Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy

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ORIGINAL RESEARCH

Health outcomes in diabetics measured with Minnesota Community Measurement quality metrics

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Objective: Our objective was to understand the relationship between optimal diabetes control, as defined by Minnesota Community Measurement (MCM), and adverse health outcomes including emergency department (ED) visits, hospitalizations, 30-day rehospitalization, intensive care unit (ICU) stay, and mortality.

Patients and methods: In 2009, we conducted a retrospective cohort study of empaneled Employee and Community Health patients with diabetes mellitus. We followed patients from 1 September 2009 until 30 June 2011 for hospitalization and until 5 January 2014 for mortality. Optimal control of diabetes mellitus was defined as achieving the following three measures: low-density lipoprotein (LDL) cholesterol <100 mg/mL, blood pressure <140/90 mmHg, and hemoglobin A_{1c} <8%. Using the electronic medical record, we assessed hospitalizations, ED visits, ICU stays, 30-day rehospitalizations, and mortality. The chi-square or Wilcoxon rank-sum tests were used to compare those with and without optimal control. We used Cox proportional hazard models to estimate the associations between optimal diabetes mellitus status and each outcome.

Results: We identified 5,731 empaneled patients with diabetes mellitus; 2,842 (49.6%) were in the optimal control category. After adjustment, we observed that non-optimally controlled patients had higher risks for hospitalization (hazard ratio [HR] 1.11; 95% confidence interval [CI] 1.00–1.23), ED visits (HR 1.15; 95% CI 1.06–1.25), and mortality (HR 1.29; 95% CI 1.09–1.53) than diabetic patients with optimal control. No differences were observed in ICU stay or 30-day rehospitalization.

Conclusion: Diabetic patients without optimal control had higher risks of adverse health outcomes than those with optimal control. Patients with optimal control defined by the MCM were associated with decreased morbidity and mortality.

Keywords: case management, diabetes mellitus, hyperlipidemia, hypertension

Introduction

Diabetes mellitus affects the lives of approximately 21 million people in the USA.[1] Patients with diabetes mellitus suffer risks of adverse outcomes, including hospitalization and emergency department (ED) visits.[2] Diabetes mellitus is a risk factor for atherosclerosis, and most treatment plans for diabetes emphasize prevention of future atherosclerosis.[3] In addition to vascular risks, diabetes mellitus has also been associated with fracture-related hospitalization.[4] Available evidence suggests that poorly controlled diabetics have higher hospital costs than diabetics with optimal control.[5] Health care organizations prioritize proper glycemic control and adequate management of vascular risks in diabetics as a means to help lower health care costs and improve health care outcomes.

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Minnesota reports five quality metrics in diabetic patients through the Minnesota Community Measurement (MCM) project.[6] Outcomes by health care institutions are publically available and reported nationally to consumers.[7] The five measurements of the MCM project are hemoglobin A_{1c} (hereafter, A_{1c}) <8%, blood pressure (BP) <140/90 mmHg, low-density lipoprotein (LDL) cholesterol <100 mg/mL, aspirin use, and tobacco cessation. These factors are combined to reflect optimal control of diabetes and are widely used to grade the quality of diabetes care within the health system. With this emphasis on population health management for diabetic patients, the Employee and Community Health (ECH) primary care practice at the Mayo Clinic has engaged in diabetes mellitus care management to improve the vascular risk factors of A_{1c}, LDL cholesterol, and BP. In a study of nurse managers working to improve LDL control, LDL levels and costs decreased with care management; however, the authors noted no change in hospitalizations.[8]

With heightened emphasis on diabetes-related population health, health care organizations are increasingly concerned about health outcomes. Health outcomes associated with adequate control of diabetes mellitus are often reported on surrogate biological markers like glucose control (A_{1c}),[9] BP,[10] and LDL cholesterol. However, most clinicians and patients are more concerned about mortality and hospitalization. Aggressive combination therapy with statins and fenofibrate to control lipids has not been shown to improve combined cardiovascular outcomes.[11] In over 20,000 diabetics with chronic kidney disease, higher and lower A_{1c} levels were associated with increased mortality.[12] Despite the widespread reporting of a single metric for diabetic care in Minnesota, we do not fully understand the association between optimal diabetic care and health outcomes.

