

RESEARCH ARTICLE

Is There a Role of Hemoglobin A1C in Predicting Hospital Re-Admission Rates for Patients with Diabetes?

Hirva Bakeri^{1*}, Dorothy Wakefield², Latha Dulipsingh³

¹Department of Medicine, University of Connecticut Health Center, USA

²Center for Public Health and Health Policy, University of Connecticut Health Center, USA

³Center for Diabetes and Metabolic Care, Saint Francis Hospital and Medical Center, USA

Abstract

The purpose of this study is to evaluate the role of HbA1C and its impact on hospital readmission. Despite widespread recognition of the burden of hospital readmissions, there are only a few studies focused on readmissions among patients with diabetes. We hypothesize that HbA1C values are associated with hospital readmission rates and would be an important indicator of risk of hospital readmission.

Data were collected retrospectively on 5, 126 patients admitted to Saint Francis Hospital Medical Center (SFHMC) with either primary or secondary diagnosis of diabetes from Oct. 1st, 2014-Sept. 30th, 2015.

The primary outcome in our study was that while HbA1C did not play a role in predicting 30-day readmissions, patients with multiple readmissions within 30 days had a significantly higher HbA1C level as compared to those with one readmission. Secondary findings in our study included: 1) patients with a primary diagnosis of diabetes had a significantly higher HbA1C than those with a secondary diagnosis, 2) patients admitted with a primary diagnosis of diabetes had a higher incidence of HbA1C testing than those admitted with a secondary diagnosis of diabetes.

The study is significant to a wider audience as it could assist in designing interventions to decrease healthcare costs related to diabetes.



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Corresponding author:

Hirva Bakeri, Department of Medicine, University of Connecticut Health Center, USA
Email: hirvabakeri@gmail.com

Keywords

Hemoglobin A1C; HbA1C; diabetes; readmission; cost effectiveness

Introduction

Hospital readmission is an indicator of quality of care and plays a significant role in total medical cost. A large proportion of hospital costs are attributed to a small percentage of patients with chronic medical conditions who have repeated hospitalizations.¹ As per Jencks *et al.*, approximately 20% of all hospitalized Medicare patients are readmitted within 30 days, and 34% are readmitted within 90 days of discharge.² Co-morbid medical conditions that have been associated with readmission included chronic obstructive pulmonary disease (COPD), alcoholism, diabetes mellitus (DM), chronic renal failure, liver disease, anemia, acute coronary syndrome, congestive heart failure (CHF), peripheral vascular disease, and malignancy.¹

The American Diabetes Association (ADA), in 2017, estimated that the cost of diabetes was \$327 billion, with \$237 billion of this cost incurred by direct medical costs and \$90 billion in reduced productivity.³ Providing care to a patient with diabetes is estimated to cost approximately 2.3 times that of a patient without diabetes³, explained by the fact that chronically elevated blood glucose is associated with an increased risk of organ damage. Complications caused by elevated glucose levels include microvasculopathy, nephropathy,

retinopathy, and death.⁴

The ADA has recommended the use of blood hemoglobin A1C (HbA1C) level to assess long-term glycemic control in patients with diabetes. Chronic glycemic control in the outpatient setting as well as attention to glycemic control in the hospital setting may facilitate sustained glycemic control post-discharge and reduce hospitalizations. The ADA proposes an HbA1C target of <7% to reduce microvascular complications in non-pregnant adults. However, it further recommends that HbA1C goals be individualized based on duration of diabetes, age/life expectancy, co-morbidities, hypoglycemic unawareness and individual considerations⁵.

Despite widespread recognition of the impact of hospital readmissions, there are only a few studies focused on readmissions among patients with diabetes, and these studies have conflicting conclusions. The aim of this study is to evaluate whether the value of HbA1C or frequency of its testing has an impact on readmission rates. We hypothesize that elevated HbA1C values are associated with increased hospital readmission rates and thus would be important indicators of risk of hospital admission. Such information could be used to design interventional programs to promote reduction in morbidity and cost related to diabetes and to find future directions to improve patient cost and safety.

