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Effects of diabetes self-management programs on time-to-hospitalization among patients with type 2 diabetes: A survival analysis model

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Abstract

Objective—This study compared time-to-hospitalization among subjects enrolled in different diabetes self-management programs (DSMP). We sought to determine whether the interventions delayed the occurrence of any acute event necessitating hospitalization.

Methods—Electronic medical records (EMR) were obtained for 376 adults enrolled in a randomized controlled trial (RCT) of Type 2 diabetes (T2DM) self-management programs. All study participants had uncontrolled diabetes and were randomized into either: personal digital assistant (PDA), Chronic Disease Self-Management Program (CDSMP), combined PDA and CDSMP (COM), or usual care (UC) groups. Subjects were followed for a maximum of two years. Time-to-hospitalization was measured as the interval between study enrollment and the occurrence of a diabetes-related hospitalization.

Results—Subjects enrolled in the CDSMP-only arm had significantly prolonged time-to-hospitalization (Hazard ratio: 0.10; $p = 0.002$) when compared to subjects in the control arm. Subjects in the PDA-only and combined PDA and CDSMP arms showed no improvements in comparison to the control arm.

Conclusion—CDSMP can be effective in delaying time-to-hospitalization among patients with T2DM.

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Practice implications—Reducing unnecessary healthcare utilization, particularly inpatient hospitalization is a key strategy to improving the quality of health care and lowering associated health care costs. The CDSMP offers the potential to reduce time-to-hospitalization among T2DM patients.

Keywords

Disease management; Health-care utilization

1. Introduction

Diabetes continues to be one of the leading causes of morbidity and mortality for adults living in America, particularly Hispanics and African Americans. Current estimates suggest that 25.6 million adults aged 20 or older have a diagnosis of diabetes [1], and additional persons, mostly immediate family members, are adversely affected by the disease and its complications. The impacts of diabetes and associated comorbidities on healthcare utilization are striking as diabetes often progresses to diverse microvascular, macrovascular, and neuropathic complications that drive up healthcare utilization, and result in significant morbidity and premature mortality.

Different approaches to improving glycemic control, which is the hallmark of diabetes treatment, have involved enhancing diabetes self-care processes using behavioral and technological programs. As part of strategic measures to combat the growing diabetes burden, the American Diabetes Association (ADA) and American Association of Clinical Endocrinologists (AACE) developed rigorous guidelines and recommendations for diabetes treatment and management. Diabetes self-management programs (DSMP) including diabetes self-management education (DSME) and information technology have been identified as critical elements of managing diabetes and improving patient outcomes [2–4].

However, current literature provides mixed results on the effectiveness of self-care interventions in glycemic control and other related health measures. Some studies have documented positive impacts of various DSMPs on outcomes such as: glycated hemoglobin and fasting blood glucose levels [5–7]; rates of hospitalization [8]; lifestyle outcomes [9] and quality of life [10]. Other studies found no significant improvements in clinical outcomes [11–13] or quality of life [7]. These conflicting findings have been attributed to different study designs and settings, as well as the differences in the levels of severity of uncontrolled diabetes in the patients studied. Even in studies with evidence that self-management training is effective, most reviews have documented treatment decay or limited long-term effects, largely due to study attrition and censoring [13,14]. Consequently, there is the need for further research that account for decay effects and study attrition.

When analyzing diabetes outcomes, complex research methodologies, such as longitudinal analysis, and survival analysis models, provide researchers with greater opportunity for analyzing patient-centered outcomes. Survival analysis models are designed to address study attrition and censoring by estimating the time-to-event for an outcome of interest, and assessing the relationship between various covariates and the time-to-event.

To date, very few research studies have focused on time-to-hospitalization in a disease management context, while accounting for censoring among patients with Type 2 diabetes (T2DM). By taking time-to an event of interest into account, researchers are able to obtain additional information rather than just a binary yes–no for an intervention of interest. Time-to-event, or survival analyses models, therefore improve power and precision of a study by addressing censoring and attrition to include subjects who "survived" the program without experiencing the event (in this case, hospitalization), left the program prematurely, or were lost to follow-up [15].

