

The Effect of Diabetes on Hospital Readmissions

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Abstract

Hospital readmission is an important contributor to total medical expenditures and is an emerging indicator of quality of care. Diabetes, similar to other chronic medical conditions, is associated with increased risk of hospital readmission. Risk factors include previous hospitalization, extremes in age, and socioeconomic barriers. Preliminary studies suggest that acute and/or chronic glycemic control may be of importance when diabetes is the primary diagnosis or when it is a comorbidity. Very limited evidence from prospective randomized controlled trials aimed at improving glycemic control is available. However, whether one concludes that inpatient or outpatient glycemic control is partly responsible for reduced hospitalizations, attention to glycemic control in the hospital may facilitate sustained glycemic control post-discharge. Limited prospective and retrospective evidence suggest that the involvement of a diabetes specialist team may improve readmission rates, but attention to more generalized comprehensive approaches may also be worthwhile. Prospective interventional studies targeting interventions for improving glycemic control are needed to determine whether glycemic control impacts readmission rates.

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Introduction

A significant proportion of hospital costs are attributable to a small percentage of patients, particularly those with chronic medical conditions.^{1,2} These costs are, in large part, due to repeated hospitalizations for the same condition.³ Approximately 20% of all hospitalized Medicare patients are readmitted within 30 days, and 34% are readmitted within 90 days of discharge.⁴ Prevention of unplanned hospital readmission has therefore received increasing attention as one way of reducing hospital costs. For example, the Medicare Payment Advisory Commission has recommended reduced reimbursement rates for patients having early rehospitalizations for congestive heart failure (CHF).⁵

The purpose of this article is to identify predictors of unplanned hospital readmissions and to describe the role of the diagnosis of diabetes and glycemic control. Then the paper will describe general measures and diabetes-specific interventions to prevent readmission.

Role of Chronic Medical Conditions

A large Medicare study revealed that the most common conditions that require rehospitalization within 30 days of discharge are CHF, pneumonia, and chronic obstructive pulmonary disease and that medical patients are more likely to require readmission than surgical patients.⁴

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Abbreviations: (CHF) congestive heart failure, (DKA) diabetic ketoacidosis, (HbA1c) hemoglobin A1c

Keywords: glycemic control, hemoglobin A1c, hospital, inpatient, readmission, rehospitalization

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Readmission is difficult to compare across studies because it is defined nonuniformly in terms of the reason for readmission (index condition versus any reason), duration of follow-up, planned versus unplanned, and preventable versus not preventable.⁶ Algorithms for identifying patients at risk of readmission have been published.^{7,8} Variables such as increasing age, low socioeconomic status, increased geographic distance, and previous admission in the past 3 years were identified as being predictive of readmission.⁸ Comorbid medical conditions that were associated with readmission included chronic obstructive pulmonary disease, alcoholism, diabetes, chronic renal failure, liver disease, anemia, acute coronary syndrome, CHF, peripheral vascular disease, and malignancy. Overall, the predictive capacity for these models is limited with a receiver operator curve of 0.65⁸ to 0.68,⁷ indicating that other factors that may be difficult to measure play a substantial role. Other factors that have been implicated include severity of illness, dependence, low mobility, and low level of care after discharge.^{9,10}

Role of Diabetes Diagnosis

The estimated cost of diabetes in 2007 was \$174 billion, with the largest expenditure being inpatient care.¹¹ The cost of a patient with diabetes was estimated at 2.3 times that of a patient without diabetes. In elderly patients with diabetes, it has been reported that 56% of Medicare costs are accounted for by 10% of patients, and these costs are, in large part, due to hospitalization.¹² Complications of diabetes were associated with increased expenses.

Predictors of hospital readmission are shown in **Table 1**. In a large study of hospital utilization in five states, 30% of hospitalized patients with diabetes were readmitted within the 1 year study period, accounting for 50% of all hospital stays among patients with diabetes.¹³ Rehospitalizations occurred disproportionately among socioeconomically disadvantaged groups, including Hispanics and African Americans, those living in lower-income zip codes, and those without private insurance.