Methods

We obtained approval from the Institutional Review Board and retrospectively collected data on patients admitted to Saint Francis Hospital Medical Center (SFHMC) with either primary or secondary diagnosis of diabetes from Oct. 1st, 2014–Sept. 30th, 2015. We selected patients who had a primary or secondary diagnosis of diabetes mellitus based on the ICD-9-CM codes ranging from 250–250.93. All patients admitted with a primary or secondary diagnosis of diabetes to any critical care or non-critical care unit in the hospital were included. Exclusion criteria included the following: patients below 18 years of age, and patients without the diagnosis of diabetes.

This study used information from reports created from the EPIC electronic medical record (EMR) system. All data were de-identified in compliance with the Health Insurance Portability and Accountability Act of 1996 before being provided to the investigators.

We gathered data from 5,126 patients. This data included inpatient encounter data, laboratory data (including HbA1C), the admission diagnosis, length of stay (LOS), and hospital readmission.

The primary outcome of interest was to evaluate whether HbA1C correlated with 30-day readmission rates. A readmitted patient was defined as any patient being admitted to the hospital within 30 days of discharge. As mentioned previously, HbA1C is a measure of glycemic control reflecting the efficacy and quality of diabetes care a patient has been receiving.

Statistical Analyses

Descriptive statistics (mean (SD) or frequency (%)) were calculated for all variables of interest. Chi-squared analyses compared the number of patients with HbA1c tests and the number of readmissions by primary or secondary diagnosis. *T*-tests compared the mean HbA1c levels by primary or secondary diagnosis. Wilcoxon rank-sum compared the hospital length of stay by group. All analyses were repeated to compare groups with (1 or more) and without readmissions. Statistical analyses were performed with SAS version 9.4 (Cary, North Carolina). *A*p value < 0.05 was considered significant.

Results

There were 7,561 admissions with a primary or secondary diagnosis of diabetes at SFHMC between October 1, 2014 and September 30, 2015 for 5,126 unique patients. Of the 7,561 admissions, 969 resulted in a total of 1,118 30-day readmissions due to multiple readmissions. The number of 30-day readmissions per patient ranged from 1 to 3. Of the 140 patients with multiple readmissions, 131 patients had 2 readmissions and 9 patients had 3 readmissions (Table 1).

HbA1C testing

HbA1C testing was considered 'complete' if it was done during the hospitalization or within 60 days prior to the initial admission. Overall, 3,189 (42.2%) of the 7,561 total admissions had a completed HbA1C. Of the 969 admissions with 30-day readmissions, 428 (44.2%) had HbA1C testing completed. The proportion with HbA1c tests among the 6,592 admissions without readmissions (41.9%) was similar ($p=0.18$). Among those who had a complete HbA1C, there was no difference in the average HbA1C values between the group that was readmitted and those that were not ((7.63% vs 7.55%), $p = 0.47$). The median LOS was higher among the readmitted group (5 vs 4 days) (Table 1).

Table 1. HbA1c Testing and Length of Stay by Readmission Status

	≥1 Readmission	No Readmissions	P-Value
# of Admissions	969 (12.8)	6592 (87.2)	
# with HbA1c Tests, <i>n</i> (%)	428 (44.2)	2971 (41.9)	0.008
Average HbA1c, mean (SD)	7.6 (2.1)	7.6 (2.2)	0.45
Length of Stay, days, median (min – max)	5 (1-53)	4 (1-116)	<0.001
Length of Stay, days, median (min – max)	3 (1-32)	4 (1-116)	<0.001
Abbreviations: <i>n</i> = number, SD = Standard of Deviation			

Primary vs. Secondary diagnosis

Of the total admissions, 453 (6%) had a primary diagnosis of diabetes, and 62 (14%) of those with the primary diagnosis of diabetes were readmitted within 30 days. Similarly, 907 (12.8%) of those admissions with a secondary diagnosis of diabetes had at least one 30-day readmission. In contrast, there was a significant difference between these two groups in the proportion with HbA1C testing done. More admissions with a primary diagnosis of DM had an HbA1C done than those with a secondary diagnosis of DM (48% vs 42%, $p=0.008$).

The group with a primary diagnosis of diabetes had a significantly higher HbA1C (mean=9.9%, $SD=3.4$) than those with a secondary diagnosis of diabetes (mean=7.5%, $SD=2.0$)($p\leq 0.001$)(Table 2).