This study compared time-to-hospitalization among T2DM patients randomized to one of four study arms: personal digital assistant hand held device (PDA), Chronic Disease Self-Management Program (CDSMP), combined PDA and CDSMP (COM), and usual care (UC). We sought to determine whether DSMP enhanced the probability of healthier outcomes and prolonged the time to first hospitalization within any of the treatment groups, after controlling for relevant demographic and clinical variables.

2. Methods

2.1. Data

A retrospective cohort analysis was conducted using secondary data from a recently concluded randomized controlled trial (RCT) of T2DM self-management interventions in Texas [12]. They study lasted 2007–2012. Enrolled individuals in the RCT were recruited from seven participating clinics of a large university-affiliated healthcare system. Potential participants were identified within the healthcare system through electronic medical records (EMR) if they: (1) had a diagnosis of T2DM; (2) were 18 years or older; (3) had a lab assessed HbA1c value of at least 7.5% within the last 6 months; and (4) were able to read, write, and speak English. Subjects were excluded if they: (1) had reports of alcoholism or drug abuse; (2) were pregnant or planning to become pregnant within 12 months; or (3) were unwilling to sign an informed consent to be randomized to any of the four treatment/control groups. 1897 potential subjects were screened on phone by project staff, of which 922 indicated an interest to participate in the randomized controlled trial. A laboratory assessment was conducted to assess HbA1c levels among those who indicated interest. Based on the laboratory results, 546 were determined ineligible because they failed to meet the inclusion criteria of HbA1c levels (≥7.5%), had no insurance or spoke no English. The resulting patient population consisted 376 adults who met the study criteria and agreed to be randomized into one of four study arms. Each subject was followed for a maximum of 2 years. Details of subject recruitment and retention are described elsewhere [12].

2.2. Design

A fixed, equal allocation stratified randomization procedure (stratifying by clinic setting and race/ethnicity) was used to randomize the 376 participants into: the Diabetes Pilot software on a personal digital assistant hand held device (PDA) (n = 81), Chronic Disease Self-Management Program (CDSMP) (n = 101), combined PDA and CDSMP (COM) (n = 99), and usual care (UC) (n = 95). Subjects randomized to the CDSMP arm received a 6-week, 2½ hour once a week classroom based training on diabetes self-management. The classroom

sessions allowed face-to-face interactions between subjects and a disease management coach on proactive approaches to diabetes self-management. The CDSMP educational model was developed by Stanford University and focuses on equipping patients to be proactive in managing their chronic diseases. The coaches received standardized prior training in diabetes self-management. Each subject in the PDA arm was given a PDA and trained to monitor his/her blood glucose, blood pressure, medication usage, physical activity, and dietary intake by tracking these measures in the PDA diabetes pilot software. Due to concern about possible treatment contamination, each clinic was assigned to have only one treatment group and one control group.

Clinical data for participants enrolled in the RCT were obtained through EMR that were reviewed and downloaded on a quarterly basis. The EMR records include:

1. HbA1c levels;
2. Acute hospital events relating to diabetes – emergency room (ER) visits, observation and inpatient hospitalization;
3. Length of stay (LOS) for each acute event;
4. Health care financing and reimbursement;
5. Identified past and current comorbidities: chronic heart failure, ischemic heart disease, stroke (hemorrhagic, ischemic or thrombotic), renal failure, atrial fibrillation, myocardial infarction, peripheral vascular disease and lower extremity amputations; and
6. Pharmaceutical data

Patient surveys were administered periodically during the two year study and included information on:

1. Socio-demographics (e.g. age, gender, race/ethnicity, education, yearly income;
2. Technological experiences (e.g. any experience using computers, the internet, a PDA, etc.)
3. Self-reported health-related quality of life (HRQoL) measures (e.g. number of days physical/mental health kept participant from usual activities, such as work)
4. Summary of diabetes self-care activities (SDSCA) measures (number of days, 0–7, any specific self-care activity was performed in the past week)
5. Pain and fatigue measures (on a scale of 1–10, 1 indicating none and 10 severe); and
6. Physical activity measures (e.g. number of physically active days in the past week).

