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Diabetes Treatments and Related Comorbidities as Factors Influencing Hospitalization: A Cross-Sectional Study

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Abstract

Diet modification, as well as oral medication, are good measures to manage Diabetes Mellitus (DM). Even so, there is limited study in this particular area. Specifically, few evaluated the association of the aforementioned treatments to hospitalization. Hence, this study investigates the influence of DM treatments and their related comorbidities on the odds of hospitalization. A retrospective, cross-sectional analysis was employed. Logistic regression was performed to assess the association between the DM patient treatment and the chance of hospitalization. This study utilized data from the Medical Expenditure Panel Survey (MEPS) in 2018 (n= 30,461), a program of the Agency for Healthcare Research and Quality (AHRQ). The results showed that after adjusting for potential confounders, DM patients who were treated with only dietary modification had 1.40 times the odds of being hospitalized compared to those treated with oral medications. However, there is an observed protective effect of the combined treatments (medication and diet), to around OR=0.69, 95% CI: 0.49-0.97, as compared to a single treatment. In addition, the presence of at least one comorbidity among DM patients could significantly double the odds for hospitalization (OR=2.54, CI: 1.15-5.60). It is recommended that the DM treatments should incorporate both oral medication and diet modification to reduce the odds of hospitalization among DM patients.

Keywords: dietary modification, oral medication, hospitalization, DM treatments, DM patients

INTRODUCTION

It is generally known that diabetic individuals are more likely to be hospitalized for any reason and experience significant health concerns because the disease is proven to be a catalyst for other health problems. A previous study indicated that hospitalization increased modestly with a longer duration of diabetes mellitus (DM), although the relationship was significant only in the older-onset group. When it comes to age, there was little association between age and hospitalization.

Hispanic DM patients had the highest percent of multiple hospitalizations, followed by non-Hispanic blacks and non-Hispanic whites. Moreover, studies on smoking status and alcohol consumption found inconsistent results if those factors were related to hospitalization [1-3]. Although men, in general, were more likely to be hospitalized, women were more likely to be hospitalized for a diabetes-related cause. In addition, the presence of major comorbidities among DM patients, especially of the liver and kidney, are factors associated with all-cause hospitalization [4]. Obesity was associated with hospitalization for participants with diabetes [3].

Proper testing, treatment and lifestyle changes, healthy eating as a strategy, promote walking, exercise, and other physical activities have beneficial effects on human health and prevention or treatment of diabetes [5]. It is also proven that through diet management, elevated hemoglobin A1c (HbA1c) levels can be improved; thus, the patients could be prevented from developing diabetes complications [6]. However, medication is also needed to achieve the state of glycemic control [7]. Conducting this present study possibly adds to more knowledge on the effects of oral medications and diet modification on hospital admission since there was a lack of studies on these issues.

It is evident that people with DM have a higher risk of encountering neurological, cardiovascular, renal, and ophthalmic problems compared to people without diabetes [8]. In 2019, there were approximately 463 million people with diabetes globally. Further, the International Diabetes Federation (IDF) has forecasted that by 2030 and 2045, there will be 578 million and 700 million diabetes cases in the world, respectively, or a 51% increase. In North America and the Caribbean Region, there were approximately 48 million people that were living with diabetes DM in 2019. One in every six adults is at risk of type 2 DM. Moreover, it was estimated that there would be 63 million diabetes cases, or a 33% increase in the following years [9].

People with DM in the US are able to choose their preferred treatment according to the advice of doctors. In the Medical Expenditure Panel Survey (MEPS)(https://www.meps.ahrq.gov/) database, diet modification is one of the recommended treatments for patients with DM. To our knowledge, we could not find evidence about using diet modification as a single treatment for DM patients in other countries around the globe. However, it is generally known that dietary modification is an essential component for diabetes care to control the blood sugar level, complications, and progression, which might possibly lead to a lower risk of hospital admission. In this study, oral medication is the main treatment for DM patients.

Diet modification, as well as oral medication, are good measures to manage DM. Even so, there is limited study in this particular area. Specifically, few evaluated the association of the aforementioned treatments to hospitalization. Hence, this study explores the effect of diabetes care management and other health determinants on hospitalization in a large sample across the United States. Furthermore, we assessed how hospitalization varies across the different DM treatment procedures, considering the presence of the other DM health determinants.