Table 2. Summary of Results by Primary or Secondary Diagnosis of Diabetes

	Overall	Primary Dx of DM	Secondary Dx of DM	P-Value
Admissions	7561	453 (6.0)	7108 (94.0)	N/A
Unique Patients, <i>n</i> (%)	5126	319 (6.2)	4807 (93.8)	N/A
# with HbA1c Tests, <i>n</i> (%)	3189 (42.2)	218 (48.1)	2971 (41.8)	0.008
Average HbA1c, mean (SD)	7.6 (2.2)	9.9 (3.4)	7.5 (2.0)	<0.001
# Readmissions, <i>n</i> (%)				0.58
0	6592 (87.2)	391 (86.3)	6201 (87.2)	
1	829 (11.0)	53 (11.7)	776 (10.9)	
2	131 (1.7)	9 (2.0)	122 (1.7)	
3	9 (0.1)	0	9 (0.1)	
Length of Stay, days, median (min – max)	4 (1-116)	3 (1-32)	4 (1-116)	<0.001
Abbreviations: <i>n</i> = number, Dx = Diagnosis, N/A = not applicable, SD = Standard of Deviation				

Multiple readmissions

There were 140 initial admissions that had more than one 30-day readmission. More than half (51%) of these did not have HbA1C tests at the initial admission. Among those that did have an HbA1C test at the initial admission, the mean HbA1C of 8.1% ($SD=2.5$) was significantly higher when compared to those with only 1 readmission (mean HbA1C of 7.5%, $SD=1.9$)($p=0.046$).

Discussion

Despite consistent evidence showing that preventive and therapeutic interventions in patients with diabetes significantly improve clinical outcomes, there continues to remain a gap between ideal and actual care. This is likely because these interventions require a multi-disciplinary approach with coordinated care amongst various departments given the complex nature of diabetes.⁶

HbA1C is a useful tool to monitor glucose control, and to predict the risk of complications from diabetes. Despite widespread recognition of the utility of HbA1C as a performance measure of diabetes care, the test is ordered infrequently in the inpatient setting.^{7,8} This was also true in our study where only 44.2% of patients with readmission and 41.9% of patients without readmissions had a recent HbA1C value.

In our study, we found that: 1) HbA1C levels were measured significantly more in patients with a primary diagnosis of diabetes (48%) as compared to those with a secondary diagnosis of diabetes (42%), 2) patients with a primary diagnosis of diabetes had a significantly higher HbA1C level (HbA1C mean of 9.94%) than those with a secondary diagnosis of diabetes (HbA1C mean of 7.46%), and 3) patients with multiple readmissions had a significantly higher mean HbA1C (8.1%) compared to those with one readmission (7.5%). These findings suggest that while a high HbA1C value may not be a predictor of 30-day readmission, it may play a role in predicting patients at high risk for multiple readmissions. In a study by Healy *et al.*, the relationship between intensive diabetes education and hospital readmission was analyzed with stepwise backward logistical regression models. Their study showed that formal intensive diabetes education was independently associated with a lower frequency of all-cause hospital readmission within 30 days.⁹ These findings are important because readmission is associated with potentially preventable cost and morbidity,⁴ and intensive inpatient diabetes education can decrease readmission rates in medical patients.⁹ As mentioned previously, this stresses the importance of timely recognition of patients with diabetes.

Studies that evaluate readmission risk factors among patients with diabetes can be grouped into those that focus primarily on patients readmitted within 30 days and those that observed readmissions over longer periods of time.¹⁰ In a review by Rubin in 2015, studies of at least 2000 patients were tabulated, and the reported factors associated with an increased risk of 30-day readmission included male gender, comorbidity burden, hospital length of stay, government insurance vs. private or no insurance, emergent or urgent vs. elective admission, recent prior hospitalization, and being discharged against medical advice.¹⁰ There are conflicting data on the association of HbA1C with 30-day readmission.