2.3. Measurement

The dependent variable or event of interest for this study was time-to-first diabetes-related hospitalization following enrollment in the RCT. Diabetes-related hospitalizations were identified based on inpatient claims obtained from the EMR. The presence of International Classification of Diseases, Ninth Revision – Clinical Modification (ICD-9-CM) Codes

250.00–250.90 within either: admitting diagnosis, principal diagnosis, or the first 3 other diagnoses fields, was used as a proxy for diabetes-related acute event. This approach captured cardiovascular, neuropathic, nephropathic and psychiatric hospital events.

Independent predictor variables include demographic information such as patient's age, gender, race, education, body mass index (BMI); clinical data such as HbA1c levels, identified medical conditions/comorbidities; and risk factors such as time (in years) since initial diagnosis of diabetes, the SDSCA measures, and a healthy days index (HDI). The HDI was calculated from the HRQoL scores and captures the minimum number of days within the past month that an individual reported good or better health. A ratio of the number of healthy days to 30, after adjusting for "potential overlap of physical and mentally unhealthy days", generates a range of indices between 0 and 1 that can be used as a proxy for quality-adjusted life-year (QALY) measures [16].

Consistent with survival analysis techniques, we measure time-to-hospitalization (survival time) as the interval between the index time and the occurrence of the event of interest. The index time is the time when enrollment in the study occurred (where each subject has a different starting time) and the event of interest is first acute hospital event relating to diabetes. In this study, information on time-to-hospitalization is not available for some individuals due to loss to follow-up or non-occurrence of hospitalization before the trial ended. This censoring problem is shown in Fig. 1.

In the illustration, observations A to G represent study subjects that were randomized into one of the four groups. The horizontal lines represent the survival time for each subject, whether hospitalized, lost to follow-up, withdrew from the study or censored. Maximum follow-up for participants in the study was 2 years.

2.4. Analysis

All data management and analyses were performed using SAS 9.2. Descriptive analyses employing frequencies, proportions, means and standard deviations were used to describe patient characteristics, complications and clinical risk factors for the four treatment groups. We used chi-square tests and ANOVA tests to determine whether there were statistically significant differences across the four study groups for baseline covariates. We ran a logistic model to ascertain odds of hospitalization for each treatment group and plotted Kaplan–Meier survival curves for the groups. Multivariate analysis employing a Cox Proportional Hazards (PH) model [17] was used to model the data while controlling for baseline independent variables. Time varying covariates and graphical methods using the log cumulative hazard function were employed to check the PH assumption [18].

3. Results

3.1. Descriptive and univariate analysis

Overall, subjects in the four study arms were comparable across baseline demographic and clinical characteristics (Table 1). Most subjects were females (55%) and 72 percent of subjects had greater than high school education. Approximately 64 percent of subjects identified as non-Hispanic whites, 20 percent were Hispanics and 16 percent were non-

Hispanic Blacks. Over 64 percent of subjects reported income ranges less than $50,000 per annum, of which most people (37%) indicated they fell within the $25,000–$49,000 per annum range. The mean subject age was 57 years, and the mean diabetes duration at orientation was 3.11 years.

An assessment of three of the four SDSCA measures in this study indicated good comparability across all study arms. Slightly over half of all subjects reported eating healthy four or more days of the week, and only a third of subjects reported engaging in the recommended physical activity four or more days of the week. Although almost 60 percent of all subjects indicated they administered the recommended blood glucose test four or more days of the week, examination of the feet using the recommended foot care guidelines was different across the groups ($p = 0.04$). BMI was not significantly different across groups. Overall, seventy-four percent of subjects in this trial were obese and an additional 20 percent were overweight; the mean BMI was 34.28 kg/m^2. The frequency of having more than 1 comorbid condition was statistically significantly different at baseline ($p = 0.03$), indicating the proportion of comorbidities within each of the four intervention groups were not similar. The mean baseline HbA1c for participants was 9.28 and did not differ significantly across all four study arms.

3.2. Bivariate results: logistic regression and Kaplan–Meier survival curves

A preliminary assessment of healthcare utilization showed the likelihood of diabetes-related hospitalization and ER visits (Table 2). Compared to subjects in UC, persons in the CDSMP-only arm had significantly lower odds of health care utilization. There were no statistically significant differences between the combined and control arms. The PDA arm had higher odds of hospitalization compared the control group.