Table 1.
Predictors of Readmission among Inpatient Diabetes Cohorts

General hospitalized diabetes cohorts				
Reference number	Number	Significant predictors	Follow-up	Relationship (all predictors in model) ^a
13	648,748	African American versus Caucasian Hispanic versus Caucasian Medicare versus private Medicaid versus private Low versus high income Medium versus high income	Multiple admissions within 1 calendar year	OR 1.15 (1.13–1.17) OR 1.20 (1.18–1.23) OR 1.48 (1.45–1.50) OR 1.63 (1.60–1.66) OR 1.03 (1.01–1.04) OR 1.03 (1.01–1.05)
14	482	Hospital length of stay Family history of atherosclerosis Dependent for basic needs Systolic blood pressure >130 mmHg CHF Atrial fibrillation Basal glucose Creatinine clearance Hemoglobin	1 year	OR 1.03 (1.00–1.07) OR 0.23 (0.11–0.485) OR 2.57 (1.17–5.68) OR 0.40 (0.24–0.67) OR 1.75 (1.07–2.89) OR 1.75 (1.01–3.02) OR 1.004 (1.001–1.007) OR 0.99 (0.98–0.99) OR 0.76 (0.68–0.85)
DKA cohorts				
Reference number	Number	Significant predictors	Follow-up	Relationship
15	168	Hispanic versus African American	Up to 3 years	OR 3.67 (1.66–8.10)
16	152	Polysubstance abuse	Up to 5 years	OR 19.5 (2.5–15.3)
17	92	(In children) Behavioral problems Young age at diagnosis Low socioeconomic status	Up to 10 years	All were significant predictors

^a OR, odds ratio.

Racial/ethnic disparities in readmissions were also reported elsewhere, particularly for microvascular complications.¹⁸

Furthermore, disadvantaged patients were more likely to be admitted for acute complications of their diabetes, as opposed to chronic complications.¹³ This is of importance because acute complications are potentially more easily prevented. Among minority patients admitted with diabetic ketoacidosis (DKA), Hispanic patients were particularly likely to be readmitted (58% versus 27% of African Americans).¹⁶ Another factor that is associated with high risk of readmission for DKA is recreational drug abuse, and this is frequently overlooked.¹⁷

Socioeconomic disparities were particularly prominent in children.¹³ Adolescents may be particularly prone to recurrent admissions for DKA.¹⁹ In a longitudinal study of newly diagnosed patients with type 1 diabetes, risk factors for recurrent DKA include elevated hemoglobin

A1c (HbA1c), behavioral problems, young age at diagnosis, and low socioeconomic status.¹⁸

In patients with diabetes, comorbidities that were predictors of readmission following hospitalization on internal medicine services at a single center include a history of CHF, renal dysfunction, anemia, and atrial fibrillation.²⁰ As a comorbidity itself, diabetes is associated with increased readmission following hospitalization for CHF,^{21,22} renal transplant,²³ cardiac surgery,^{24–26} and coronary artery bypass surgery with preexisting left ventricular dysfunction²⁷ (Table 2).

Role of Glycemic Control

There are few studies indicating whether there is a relationship between glycemic control and hospital admission (Table 3). In one study, very poor glycemic control (HbA1c > 10%) but not moderate to poor glycemic

Table 2.
Cohorts in which Diabetes Is Tested as a Predictor of Readmission

Reference number	Number	Population	Follow-up	Relationship ^a
22	1129	CHF	6 months	OR 1.62 (1.23–2.14)
23	5791	CHF	2–3 months	OR 5.54 (4.94–6.20)
24	366	Renal transplant	Up to 14 years	10.89 versus 18.28 months ($p = .047$)
25	1665	Cardiac surgery, readmission for CHF	1 month	Adjusted OR 1.18 (0.87–1.60)
26	7493	Cardiac surgery	Up to 10 years	Cox HR 1.3 (1.20–1.41)
27	2574	Cardiac surgery	1 month	OR 1.64 (1.25–2.14)
28	900	Cardiac surgery	48 months	OR 2.56 (1.81–3.63)

^a Cox HR, Cox prandial hazard ratio; OR, odds ratio.

