in prior reports as well [16]. Our study did not control for changes in other medications, diet, exercise and post discharge follow-up with a diabetes specialist and/or educator. In addition, after one education session, knowledge retention decreases as soon as 7 days after admission [25]. Altogether, these factors can account for our failure to find a difference post discharge.

Our study has several strengths including inclusion of all diabetes admissions, a comprehensive chart review and a long duration of follow-up post discharge. The initial phase was a retrospective review and therefore has its inherent limitations. We also did not match the groups which leaves confounders to influence results but allows our data to represent the real clinical world. Data were limited to one tertiary hospital. The Mayo Clinic is a referral center and follow-up data on many patients were not consistent. We had a poor response rate on the survey (27.9%) and therefore at risk for response bias. The response rate however, was similar to prior survey based studies [21].

CONCLUSION

Inpatient diabetes consultation improves post discharge glycemic control at 3 months as well as health care access and confidence with treating hypoglycemia. Unfortunately, we could not detect a difference in frequency of hypoglycemia and glycemic control at 6 and 12 months after discharge despite increased health care access. A more structured approach with several follow-up visits by diabetes specialists and educators are needed after discharge to sustain the significant improvements implemented during hospitalization.

Notes

Author contributions: All authors have seen and approved the manuscript and contributed significantly to the work.

Financial support: Authors declare that no financial assistance was taken from any source.

Potential conflicts of interest: Authors declare no conflicts of interest.

References

1. National Diabetes Statistics Report. Center of Disease Control and Prevention. https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf. Published 2017. Accessed September 12th, 2017.
2. Donnan PT, Leese GP, Morris AD. Hospitalizations for people with type 1 and type 2 diabetes compared with the nondiabetic population of Tayside, Scotland:

a retrospective cohort study of resource use. *Diabetes care.* 2000;23(12):1774-1779.
3. Gornik I, Vujaklija-Brajkovic A, Renar IP, Gasparovic V. A prospective observational study of the relationship of critical illness associated hyperglycaemia in medical ICU patients and subsequent development of type 2 diabetes. *Crit Care.* 2010;14(4):R130.
4. Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE. Hyperglycemia: An Independent Marker of In-Hospital Mortality in Patients with Undiagnosed Diabetes. *The Journal of Clinical Endocrinology & Metabolism.* 2002;87(3):978-982.
5. Mackey PA, Boyle ME, Walo PM, Castro JC, Cheng MR, Cook CB. Care directed by a specialty-trained nurse practioner or physician assistant can overcome clinical inertia in management of inpatient diabetes. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists.* 2014;20(2):112-119.
6. Levetan CS, Salas JR, Wilets IF, Zumoff B. Impact of endocrine and diabetes team consultation on hospital length of stay for patients with diabetes. *The American journal of medicine.* 1995;99(1):22-28.
7. Healy SJ, Black D, Harris C, Lorenz A, Dungan KM. Inpatient diabetes education is associated with less frequent hospital readmission among patients with poor glycemic control. *Diabetes care.* 2013;36(10):2960-2967.
8. Wei NJ, Grant RW, Nathan DM, Wexler DJ. Effect of hospital admission on glycemic control 1 year after discharge. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists.* 2012;18(4):456-463.
9. Levey AS, Coresh J, Greene T, et al. Using standardized serum creatinine values in the modification of diet in renal disease study equation for estimating glomerular filtration rate. *Annals of internal medicine.* 2006;145(4):247-254.
10. McCoy RG, Van Houten HK, Ziegenfuss JY, Shah ND, Wermers RA, Smith SA. Self-report of hypoglycemia and health-related quality of life in patients with type 1 and type 2 diabetes. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists.* 2013;19(5):792-799.
11. Cox DJ, Irvine A, Gonder-Frederick L, Nowacek G, Butterfield J. Fear of hypoglycemia: quantification, validation, and utilization. *Diabetes care.* 1987;10(5):617-621.
12. Van Der Ven NC, Weinger K, Yi J, et al. The confidence in diabetes self-care scale: psychometric properties of a new measure of diabetes-specific self-efficacy in Dutch and US patients with type 1 diabetes. *Diabetes care.* 2003;26(3):713-718.
13. EuroQol--a new facility for the measurement of health-related quality of life. *Health policy (Amsterdam, Netherlands).* 1990;16(3):199-208.
14. Spitzer RL, Kroenke K, Williams JB, Lowe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine.* 2006;166(10):1092-1097.
15. Garg R, Schuman B, Bader A, et al. Effect of Preoperative Diabetes Management on Glycemic Control and Clinical Outcomes After Elective Surgery. *Annals of Surgery.* 2018;267(5):858-862.
16. Wang YJ, Seggelke S, Hawkins RM, et al. Impact of glucose management team on outcomes of hospitalized patients with type 2 diabetes admitted to the medical service. *Endocrine Practice.* 2016;22(12):1401-1405.
17. Bansal V, Mottalib A, Pawar TK, et al. Inpatient diabetes management by specialized diabetes team versus primary service team in non-critical care units: impact on 30-day readmission rate and hospital cost. *BMJ open diabetes research & care.* 2018;6(1):e000460.
18. Economic costs of diabetes in the U.S. In 2007. *Diabetes care.* 2008;31(3):596-615.
19. Dungan KM, Osei K, Nagaraja HN, Schuster DP, Binkley P. Relationship between glycemic control and readmission rates in patients hospitalized with congestive heart failure during implementation of hospital-wide initiatives. *Endocrine practice : official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists.* 2010;16(6):945-951.
20. Gardiner FW, Nwose EU, Bwititi PT, Crockett J, Wang L. Does a hospital diabetes inpatient service reduce blood glucose and HbA1c levels? A prospective cohort study. *Annals of medicine and surgery (2012).* 2018;26:15-18.

21. Marrett E, Radican L, Davies MJ, Zhang Q. Assessment of severity and frequency of self-reported hypoglycemia on quality of life in patients with type 2 diabetes treated with oral antihyperglycemic agents: A survey study. *BMC research notes.* 2011;4:251.
22. Anderbro T, Gonder-Frederick L, Bolinder J, et al. Fear of hypoglycemia: relationship to hypoglycemic risk and psychological factors. *Acta diabetologica.* 2015;52(3):581-589.
23. Polonsky WH, Fisher L, Hessler D, Edelman SV. Identifying the worries and concerns about hypoglycemia in adults with type 2 diabetes. *Journal of diabetes and its complications.* 2015;29(8):1171-1176.
24. Minimizing Hypoglycemia in Diabetes. *Diabetes care.* 2015;38(8):1583-1591.
25. White M, Garbez R, Carroll M, Brinker E, Howie-Esquivel J. Is "teach-back" associated with knowledge retention and hospital readmission in hospitalized heart failure patients? *The Journal of cardiovascular nursing.* 2013;28(2):137-146.