A graphical assessment of the randomization groups using the Kaplan–Meier survival curves showed that the CDSMP-only group had a better survival probability (Fig. 2) in terms of time-to-hospitalization than any of the study groups ($p < 0.05$). The PDA only group had the least survival probability, indicating the shortest time-to-hospitalization.

3.3. Multivariate results

Table 3 shows the results of the proportional hazard model with time-to-hospitalization as the outcome of interest. After adjusting for other covairates, subjects enrolled in the CDSMP-only arm had a statistically significant lower odds (Hazard ratio: 0.10; $p = 0.002$) of being hospitalized when compared to subjects in the control arm. Subjects in the PDA and combined arm had worse outcomes in comparison to the control arm. Increasing age and higher HbA1c values were significantly associated with shorter time-to-hospitalization at the 0.05 significance level (hazard ratios: 1.03 and 1.20, respectively; *p*-values: 0.01 and 0.006, respectively). Greater educational attainment (persons with greater than high school education) was associated with longer times to hospitalization (Hazard ratio: 0.6; $p = 0.008$) when compared to people with high school education or less. In comparison to non-Hispanic whites, Hispanics were associated with significantly longer time-to-hospitalization (Hazard ratio: 0.5; $p = 0.02$) while non-Hispanic blacks were associated with shorter time-to-hospitalization, though insignificant (Hazard ratio: 1.1; $p = 0.64$). As the number of

comorbidities increased, the time to hospitalization reduced significantly (hazard ratio: 1.8; $p = 0.003$). Higher quality of life (Healthy Days Index) was not significantly associated with time-to-hospitalization. Interestingly, longer diabetes duration was associated with longer time-to-hospitalization (hazard ratio: 0.8, $p = 0.004$). There were no statistically significant differences in outcomes by gender.

Table 4 shows the results of the proportional hazard model with time-to-ER visits as the outcome of interest. Again, subjects enrolled in the CDSMP only arm had a statistically significant lower risk/shorter time-to-ER (Hazard ratio: 0.12; $p < 0.001$) when compared to subjects in the control arm. In addition, the PDA and combined group had worse outcomes in comparison to the controls (Hazard ratios: 2.89; $p < 0.001$; 1.89; $p = 0.01$, respectively). With the exception of longer diabetes duration which was associated with longer time-to-ER (Hazard ratio: 0.87, $p = 0.02$), none of the other variables were associated with time-to-ER visits in this model. Results of the proportional hazards assumption test using time-varying covariates indicated the proportionality of hazards assumption was good across all baseline covariates (proportionality test: $p = 0.56$). Table 5 shows specific comorbidities and how they differ across intervention groups. The combined group had a significantly higher proportion of ischemic heart disease than any of the other groups; other cardiac conditions (myocardial infarction and atrial fibrillation) and stroke were also highest in this group (Table 5).

4. Discussion and conclusion

4.1. Discussion

In this study, we sought to determine whether three types of diabetes self-management intervention programs prolonged the time to hospitalization among participants enrolled in a T2DM randomized controlled trial. Although several studies have documented the impacts of diabetes self-management on hospitalization rates in the United States, our study is the first, to our knowledge, to compare time-to-hospitalization among subjects randomized to different diabetes self-management groups.

After controlling for relevant demographic and clinical variables, the CDSMP-only group appeared effective in prolonging time-to-hospitalization among patients with T2DM in this trial. Because no similar improvements were observed in the combined arm, the interpretation of our findings warrants some caution.

The CDSMP intervention reduced the odds of hospitalization and prolonged the time to hospitalization for persons in that study arm; persons in the combined arm had similar odds of hospitalization as the controls but shorter time to hospitalization while persons in the PDA arm had higher odds of hospitalization and shorter time to hospitalization. These findings add information to previous studies on healthcare utilization following enrollment in the CDSMP or other self-management programs. Evidence exists in the literature suggesting CDSMP can improve health status while reducing hospitalization. Lorig et al. reported that persons with chronic diseases who were randomized to receive the CDSMP class had fewer hospitalizations and spent, on average, 0.8 fewer nights in the hospital after 6 months of receiving the intervention [19]. Other studies have reported that self-

management programs for persons with chronic conditions did not significantly alter healthcare use. A systematic review by Foster et al. reported no statistically significant differences for days/nights spent in hospital between groups that received self-management education vs. those who did not [20].