We sought to understand the relationship between optimal control of diabetic risk factors (A_{1c}, LDL cholesterol, BP) and adverse health outcomes of hospitalizations, 30-day rehospitalizations, intensive care unit (ICU) stays, ED visits, and mortality. The combined factor as a single measure was chosen because it reflects the publically reported measure of diabetic care quality for Minnesota health systems. As secondary outcomes, we performed subgroup analysis by sex and also stratified control of diabetes mellitus into complete control and control of zero, one, and two risk factors.

Methods

Design

We conducted a retrospective cohort study. The study was approved by the Mayo Clinic Institutional Review Board.

Setting

The study was conducted with patients empaneled within the ECH primary care practice. The ECH primary care practice involves four sites (downtown Rochester, Minnesota; suburban clinics in NE and NW Rochester, Minnesota; and rural Kasson, Minnesota). All patients within the ECH have an assigned primary care provider (physician, nurse practitioner, or physician's assistant) and have an assigned primary care team. The ECH is a primary care practice within the Mayo Clinic in Rochester. Of the ECH population, 52% have insurance through the Mayo Clinic and thus have a financial incentive to receive care within the Mayo system. The Mayo Clinic is an integrated, multispecialty group practice with a common electronic medical record (EMR) that allows tracking of laboratory results, diagnosis, and hospitalization. We reviewed the records of empaneled patients from September 2007 to September 2011. The index date for development of the cohort was 1 September 2009. The administrative record was evaluated for 2 years prior (September 2007) to calculate the Charlson index[13] and determine diabetes mellitus status. The hospital outcomes were determined between 1 September 2009 and 30 June 2011. Mortality was determined between 1 September 2009 and 5 January 2014.

Participants

All patients were 18 years of age or older and empaneled in the ECH primary care practice. Each patient was determined to have a clinical diagnosis of type 2 diabetes mellitus by their primary care provider by the index date. Determination of diabetes mellitus status was based on International Classification of Diseases, 9th edition (*ICD*-9) codes. Patients were excluded if they did not give research authorization for medical record review. Patients were also excluded if they did not have LDL cholesterol, A_{1c}, or BP measures within calendar year 2009.

Outcome variables

Primary outcome variables included hospitalizations, 30-day rehospitalizations, ICU stays, ED visits, and mortality. Hospitalization after index date for development of the cohort was determined via billed inpatient hospitalization. The 30-day rehospitalization outcome was determined through identification of a second hospitalization for any cause within 30 days of the dismissal date for the initial hospitalization. ED visits were defined as any visits to the ED including visits resulting in hospitalization. ICU utilization was defined as admission to any ICU (surgical, medical, cardiac, neurology).

The above health care outcomes were based on hospital billing records from the EMR. Mortality was determined using the EMR, which captures the date of death in hospital or local care facilities. In addition, the EMR is updated using local news outlets to determine mortality.

Predictor variables

The primary predictor variables were optimal control of LDL cholesterol, BP, and A_{1c}. LDL cholesterol was categorized as <100 mg/mL versus ≥100 mg/mL. BP was categorized as <140/90 mmHg versus ≥140/90 mmHg. A_{1c} was categorized as <8% versus ≥8%. Patients were categorized as achieving optimal control when they met the following criteria: BP <140/90 mmHg, A_{1c} <8%, and LDL cholesterol <100 mg/mL. Patients who did not meet all criteria were considered non-optimally controlled. Categorization was based on final LDL cholesterol, BP, and A_{1c} closest to the index date. Demographic variables, including age and sex were obtained from the EMR. We also reported the Charlson index as a measure of comorbid health conditions.[13] The Charlson index is used to predict adverse health outcomes based upon weighted comorbid health conditions. It includes heart disease, renal disease, and diabetes mellitus, among other comorbid health conditions, and has been validated as a measure to predict mortality[14] and other adverse health outcomes.[15] We used administrative data from the EMR to construct the Charlson index. The score was calculated using ICD-9 codes from prior to the index date.

Statistical analysis

Descriptive characteristics of the 2009 diabetic cohort were presented overall and by optimal vs non-optimal control of LDL cholesterol, BP, and A_{1c}. Chi-square (categorical variables) or Wilcoxon rank-sum (continuous variables) tests were used to compare those with and without optimal control.