Table 3.
Hyperglycemia as a Predictor of Readmission

Reference number	Number	Population	Follow-up	Measure of glycemia	Relationship ^a
14	482	Diabetes (internal medicine units)	1 year	Basal glucose	OR 1.004 (1.001–1.007) adjusted
29	1931	Non-diabetic renal transplant (readmit for infection)	Up to 22 years	2 glucoses > 126 mg/dl in early post-transplant period	Cox HR 2.93 (1.55–5.56)
30	748	CHF (readmit for CHF)	30–90 days	Time-weighted in-hospital capillary blood glucose, HbA1c	Glucose: OR 3.3 ($p = .03$) HbA1c: OR 5.5 ($p = .04$) adjusted
31	969	Community-acquired pneumonia	30 day	Admission glucose	No association (summary data not reported)
32	2366	Community-acquired pneumonia	90 day	Admission glucose	Adjusted OR versus 72–110 mg/dl: 110–140 mg/dl, 0.74 (0.53–1.04) 140–200 mg/dl, 0.85 (0.58–1.25) 200–360 mg/dl, 0.92 (0.48–1.76)

^a Cox HR, Cox prandial hazard ratio; OR, odds ratio.

control (HbA1c 8–9% or 9–10%) was associated with increased odds for diabetes-related hospitalization (odds ratio 2.13, 95% confidence interval 1.36–3.33 versus HbA1c < 7.0%).²⁸ Likewise, there are few studies investigating a relationship between glycemic control and hospital readmission. A small study of hospitalized internal medicine patients with diabetes showed that patients who were readmitted within 1 year had higher plasma glucose levels at the index admission.²⁰ Early post-renal transplant hyperglycemia in patients without known diabetes was associated with increased risk of readmission for infectious complications.¹⁵

Given the high risk of readmission in patients with CHF, Dungan and coauthors³³ used a centralized information warehouse to investigate whether readmission for CHF may be related to glycemic control. Data showed that higher HbA1c and higher time-weighted mean glucose were both associated with increased frequency of CHF readmission. It is not immediately obvious why improved glycemic control either in the hospital or beyond would reduce readmissions for other conditions. The most intriguing explanation is modification of the comorbidity through glycemic control. In the case of CHF, hyperglycemia (and insulin resistance) has been hypothesized to play a role in the development of diabetic cardiomyopathy, in part, via inefficient myocardial fuel metabolism.³⁴ Limited evidence suggests that improvement in glycemic control may improve cardiac function by as early as 3 weeks, at least early in the course of CHF.²⁹ Furthermore, severe hyperglycemia is known to induce shifts in fluids and electrolytes that may be of particular relevance in patients with CHF. In a more generalized view, hyperglycemia may lead to impaired immune function³⁰ and, in particular, has been associated with postoperative infection,^{35,36} a common cause of hospital readmission among surgical patients.

Another possibility is that good glycemic control is simply a predictor of adherence to medical and dietary therapies in general, better self-care behaviors, and fewer socioeconomic barriers that are important for many chronic disease states. However, this does not necessarily explain why inpatient glycemic control would predict readmissions, unless inpatient control is heavily influenced by preadmission glycemic control, and interventions in the hospital to rectify hyperglycemia are either not implemented or are ineffective. Dungan and colleagues³³ found that HbA1c was only modestly correlated with inpatient time-weighted glycemic control, although this correlation was statistically significant (R -value 0.47, $p < .0001$).

By extension, it is unclear whether attention to inpatient glycemic control can reduce readmissions. In the CHF cohort, inpatient glycemic control was associated with later (30–90 day) but not early (<30 day) readmissions, and both HbA1c and inpatient glycemic control were predictors. Admission glucose was not associated with readmission. These observations suggest that any benefit acquired from glycemic control requires time to develop. This is further illustrated by studies of patients hospitalized with community-acquired pneumonia, where admission glucose alone was not a predictor of 30-day³⁷ or 90-day³⁸ hospital readmission. It is unknown whether an assessment of glycemia over a more extended period would have shown a relationship. However, whether one concludes that inpatient or outpatient glycemic control is partly responsible for reduced hospitalizations, attention to glycemic control in the hospital may facilitate sustained glycemic control post-discharge.