While we find some evidence that CDSMP interventions might be able to delay the occurrence of any acute event necessitating hospitalization, ER visits and observations among patients with T2DM, we suggest a number of hypotheses for the observed outcomes in the PDA-only and combined groups:

1. The RCT study index time coincided with the introduction and national marketing of the ground-breaking popular iPhone™. For this reason, a number of participants were not as keen to use old technology, the PDAs, for diabetes self-management. Perhaps, study subjects saw the iPhone as an alternative and, therefore abandoned the PDAs.
2. As noted in a recent study, persons in the PDA arm discontinued their PDA use primarily because they were frustrated with the device and/or the diabetes pilot software on it [21]. In evaluating this, Vuong et al. identified several limitations that may have contributed to the observed frustration, including usability, data loss/errors, and time constraints.
3. In terms of comorbidities, the frequency of having more than one comorbidity was significantly different across groups at baseline. The combined group was the sickest group, having the highest proportions of persons with more than one comorbidity. Ischemic heart disease (IHD) notably stood out as a major driver of the impact of comorbidities. Other cardiac conditions (myocardial infarction and atrial fibrillation) and stroke were also highest in this group.
4. Although persons in the CDSMP-only and combined groups received the CDSMP intervention, healthcare utilization outcomes varied perhaps because persons in the combined group were generally less healthy: 2% with normal weight and 80% obese versus 9% normal weight and 65% obese in the CDSMP-only group. Demographic results from the Summary of Diabetes Self Care Activities also revealed that persons in the combined group ate less healthy than persons in the CDSMP group (58% vs. 44%). Both diet and weight are significantly associated with diabetes outcomes and could have played a role in mitigating the expected positive effects for this group.

An analysis of the factors influencing time-to-ER visits, and those influencing time-to hospitalization showed quite different results. Gender, race, education, age, HbA1c levels, comorbidity count and quality of life were not correlated with time-to ER visits. This suggests that, by and large, the use of emergency services may not be associated with demographic variables, but rather clinical symptoms experienced at the time of the ER visit. These symptoms may then warrant hospitalization, as deemed fit by the attending emergency physician.

On the other hand, education, age, race, HbA1c levels and comorbidity count were all associated with time-to-hospitalization. The authors posit that persons with greater educational attainment are able to make better judgments of the symptoms they are experiencing, and may maintain healthy lifestyles that can prolong time-to-hospitalization, compared to persons with lesser education. Additionally, older persons are typically associated with higher health care utilization than younger persons [22], as our findings support. Compared to non-Hispanic whites, we submit that persons of Hispanic origin who have health insurance are less likely to go the hospital for cultural reasons. Previous studies have documented that Hispanics may delay seeking healthcare [23] and postpone going to the hospital until they are in a critical or life-threatening condition [24]. Higher HbA1c levels were also associated with shorter time-to-hospitalization supporting previous studies that report findings of increased hospitalization risks among persons with extreme HbA1c levels [25]. The relationship between HbA1c and time-to-hospitalization also corroborates the compendium of UKPDS articles that report a decreased risk of hospitalization for every percentage point decrease in HbA1c [26].

This study is not without limitations. Generalizability of results to non-managed care populations cannot be ascertained as all study subjects were enrolled in a large university-affiliated Health Maintenance Organization (HMO). Secondly, subjects in this study may have visited emergency departments and hospitals out of their HMO network, for which we do not have information. Nevertheless, we do not foresee a significant number of out-of-network hospitalizations to bias our results. This is due to the fact that the HMO healthcare system has 27 clinics and four hospitals regionally throughout Texas with linked EMR capacity. Thirdly, although subjects in this study were randomized to receive the intervention, they attended the same clinics indicating potential correlation of results. To promote treatment fidelity of the RCT and limit contamination of intervention, the study was designed such that only two interventions occurred in each of the seven clinics. For this reason, our results may be biased by clinic effects which are unaccounted for in the model. Fourthly, although the duration of this study was 5 years (2007–2012), the maximum follow-up time for each subject was 2 years. Hence, we were unable to obtain hospitalization information after the 2 year (+45 days extension) period. Lastly, this study is limited by the secondary nature of our dataset, which could include primary admissions for non-diabetes reasons. We however see no reason exists for this misclassification to vary across our intervention groups and introduce bias in our findings.