Separate analyses were conducted for each outcome (hospitalization, 30-day rehospitalization, ED visit, ICU stay, and mortality). Rehospitalization within 30 days was limited to those who had at least one hospitalization. For each analysis, follow-up was from the index date until the first occurrence of the given outcome. Date of mortality or date of last follow-up was used when assessing risk of mortality. Participants were defined as either in optimal control or not in optimal control at the start of the study based upon BP, LDL cholesterol, and A_{1c} closest to index date. Cox proportional hazard models were used to estimate the associations between optimal control of diabetes mellitus and each of the outcomes. They are presented as hazard ratios (HRs) and their associated 95% confidence intervals (CIs). Multivariable models were used to adjust for potential confounders, including age, sex, and Charlson index. To assess potential interactions between diabetic control and sex, Cox proportional hazard models were stratified by sex. To assess a potential dose response, additional models were used to estimate the association of number of factors under control with each outcome.

All analyses were performed using SAS version 9.2 (SAS Institute, Inc., Cary, NC, USA), and a P value of <0.05 was considered significant.

Results

We initially found 7,050 patients with diabetes mellitus; 5,731 (81.3%) had complete LDL cholesterol, A_{1c}, and BP information. The average age in the cohort was 64.5 years (±13.9). In the cohort, 2,842 patients (49.6%) were considered optimally controlled. In the unadjusted analysis, we observed that optimally controlled patients were more likely to be older, male, and have a higher Charlson index (more comorbidity) and were less likely to have an ED visit (Table 1).

In the models adjusting for age, sex, and Charlson index, non-optimally controlled diabetics had a higher risk of mortality (HR 1.29; 95% CI 1.09–1.53) than optimally controlled diabetics (Table 2). Non-optimally controlled diabetics also had a higher risk for ED visits (HR 1.15; 95% CI 1.06–1.25) and hospitalizations (HR 1.11; 95% CI 1.00–1.23) than those optimally controlled. No differences were observed between groups for ICU stays and 30-day rehospitalizations.

In subgroup analyses stratified by sex, risk for ED visits was significantly higher in both men and women with non-optimally controlled diabetes mellitus than in those with optimal control (Table 3). For mortality, only men with non-optimal diabetic control had a higher risk for mortality (HR 1.34; 95% CI 1.07–1.67).

We observed that the risk of adverse health outcomes increased as the number of factors under control decreased (Table 4). Patients with one controlled risk factor suffered higher mortality than those with three controlled factors (HR 1.85; 95% CI 1.43–2.38). A 37% (95% CI 2–83) increased risk of an ED visit was observed among patients with zero or one controlled diabetic factor compared with those with optimal control. The risk for ICU stays was higher among patients with zero controlled factors than among those with optimal control (HR 2.47; 95% CI 1.43–4.28). The risk of hospitalization also increased among patients with fewer controlled diabetic risk factors.

Table 1 Characteristics of 5,731 diabetics in 2009, overall, and by optimal control status[a]

Characteristic	Population 7,050 n=5,731 (81.3%)	Non-optimal control n=2,889	Optimal control n=2,842	*P*-value[b]
Age (years), mean (SD)	64.5 (13.9)	62.6 (14.5)	66.4 (13.0)	<0.001
Age (years)				<0.001
<75	4,311 (75.2)	2,266 (78.4)	2,045 (72.0)	
≥75	1,420 (24.8)	623 (21.6)	797 (28.0)	
Sex				<0.001
Women	2,623 (45.8)	1,424 (49.3)	1,199 (42.2)	
Men	3,108 (54.2)	1,465 (50.7)	1,643 (57.8)	
Charlson index, mean (SD)	4.5 (3.2)	4.4 (3.2)	4.6 (3.2)	0.002
Diabetic control measures, median (IQR)				
LDL cholesterol (mg/mL)	84 (68, 102)	102 (77, 119)	76 (64, 87)	<0.001
SBP (mmHg)	124 (114, 134)	129 (118, 144)	120 (112, 128)	<0.001
DBP (mmHg)	70 (62, 77)	72 (65, 80)	68 (60, 74)	<0.001
Hemoglobin A_{1c} (%)	6.9 (6.3, 7.7)	7.3 (6.4, 8.4)	6.7 (6.2, 7.2)	<0.001
Diabetic control measures				
LDL cholesterol <100 mg/mL	4,168 (72.7)	1,326 (45.9)	2,842 (100.0)	<0.001
BP <140/90 mm/Hg	4,645 (81.1)	1,803 (62.4)	2,842 (100.0)	<0.001
Hemoglobin A_{1c} <8%	4,623 (80.7)	1,781 (61.6)	2,842 (100.0)	<0.001
No of measures under control				<0.001
0	100 (1.7)	100 (3.5)	0 (0.0)	
1	668 (11.7)	668 (23.1)	0 (0.0)	
2	2,121 (37.0)	2,121 (73.4)	0 (0.0)	
3	2,842 (49.6)	0 (0.0)	2,842 (100.0)	
ED visit	2,240 (39.1)	1,187 (41.1)	1,053 (37.1)	0.002
ED visits				0.002
0	3,491 (60.9)	1,702 (58.9)	1,789 (62.9)	
1–2	1,638 (28.6)	851 (29.5)	787 (27.7)	
≥3	602 (10.5)	336 (11.6)	266 (9.4)	
Hospitalization	1,529 (26.7)	790 (27.3)	739 (26.0)	0.25
No of hospitalizations				0.45
0	4,202 (73.3)	2,099 (72.7)	2,103 (74.0)	
1	867 (15.1)	453 (15.7)	414 (14.6)	
≥2	662 (11.6)	337 (11.7)	325 (11.4)	
30-day rehospitalization[c]	211 (13.8)	109 (13.8)	102 (13.8)	0.99
ICU stay	403 (7.0)	215 (7.4)	188 (6.6)	0.22
No of ICU stays				0.09
0	5,328 (93.0)	2,674 (92.6)	2,654 (93.4)	
1–2	366 (6.4)	190 (6.6)	176 (6.2)	
≥3	37 (0.6)	25 (0.9)	12 (0.4)	
Mortality	540 (9.4)	275 (9.5)	265 (9.3)	0.80