Healy *et al.* showed that formal diabetes education in hospitalized patients with poor glycemic control (HbA1C >9%) was associated with decreased frequency of all-cause hospital readmission within 30 days. However, given the narrow HbA1C range, they were unable to draw a conclusion regarding the effect of HbA1C on readmission.⁹ In a retrospective cohort study of ~70,000 inpatients, Strack *et al.* demonstrated that, regardless of the result, simply measuring the HbA1C was associated with a decreased risk of 30-day readmission in patients with a primary diagnosis of diabetes, but not those with other primary diagnoses. This may suggest that greater attention to diabetes reflected by measuring the HbA1C may improve outcomes among patients hospitalized for diabetes.¹¹ In contrast, in a retrospective cohort study with 880 patients undergoing coronary artery bypass surgery who were divided into 3 HbA1C groups, Engoren *et al.* showed that rates of readmission rose from 9% in patients with HbA1C < 6.0%, to 15% in those with HbA1C between 6.0%–7.0%, and to 17% for those with HbA1C > 7.0%.⁴ Liberty *et al.* investigated the association between HbA1C levels and outcomes in patients hospitalized in general internal medicine wards. They identified two groups of patients that exhibited different patterns of association between HbA1C levels and 1-year mortality. Among patients with no known prior history of diabetes, an HbA1C level ≥ 6.5% was associated with increased 1-year mortality risk. In patients with a known history of diabetes, HbA1C < 6.5% was associated with an increased 1-year mortality risk, however, an HbA1C > 10.0% showed an elevated risk that was not statistically significant. This suggests that using HbA1C measurement as a surrogate marker for diabetic care and early identification of possible high-risk patients may assist in implementing measures to improve outcomes and readmission rates among patients hospitalized for diabetes.¹²

In patients with other comorbidities, diabetes is also associated with an increased risk of readmission in patients hospitalized for cardiac surgery,^{13,14} heart failure,^{15,16} acute myocardial infarction,¹⁷ stroke,¹⁸ or liver disease.¹⁹ Considered together, these data suggest that the effect of diabetes on readmission risk may vary by length of follow-up and by primary reason for hospitalization.¹⁰

A review by Rubin of the existing literature showed that HbA1C had a varying association with 30-day readmission. Our study adds another dimension to the current literature by

showing that patients with multiple readmissions within 30 days had a higher HbA1C when compared to those with one readmission. Additionally, we found that HbA1C levels are measured more frequently and are higher in value in patients with a primary diagnosis of diabetes.

There are limitations to our study. First, the data were retrieved over a period of 1 year from a single center that practiced tight glycemic control. Dulipsingh *et al.* carried out an educational intervention at SFHMC for standardization of diabetes care. A hospital-wide multi-disciplinary task force was formed and nursing staff was educated regarding the importance of inpatient glycemic control based on recommendations by this task force.²⁰ Hence, while this was possible at SFHMC, similar results may not be observed in hospitals where there is not an already established multi-disciplinary task force in place. Second, as this is a retrospective study, it has some inherent biases and may have some confounding variables that we have not been able to control for. Limitations of using data obtained from the electronic medical record retrospectively include incomplete or missing data, difficulty in verifying documented information, and variability in the documentation among health care personnel. Primary care physicians affiliated with SFHMC use EPIC EMR and we were able to use the HbA1C values completed in the outpatient setting as long as it was completed in our laboratory. We were not able to include results from a laboratory outside the hospital or by providers who do not share our EMR. Third, our modest sample size is a limitation. Additionally, our data indicate that, while the utility of HbA1C is widely understood in evaluating patients with diabetes, it continues to be ordered infrequently with <50% of discharges having a current HbA1C despite current guideline recommendations to do so. Finally, we looked at data from Oct. 1st, 2014–Sept. 30th, 2015. Any first admission during that period was indexed as a first admission and any additional admission after that was indexed as a readmission. Some of these patients who were admitted in October may have had prior admissions and may have been readmits, but their October admission was still counted as a first admission.

Conclusion

In conclusion, obtaining an HbA1C measurement at time of admission may be a useful tool for predicting patients more likely to have more than one readmission. Due to the inherent limitations of obtaining data retrospectively from electronic medical records we suggest the need for longer term follow-up and further prospective study to evaluate the association between HbA1C and hospital readmissions. While HbA1C did not play a role in predicting 30-day readmissions, patients with multiple readmissions had higher HbA1C values. Our analyses also showed that patients with a primary diagnosis of diabetes had significantly higher HbA1C levels compared to those with a secondary diagnosis of diabetes, stressing the importance of recognizing and diagnosing these patients appropriately in order to provide the appropriate inpatient treatment and thereby prevent further readmissions.

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Conflict of Interest Statement:

The authors declare no conflict of interest

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