Prevention of Readmission

General Measures

A more generalized approach to reducing readmissions in patients with diabetes seems reasonable for three reasons. (1) There are very few published data for interventions targeted at prevention of readmission in patients with diabetes. (2) Comorbidities are common in patients with diabetes, which may not be the primary reason for admission. (3) Important predictors of readmission may be common to multiple diseases, including socioeconomic, psychosocial, and educational disparities. Appropriate targeting of interventions to high-risk groups would potentially optimize the cost-to-benefit ratio.

Various approaches have been employed in generalized inpatient populations. One potentially cost-effective approach is a phone call to patients following discharge, but this has shown limited effectiveness.^{31,39} There were no studies specifically targeted to telephone follow-up of hospitalized patients with diabetes. However, barriers to obtaining prescriptions are common among hospitalized patients with diabetes.³² Thus early identification of post-discharge problems while they are still manageable could potentially reduce the need for readmission.

Methods specifically intended to encourage hospital follow-up have also received interest because half of Medicare patients who are readmitted within 30 days did not have an outpatient encounter following discharge.⁴ In patients with diabetes, a direct referral from inpatient staff significantly increases the odds of keeping a follow-up

visit.⁴⁰ However, other barriers to hospital follow-up are common among patients with diabetes, including lack of transportation, expense, and lack of health insurance.⁴¹

There is evidence for a small benefit from individualized discharge planning for decreasing readmissions in undifferentiated hospitalized patients.⁴² Successful programs utilize multiple approaches, such as a nurse discharge advocate, prearranged follow-up appointments, medication reconciliation, patient education, and communication with the primary care provider.^{43,44}

Diabetes-Specific Measures

Although the evidence is still limited, diabetes-specific measures may play a role in reducing unnecessary

readmissions. In general, these measures are best implemented closer to admission, not at discharge (**Figure 1**). There are several key points that warrant emphasis.

Reinforcement by Example

The inpatient setting could be viewed as an ideal environment for reinforcing the importance of glycemic control and diabetes self-care habits following discharge. It is unclear whether interventions to improve glycemic control in the hospital actually reduce the frequency of readmission. However, assuming this to be true, strategies for glycemic control would need to be implemented early in the hospital course in order to achieve optimal outcomes at discharge since effective glycemic control takes several days to implement.^{45,46}