Notes: Data are presented as n (%) unless otherwise indicated. [a]Optimal control includes presence of all three measures at baseline: LDL cholesterol <100 mg/mL, hemoglobin A_{1c} <8%, and blood pressure <140/90 mm/Hg; [b]*P* value from chi-square (categorical variables) or Wilcoxon rank-sum (continuous variables) tests; [c]defined as a rehospitalization within 30 days following the first hospitalization that occurs after 9/1/2009; limited to those who had at least one hospitalization.

Abbreviations: BP, blood pressure; DBP, diastolic blood pressure; ED, emergency department; ICU, intensive care unit; IQR, interquartile range; LDL, low-density lipoprotein; SBP, systolic blood pressure; SD, standard deviation.

Discussion

In this retrospective cohort study of patients with diabetes mellitus, we observed that patients with non-optimal control of LDL cholesterol, BP, and A_{1c} (as defined by MCM) had higher adjusted rates of ED visits, hospitalizations, and mortality than those with optimal control. We found that, as the number of optimized factors increased, the risk of ED visit, hospitalization, ICU stay, and mortality decreased. In a population of 608 diabetics, higher A_{1c} levels were associated with higher risk of heart failure admissions.[16] In another study of 4,704 patients with diabetes in the UK, higher A_{1c} was associated with higher all-cause hospitalization.[17] Our findings demonstrate the relationship between reportable diabetic quality measures and adverse health outcomes. This study is unique because it looked at the association between aggregate quality metrics, which is

Table 2 Risk of health outcomes[a] among patients with non-optimal control of diabetes mellitus compared with patients with optimal control (referent)

Outcome	Unadjusted		Adjusted[b]	
	HR (95% CI)	*P*-value	HR (95% CI)	*P*-value
ED visit	1.16 (1.07–1.26)	<0.001	1.15 (1.06–1.25)	<0.001
Hospitalization	1.07 (0.97–1.18)	0.18	1.11 (1.00–1.23)	0.04
30-day rehospitalization[c]	1.02 (0.78–1.34)	0.88	1.03 (0.78–1.36)	0.83
ICU stay	1.13 (0.93–1.38)	0.21	1.19 (0.97–1.45)	0.09
Mortality	1.05 (0.89–1.25)	0.55	1.29 (1.09–1.53)	0.003

Notes: [a]Risk was estimated from Cox proportional hazard models comparing those with non-optimal control with those with optimal control (referent group); [b]adjusted for age, sex, and Charlson index; [c]defined as a rehospitalization within 30 days following the first hospitalization that occurs after 9/1/2009; limited to those who had at least one hospitalization.
Abbreviations: CI, confidence interval; ED, emergency department; HR, hazard ratio; ICU, intensive care unit.

the public reporting mechanism for Minnesota and health outcomes.