METHODOLOGY

Data sources and selection criteria

We analyzed data from the MEPS in 2018 (n= 30,461), a program of the Agency for Healthcare Research and Quality (AHRQ). MEPS is a set of comprehensive surveys that provides national estimates of healthcare use, expenditures, payments, and insurance coverage. It collects information from individual households, medical providers, and employers in the USA. Data were

collected in an overlapping panel design, with respondents undergoing five rounds of interviews in a two-calendar year period.

There are three main components to MEPS: The Household Component (HC), Medical Provider Component, and Insurance Component. The MEPS HC includes data from household respondents with additional information supplemented from the Medical Provider Component. The HC provides person-level data on the demographics, health conditions, health status, and healthcare use for a representative sample of the non-institutionalized civilian population. Each event in the file represents a unique household-reported medical event, and details such as date of visit, type of care, and condition codes are provided. In addition, we accessed data from the Diabetes Care Survey (DCS), one of the five HC supplemental paper questionnaires provided to respondents with a self-reported diagnosis of DM.

From this study, we excluded admissions from individuals aged younger than 18 years old and DM patients who don't use any treatment procedures (e.g., oral medicine and diet modification). Also, to secure the temporality in this study, we excluded patients with DM duration in zero value *(n=2)*, as we couldn't perceive if the risk factor preceded the outcome. In addition, we make an assumption that patients diagnosed with DM should have their choice treatment following ahead the diagnosis for them to sustain their health, which could define the temporality of this study as samples included where patients with more than 1-year DM duration. The final sample contained 1,805 DM patients.

Study design and definitions

We performed a retrospective, cross-sectional analysis of DM patients with varying treatments and health determinants to identify the odds of hospitalization in 2018. In the MEPS interviews, survey respondents' health conditions were coded using the Clinical Classification Software (CCS) codes. DCS was used to gather individuals with DM as identified with CCS code 049 or 050 who use different treatment procedures coded as DSMED53 for medication and DSDIET53 for diet modification. The main outcome, which is hospitalization, was gathered using the MEPS HC coded as IPDIS18. Also, using this questionnaire where demographic characteristics, comorbidities, and other health determinants were extracted. Also, specific comorbidities were asked in the DC questionnaire, like complications in the eye and kidney. Other related diseases like cancer were also extracted from the Cancer Self-Administered Questionnaire (CSAQ). Adults aged 18 years and older were included in the study. Individuals with DM were identified as those with a CCS code 049 or 050.

Data and statistical analysis

We characterized DM patients' treatment by sex, age, education status, race, and health determinants and estimated its proportion of hospitalization using the chi-square test and one-way ANOVA. Logistic regression was performed to assess the association between the DM patient treatment and the chance of hospitalization. In this baseline model (model 1), simple logistic regression will be employed to analyze the focal relationship. For the second model (model 2), we employ the multiple logistic regression where we estimate the risk for hospitalization by DM treatment adjusted for the demographic characteristics (sex, age group, educational status, and race). For the third model (model 3), we analyze the focal relationship after adjusting for the health determinants (DM duration, BMI, comorbidities, smoking status, and alcohol behavior). Statistical

analyses were performed using SPSS software version 24.0. A level of significance < 0.05 for a 95% confidence interval was defined.

RESULTS

The data represented DM patients who had been using DM treatments and hospitalized, around 16.45%, as compared to those not hospitalized, around 83.55%, among the US population in 2018. Table 1 illustrates the distribution of characteristics of the DM patients by treatment groups, and there are more patients who used combined treatment (medication and diet modification) for their diabetes disease, around 1,088 (63.93%), as compared to treatment alone. Also, DM treatment was almost equally distributed by sex. In terms of age, most DM patients were above 60 across treatment groups. However, most of them were attained undergraduate, around 876 (60.63%). Another, the most DM patients were distributed among the white race, around 1,219 (71.60%). In addition, the average duration of their diabetes condition was around 13 years, and almost all patients have comorbidities, around 1,543 (92.80%). Surprisingly, around 222 (13.05%) were smokers, but more than half of the DM patients were alcohol drinkers, around 889 (53.27%).