Despite these limitations, this study provides a practical approach of dealing with diabetes outcomes, such as hospitalization, following the introduction of a diabetes self-management intervention. Compared to the conventional total population approach of dealing with study attrition and censoring, survival models are more appropriate as they account for participants that left the program prematurely.

4.2. Conclusions

The CDSMP is likely to be effective within a short time span (2 years) in prolonging time-to-hospitalization among patients with T2DM patients.

4.3. Practice implications

Reducing unnecessary healthcare utilization, particularly inpatient hospitalization is a key strategy to improving the quality of health care and lowering associated health care costs. The CDSMP examined in this trial offers the potential to reduce time-to-hospitalization among T2DM patients. Persons who are young, have lower HbA1c values, have more than a high school education and have fewer comorbidities, are more likely to experience longer time-to-hospitalization following enrollment in a diabetes self-management program.

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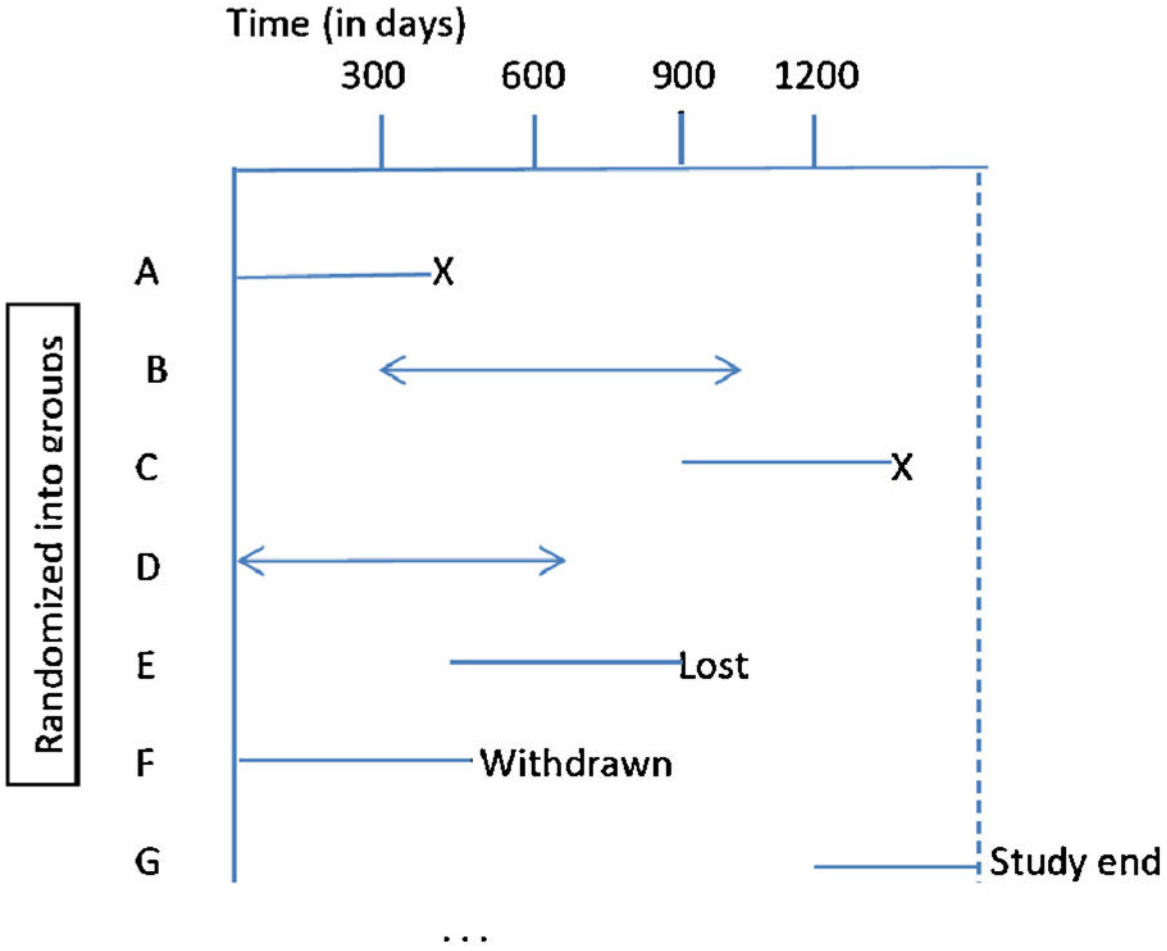

Fig. 1.
Censoring illustration in study.