The higher risk for mortality in patients with non-optimal control of diabetes mellitus observed in our data is consistent with literature demonstrating reduced mortality in diabetic patients with better control of BP, A_{1c}, and LDL cholesterol. For example, in a previous life table analysis evaluating type 2 diabetics, keeping other factors constant, increases in A_{1c}, BP, and LDL cholesterol were associated with decreased life expectancy.[18] Furthermore, treatment of individual components of diabetes, (eg, hypertension) has resulted in 14% lower mortality in clinical trials of antihypertensives.[19] In studies in diabetics with hyperlipidemia, higher LDL has been associated with higher mortality.[20] In our analyses, we observed sex differences wherein higher mortality occurred in men with non-optimally controlled diabetes than in men with optimally controlled diabetes. We are uncertain of the potential etiology for this finding; however, marital status is a potential confounder that could affect both diabetic control and mortality. In previous studies, similar rates of cardiovascular mortality have been documented for men and women.[21]

We also observed that non-optimal control of diabetic risk factors was associated with higher risk for ED visits. Patients with poorer glycemic control have been observed to have higher rates for ED visits and health care utilization.[22] The potential connection between non-optimal diabetic control and ED visits could involve either microvascular or macrovascular complications. Hyperglycemia and higher BP place diabetics at increased risk of both microvascular and macrovascular complications.[23] This increase in macrovascular complications from non-optimal control of diabetes mellitus could place a patient at higher risk for ED visits.[24] Another potential explanation for this finding could relate to the use and misuse of diabetic medications. Diabetic medications have been associated with higher emergency hospitalizations.[25]

In our study, non-optimally controlled patients had a marginally significant (P=0.04) 11% increased risk of hospitalization than those with optimal control. Furthermore, the fewer controlled risk factors, the higher the risk of hospitalization compared with optimal control. Higher A_{1c} levels in patients with type 2 diabetes mellitus have been associated with higher risks of hospitalization.[17] The goal of a BP <140/90 mmHg has been subjected to extensive review by the Eighth Joint National Committee (JNC 8), and their recommendations on BP goals of <140/90 mmHg were based on expert opinion.[26] Action to Control Cardiovascular Risk in Diabetes (ACCORD) Blood Pressure trial did not show improvement in combined cardiovascular outcomes with intensive BP control.[27] Experts are starting to shift recommendations for LDL cholesterol from the Adult Treatment Panel (ATP)-4 from a treat-to-target LDL cholesterol to a treat-with-statin protocol based on risk.[28] Ultimately, the guidelines from ATP 4 and JNC 8 for LDL cholesterol and BP management reveal the lack of solid evidence that treating to a target BP <140/90 mmHg and LDL cholesterol <100 mg/mL can reduce certain outcomes, like hospitalization. Our findings provide some evidence that maintaining target BP, A_{1c}, and LDL cholesterol is associated with a decreased

Table 3 Adjusted[a] risk of health outcomes among men and women with non-optimal control of diabetes mellitus compared with patients with optimal control (referent)

Outcome	Men			Women		
	No (%)	HR (95% CI)	*P*-value	No (%)	HR (95% CI)	*P*-value
ED visit	1,160 (37.3)	1.16 (1.03–1.30)	0.01	1,080 (41.2)	1.15 (1.02–1.29)	0.03
Hospitalization	836 (26.9)	1.13 (0.99–1.30)	0.08	693 (26.4)	1.09 (0.94–1.27)	0.25
30-day rehospitalization[b]	127 (15.2)	1.06 (0.74–1.51)	0.75	84 (12.1)	0.97 (0.63–1.50)	0.90
ICU stay	232 (7.5)	1.29 (0.99–1.67)	0.06	171 (6.5)	1.08 (0.79–1.46)	0.64
Mortality	320 (10.3)	1.34 (1.07–1.67)	0.01	220 (8.4)	1.18 (0.91–1.54)	0.22

Notes: [a]Adjusted for age and Charlson index. Risk was estimated from Cox proportional hazard models comparing those with non-optimal control with those with optimal control (referent group); [b]defined as a rehospitalization within 30 days following the first hospitalization that occurs after 9/1/2009; limited to those who had at least one hospitalization.
Abbreviations: CI, confidence interval; ED, emergency department; HR, hazard ratio; ICU, intensive care unit.