Different models were presented in Table 2, wherein Model 1 shows the direct association of DM treatment and risk for hospitalization. In where, treatment by diet modification alone shows that it could significantly increase the risk for hospitalization among DM patients, around 45.00%, as compared to medication alone. On the other hand, the combination of both treatments could have a significant protective effect, in contrast to any single DM treatment. Also, if we compare the risk for hospitalization between sex, female patients have a higher risk (OR=1.21, 95% CI: 0.94 - 1.58) than male patients. Age also has a significant factor that affects the direct risk for hospitalization among DM patients (0R=1.02, 95% CI: 1.01 - 1.03). It is expected that the longer duration for diabetes disease has a significant association with hospitalization (0R=1.02, 95% CI: 1.01 - 1.04). However, the highest risk that we could notice to affect the hospitalization outcome was the presence of any single DM comorbidities, accounting for odds of around 232.00%. In contrast, the direct association of being overweight and underweight shows no effect on the risk of being hospitalized when compared to normal weights, 0R=0.72, 95% CI: 0.39 - 1.31 and 0R=0.92, 95% CI: 0.62-1.38, respectively. Other health behavior like alcohol consumption could still notice to increase the chance for hospitalization, 0R=1.27% CI: 0.98 - 1.64. In contrast, smoking has been observed as not associated with hospitalization, but it is not significant (0R=0.98, 95% CI: 0.67 - 1.44). While in model 2, after adjusting for the demographic profile of the DM patients, only the age factor has a significant effect on a higher risk of being hospitalized (0R=1.02, 95% CI: 1.01 - 1.03). Additionally, females could have a higher chance for risk of hospitalization, around 23.00% as compared to males. Also, it was observed that being a non-white race could be a protective factor to hospitalization (OR=0.71, 95% CI: 0.70 - 1.27). The consistent result had been found out on the association of DM treatments and hospitalization in model 3, after adjusting health determinants and demographic profile as other factors for hospitalization. The most observed factor with a significant effect on hospitalization was the presence of any single comorbidities for DM patients, where risk could be around 154.00%, compared to those without any comorbidity. Another risk for hospitalization significantly increases by the longer duration of having DM (OR=1.02, 95% CI: 1.01 - 1.03). Also, a significant change in the odds of being hospitalized was noticed among alcohol drinkers compared to non-drinkers, OR=1.33, 95% CI: 1.01- 1.76. Other health determinants like overweight health status and smoking behavior could also increase the risk for hospitalization, OR=1.04, 95% CI: 0.70 - 1.57 and OR=1.104, 95% CI: 0.70 - 1.57, respectively. However, a marginally significant finding could be observed between

these factors. In contrast to the increased risk of hospitalization, it has been observed that the low BMI status could be a protective factor for being hospitalized as compared to those having normal BMI status (OR=0.88, 95% CI: 0.46 – 1.70).

Table 1: Characteristics of the DM patients by treatment groups (n=1,702)

	Diabetes Mellitus (DM) Treatments			P-value
	Medication	**Diet Modification**	**Combination**	
Total Number (%)	333 (19.68)	279 (16.39)	1,088 (63.93)	
Sex (%)				
Female	170 (50.71)	165 (59.14)	568 (52.21)	0.075†
Age (years)	64.77 (11.49)	62.15 (14.47)	63.475 (12.25)	0.035‡
Education Status (%)				
No Degree	65 (19.58)	54 (19.49)	224 (20.65)	0.103†
Undergraduate	215 (64.76)	163 (58.84)	662 (61.01)	
Graduate	14 (4.22)	29 (10.47)	93 (8.57)	
Other Degree	38 (11.44)	31 (11.19)	106 (9.77)	
Race (%)				
White	235 (70.15)	201 (72.043)	783 (71.97)	0.800†
DM Duration	12.50 (9.61)	13.30 (10.23)	12.17 (9.39)	0.198‡
BMI (%)				
Normal	38 (11.34)	37 (13.261)	111 (10.20)	0.594†
Underweight	29 (8.66)	27 (9.68)	93 (8.55)	
Overweight	268 (80.00)	215 (77.06)	844 (81.25)	
Comorbidities (%)	306 (94.44)	252 (92.65)	985 (92.40)	0.454†
Smoker (%)	52 (15.52)	38 (13.67)	132 (12.13)	0.258†
Alcohol Drinker (%)	155 (47.26)	150 (54.95)	584 (54.68)	0.052†
Hospitalization (%)	62 (18.51)	69 (24.73)	149 (13.69)	<0.001†