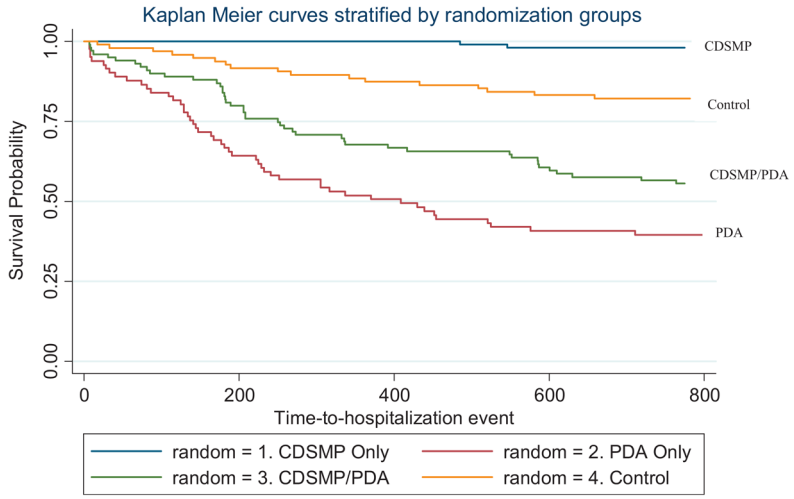

Fig. 2.
Kaplan–Meier curves stratified by randomization groups.

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Table 1

Demographic and clinical characteristics of subjects by randomization groups.

Characteristics of participants	CDSMP only group (*N* = 101)		PDA only group (*N* = 81)		Combined group *N* = 99		Control group *N* = 95		All *N* = 376	
	No.	%	No.	%	No.	%	No.	%	No.	%
Male	47	46.53	34	41.98	46	46.46	42	44.21	169	44.95
Education: greater than high school	75	74.26	54	66.67	71	71.72	70	73.68	270	71.81
Race										
Non-Hispanic black	21	20.79	11	13.58	12	12.12	17	17.89	61	16.22
Hispanic	20	19.80	19	23.46	22	22.22	15	15.79	76	20.21
Non-Hispanic white	60	59.41	51	62.96	65	65.66	63	66.32	239	63.56
Income										
<$15,000	12	11.88	11	13.58	7	7.07	9	9.57	39	10.40
$15,000–$24,999	11	10.89	14	17.28	19	19.19	16	17.02	60	16.00
$25,000–$49,999	41	40.59	37	45.68	32	32.32	30	31.91	140	37.33
$50,000–$75,000	12	11.88	12	14.81	23	23.23	17	18.09	64	17.07
>$75,000	12	11.88	6	7.41	14	14.14	14	14.89	46	12.27
Prefer not to answer	13	12.87	1	1.23	4	4.04	8	8.51	26	6.93
BMI (kg/m^2)										
Normal	9	8.91	5	6.17	2	2.02	7	7.37	23	6.12
Overweight	26	25.74	13	16.05	18	18.18	18	18.95	75	19.95
Obese	66	65.35	63	77.78	79	79.80	70	73.68	278	73.94
>1 comorbid condition[a]	31	30.69	32	39.51	51	51.52	38	40.00	152	40.43
Summary of Diabetes Self-Care Activities (SDSCA) measures										
General diet: persons with ≥4 days/week of healthy eating	59	58.42	51	62.96	44	44.44	49	51.58	203	53.99
Exercise: persons with ≥4 days/week of physical activity	36	35.64	21	25.93	33	33.33	27	28.42	117	31.12
Blood Glucose Testing: persons with ≥4 days/week of blood glucose testing	56	55.45	55	67.90	60	60.61	52	54.74	223	59.31
Foot-care:[a] persons with ≥4 days/week of foot care	39	38.61	45	55.56	55	55.56	53	55.79	192	51.06