Table 4 Adjusted[a] risk of health outcomes among patients with different control levels of diabetes mellitus compared with patients with optimal control (referent)

No of factors under control	ED visit	Hospitalization	30-day rehospitalization[b]	ICU stay	Mortality
3	Reference	Reference	Reference	Reference	Reference
2	1.08 (0.99–1.19)	1.06 (0.95–1.18)	0.99 (0.73–1.34)	1.11 (0.89–1.38)	1.15 (0.95–1.39)
1	1.37 (1.21–1.56)	1.26 (1.07–1.47)	1.11 (0.74–1.68)	1.29 (0.95–1.75)	1.85 (1.43–2.38)
0	1.37 (1.02–1.83)	1.33 (0.93–1.90)	1.31 (0.53–3.23)	2.47 (1.43–4.28)	1.32 (0.62–2.81)
P-value[c]	<0.001	0.004	0.57	0.007	<0.001

Notes: Data are presented as HR (95% CI) unless otherwise indicated. [a]Adjusted for age, sex, and Charlson index. Risk was estimated from Cox proportional hazard models comparing those with non-optimal control with those with optimal control (referent group); [b]defined as a rehospitalization within 30 days following the first hospitalization that occurs after 9/1/2009; limited to those who had at least one hospitalization; [c]*P* value for chi-square test for trend.
Abbreviations: CI, confidence interval; ED, emergency department; HR, hazard ratio; ICU, intensive care unit.

risk of hospitalization. We did not observe that non-optimal control of diabetes mellitus resulted in higher 30-day rehospitalization. The total outcomes on both measures were small, and the variance was small with 30-day rehospitalization. In ICU stays, there was no difference in adjusted analysis; however, in graded evaluation, there was a 2.5-fold increase in ICU stay in patients with no factors under control compared to patients with optimal control.

Our results provide potential evidence for the need for population health and/or care management in the diabetic population. While this study does not directly measure care management, the association between better control of risk factors and fewer adverse outcomes encourages important clinical questions. How can health care systems provide better control of risk factors in diabetic patients? Care management has been the primary clinical intervention to improve diabetes mellitus quality metrics.[29,30] Most outcomes of diabetes care management have focused on A_{1c} levels and other measures of glycemic control.[9,31] Evaluating LDL cholesterol, A_{1c}, and BP outcomes are surrogate clinical measures that may improve quality metrics but have unknown effects on health outcomes. In a recent meta-analysis, the authors concluded that most studies have not evaluated health outcomes in diabetic care management.[30] Furthermore, the authors could not derive a conclusion regarding the effectiveness of this intervention.[30] Population health studies with large cohorts are required to evaluate outcomes like mortality and hospitalization. In studies of broader care management not restricted to diabetes mellitus, a meta-analysis did not show an improvement in hospitalization with care management.[32] Despite the lack of clear evidence from the literature, the results of our study indicate the potential need to manage this high-risk group of non-optimally controlled diabetics. Specifically, one might continue to emphasize alerts in the medical record or nurse management to improve care.[33]

Our study has several limitations. First, inherent differences between the groups may have not been accounted for in our adjustment. One potential bias is socioeconomic status, which is not easily measured in the EMR. Socioeconomic status has been a risk factor for mortality in diabetic patients; thus, there is a potential for confounding.[34] There may be other inherent differences, including adherence with medical advice, which might result in less than optimal control of diabetes mellitus and worse health outcomes. Certain outcomes, like hospitalization or ED visits, could have been missed if these events occurred outside of the Mayo Clinic Rochester hospital system. There is a possibility of misclassification of diabetes, with a particular concern with inclusion of diabetes in patients who may not fit criteria. The ECH population is predominantly White,[35] thus potentially limiting the generalizability of our findings to other populations. Our population is similar to the rest of Minnesota, for which the MCM was designed; however, the ECH population is less diverse than the rest of the USA.[36]

Conclusion

Non-optimal diabetic control was associated with higher mortality rates and increased hospitalizations and ED visits after adjustment for age, sex, and comorbid health status. These findings support the emphasis that Minnesota health systems have placed upon population management systems and data systems to improve measures of diabetic control.[37] However, these findings do not directly support case management. Our findings encourage clinicians and health care systems to invest in processes to proactively manage at-risk patient populations and optimize population health. Future research should center on these processes to improve care for populations of diabetic patients.

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Disclosure

The authors declare no conflicts of interest in this work.

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