Note: Data presented in Mean (SD), frequency (%);
†Chi- square test, ‡One-way ANOVA

Table 2: Analysis for the association of the Different Treatments for DM and Hospitalization in a Complete-case Analysis

		Model 1[a]	Model 2[b]	Model 3[c]
		OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Treatments	Medicine	1	1	1
	Diet Modification	1.45 (0.98 - 2.13)	1.45 (0.98 – 2.14)	1.40 (0.91 - 2.06)
	Combination	0.70* (0.51 – 0.97)	0.69* (0.50 – 0.96)	0.69* (0.49 – 0.97)
Sex	Male	1	1	1
	Female	1.21 (0.94 – 1.58)	1.23 (0.95 - 1.609)	1.26 (0.96 - 1.65)
Age		1.02*(1.01 – 1.03)	1.02* (1.01 - 1.03)	1.01 (1.01 - 1.02)
Education	No degree	1	1	1
	Undergraduate	0.83 (0.60 – 1.15)	0.85 (0.62 - 1.18)	0.79 (0.56 - 1.11)
	Graduate	1.10 (0.67 – 1.82)	1.12 (0.67 - 1.87)	1.06 (0.62 - 1.80)
	Other Degree	0.78 (0.47 – 1.28(	0.80 (0.48 - 1.33)	0.75 (0.44 - 1.27)
Race	White	1	1	1
	Non-White	0.91 (0.68 – 1.21)	0.71 (0.702 - 1.27)	0.95 (0.70 - 1.28)
DM Duration		1.02* (1.01 – 1.04)	—	1.02* (1.01 - 1.03)
BMI	Normal	1	—	1
	Underweight	0.72 (0.39 – 1.31)	—	0.88 (0.46 - 1.70)
	Overweight/Obese	0.92 (0.62 – 1.38)	—	1.06 (0.69 - 1.63)
Comorbidities	No	1	—	1
	Yes	3.32* (1.53 – 7.20)	—	2.54* (1.15 - 5.60)
Smoking Status	Non-Smoker	1	—	1
	Smoker	0.98 (067 = 1.44)	—	1.04 (0.70 - 1.57)
Alcohol Drinker	Non-Drinker	1	—	1
	Drinker	1.27 (0.98 = 1.64)	—	1.33* (1.01 - 1.76)

*Note: Robust standard errors in parentheses: *<0.005*

[a]*Model 1. Logistic regression on the focal relation of DM treatment and hospitalization*

[b]*Model 2: Multivariable logistic Regression on the first model adjusted for the demographic characteristics (Basic adjusted for sex, age, education, and race).*

[c]*Model 3. Multivariable logistic regression on the second model adjusted for the health determinants (full adjusted for sex, age, education, race, DM duration, BMI, comorbidities, smoking status, and alcohol consumption).*

DISCUSSION

Our observations affirm that when comparing oral medication and diet modification treatment among DM patients, diet modification alone can increase the risk of hospitalization. Aligned with our study result, single treatment could have a higher risk for hospitalization among Type II DM patients, where oral medication could be a factor for hospital admission [10]. It was expected in this study that diet modification could lower the risk for hospitalization, as the medical nutrition therapy (MNT) management of hyperglycemia in hospitalized patients with diabetes could optimize glycemic control to provide adequate calories to meet metabolic demands, which we conclude to reduce the risk for any other complications that might result to hospitalization [11].

However, the result shows that diet modification alone as DM treatment to the hospitalization shows the opposite. Nonetheless, the result was not statistically significant. Furthermore, when diet modification and oral medication are combined, it could be a protective factor against DM patients' risk for hospitalization. This means that a combination of the two treatments can decrease the chance of hospitalization.