Characteristics of Participants	CDSMP only group *N* = 101		PDA only group *N* = 81		Combined group *N* = 99		Control group *N* = 95		All *N* = 376	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age (years)	56.39	10.76	57.73	10.76	57.73	10.29	58.51	11.89	57.56	10.92
Mean BMI (kg/m^2)	33.50	8.0	35.26	7.34	34.57	6.28	33.95	7.73	34.28	7.36
Healthy days index (HDI)	0.68	0.36	0.72	0.38	0.72	0.35	0.77	0.31	0.72	0.35
Diabetes duration (years)	3.07	2.66	2.70	1.83	3.33	2.59	3.27	2.48	3.11	2.43
HbA1c (%)	9.4	1.71	9.28	1.55	9.20	1.38	9.23	1.57	9.28	1.56
Time to ER (days)[a]	723.8	10.6	405.4	33.1	515.1	28.4	619.1	23.3	569.6	12.7
Time to hospital (days)[a]	729.1	9.5	458.7	29.9	524.0	27.3	659.9	21.8	585.5	13.5

[a] p = <0.05.

Table 2

Logistic regression for diabetes-related hospitalizations and ER visits.

	Hospitalization				ER visits			
	Odds ratio	**95% Confidence intervals**		***p*-value**	**Odds ratio**	**95% Confidence intervals**		***p*-value**
CDSMP	0.12	0.03	0.43	0.0010	0.05	0.01	0.21	<.001
PDA	3.20	1.64	6.23	0.0010	2.71	1.46	5.03	0.0020
COM	1.14	0.60	2.28	0.7050	1.19	0.65	2.20	0.5630
Control	Ref				Ref			

Table 3

Proportional Hazard model of time-to-hospitalization.

Parameter	Hazard ratio	95% Hazard ratio confidence limits		*p*-value
PDA	5.428	3.078	9.574	<.0001
CDSMP	0.100	0.023	0.438	0.0022
Combined PDA and CDSMP	2.793	1.578	4.945	0.0004
Males	1.077	0.701	1.654	0.7346
Hispanic	0.484	0.271	0.866	0.0145
Non-Hispanic Black	1.143	0.644	2.026	0.6484
Education >High School	0.550	0.354	0.853	0.0076
Diabetes duration	0.843	0.748	0.950	0.0050
Age	1.026	1.006	1.048	0.0130
HbA1c	1.204	1.053	1.376	0.0067
BMI	0.995	0.965	1.025	0.7347
>1 comorbid conditions	1.839	1.223	2.766	0.0034
Healthy Days Index	0.923	0.522	1.633	0.7835

Table 4

Proportional Hazard model of time-to-ER visits.

Parameter	Hazard ratio	95% Hazard ratio confidence limits		*p*-value
PDA	2.892	1.794	4.662	<.0001
CDSMP	0.115	0.040	0.333	<.0001
Combined PDA and CDSMP	1.890	1.162	3.075	0.0103
Males	1.003	0.683	1.475	0.9866
Hispanic	0.606	0.356	1.031	0.0648
Non-Hispanic Black	1.430	0.877	2.333	0.1516
Education >High School	0.803	0.533	1.210	0.2939
Diabetes duration	0.871	0.778	0.976	0.0175
Age	1.008	0.989	1.029	0.4098
HbA1c	1.122	0.990	1.272	0.0722
BMI	1.012	0.986	1.039	0.3732
>1 comorbid conditions	1.389	0.956	2.017	0.0846
Healthy Days Index	1.028	0.604	1.750	0.9199

Table 5

Comorbidities by intervention groups.

	CDSMP	PDA	Combined	Controls	*p*-value
Chronic heart failure	12 (12%)	13 (16%)	14 (14%)	11 (12%)	0.7980
Ischemic heart disease	29 (28%)	37 (46%)	49 (50%)	36 (38%)	0.0160
Renal failure	10 (10%)	12 (15%)	13 (13%)	7 (7%)	0.3890
Other cardiac conditions[a]	10 (10%)	14 (17%)	18 (19%)	13 (13%)	0.2770

[a]Includes stroke, myocardial infarction, and atrial fibrillation. Categories collapsed due to small cell sizes.