There is a plausible explanation for the increased risk of single treatment alone, as compared to combined DM treatments. Some non-insulin glucose-lowering agents, which are medication by mouth, like Metformin, have different side effects, where there is any evidence of dehydration or renal impairment. Thiazolidinedione is excellent at lowering glucose, but they take several weeks to reach their maximum effect, may precipitate heart failure, and may cause peripheral edema due to fluid retention [12]. With these drugs' side effects, oral medication alone could explain the increased risk for hospitalization. For diet modification among patients with diabetes, receiving enteral nutrition and the use of a formula with a lower glycaemic index is recommended [13]. In the follow-up of the Da Qing Diabetes Prevention Study, they also demonstrated that diet modification as DM treatment could have a reduction in cardiovascular disease, which might increase the risk for hospitalization and all-cause mortality [14]. With all the evidence about DM treatment's positive effect to avoid health complications and the chance of being admitted to hospital, there are still possible explanations that could influence diet modification as DM treatment alone elevates the risk for hospitalization. One of them is the non-adherence to dietary recommendations among DM patients. Socioeconomic status, duration of disease, lack of diabetes knowledge, cost of a healthy diet, and poor communication with healthcare providers could be the possible reasons for non-adherence to diet modification as DM treatment [15-18]. In addition, in this study, we have found a high association between the presence of comorbidity among DM patients and hospitalization. A study conducted in Ethiopia explained that patients with comorbidity are often on complex medication regimens as well as complex dietary recommendations. Therefore, providing adequate information on the benefit of dietary adherence for patients with diabetes with a special focus on patients with comorbidities could also be another factor to consider in DM medication, especially among those using a dietary treatment for diabetes [19].

The recommendation for combined treatment is important to prevent DM from becoming more severe. One medicine alone is not always enough to keep blood glucose levels within the targeted range. For people with diabetes, it is often harder to manage blood glucose levels over time, where a combination of medication and diet modification therapy may improve more effective results among DM patients' health conditions. In the general dietary guidelines for DM patients treated with insulin or certain oral hypoglycemic agents, a proper diet modification plan should be integrated to avoid other health complications. [5, 20]

To our knowledge, there are no studies comparing oral medication and diet modification treatment among DM patients and the risk for hospitalization. Some studies also suggest future scrutiny on the relationship of the aforementioned topic [1, 2]. As MEPS is gathered among the non-institutionalized civilian population, we can generalize the findings of this study to the US population. In addition, this study is able to address the treatment by diet modification alone, as in the US, the use of this treatment as an alternative to mouth medication to support lifestyle medicine is recommended [21, 22]. However, there are several limitations to our study. First, the MEPS dataset did not differentiate the DM classifications, Type I or Type II, which means that it is not possible to explore whether a certain type of diabetes is an important predictor for hospitalization and where different types of DM classifications have different treatment procedures and effects. Regarding

the related comorbidities of DM, there might be other confounding comorbidities that could be included in this study (e.g., sepsis, ketoacidosis, and others), but the lack of addition related to the disease variables was an issue due to the use of a secondary dataset. Additionally, adherence to the drugs and even to the diet were not measured in this study as it might limit the actual effect of DM treatment to the risk of being hospitalized. Lastly, the limitation to probable reverse causation and length to follow-up were minimized through treating the DM duration to produce a temporal relationship of DM treatments and hospitalization. Patients with a history of at least a year of DM were included, where it can be assumed that after diagnosed, a specific treatment was recommended by health practitioners. As this study is a cross-sectional design gathered in 2018, patients with an extended case duration of the disease may have been hospitalized prior to the study period. Thus, we are not able to account for the specific treatment they used within the DM duration.

CONCLUSION

In this study, we recommend that health practitioners who manage the DM treatment plan should incorporate a combination of oral medication and diet modification to reduce hospitalization among DM patients. Also, a well-defined and multilevel decision plan for diet therapy should be implemented by the health providers, where a DM patient could adhere to the provided treatment plan. In addition, patients with comorbidity are often on complex medication regimens as well as complex dietary recommendations. Therefore, providing adequate information on the benefit of diet and oral medication adherence for patients with diabetes with a special focus on patients with comorbidities is an important approach.

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