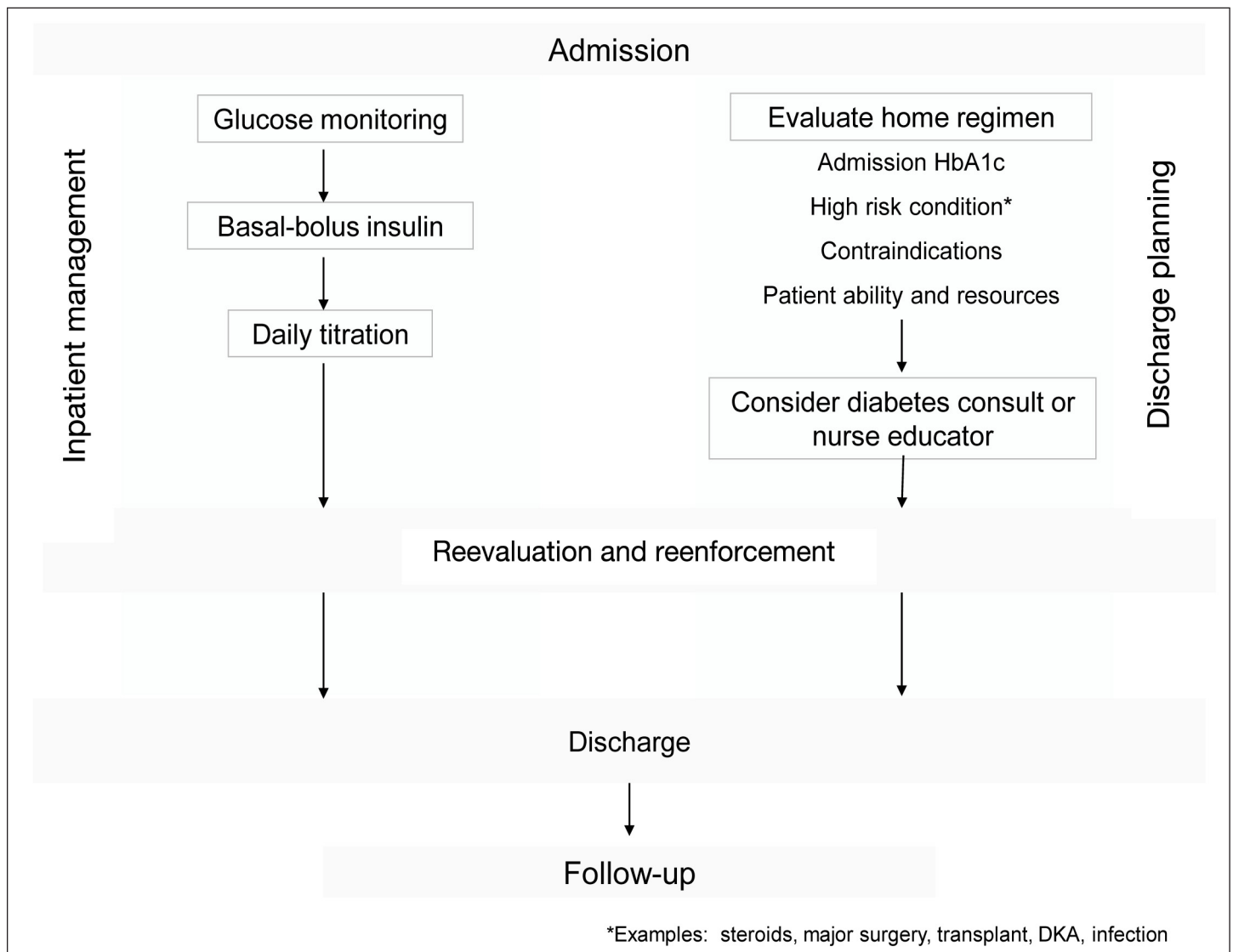


Figure 1. An expanded view of inpatient diabetes management encompasses two early parallel therapeutic tracks, addressing inpatient glucose stabilization and management as well as diabetes-specific discharge planning, both of which require ongoing reevaluation and reinforcement.

Choosing a Discharge Regimen

The default approach to discharge therapy is often to restart the previous home diabetes regimen without regard to its effectiveness. Establishing a discharge regimen is further complicated by guidelines that recommend discontinuation of noninsulin diabetes therapies at admission,⁴⁷ which can add to confusion and lapses in care of diabetes at discharge.⁴⁸ Computerized support tools and medication reconciliation procedures may help to avoid omissions of discharge medications. However, the ideal discharge regimen should be implemented with knowledge of the pre-hospital and in-hospital glycemic control, and the needs and capabilities of the individual patient. At a minimum, a recent HbA1c should be available or ordered at the time of admission in order to inform discharge treatment decisions for all patients with diabetes.⁴⁷

Acknowledging the Diagnosis of Diabetes

One study demonstrated a significant association between failure to record the diagnosis of diabetes in hospital discharge data and 30-day readmissions.⁴⁹ It is unclear whether such omissions are related to inadequate glycemic control or to a more global problem of poor transitions in care. Diabetes is not typically the primary indication for admission, and it is likely that competing medical priorities could eclipse glycemic management in the hospital and at discharge. Documenting the diagnosis on the problem list is the first step toward ensuring that proper attention is received during hospitalization and at discharge. Electronic medical records may decrease the impact of this problem over time.

Provider Responsibility

Diabetes is often considered an outpatient problem that should be relegated to the primary physician or endocrinologist. Unfortunately, the outpatient provider is typically also dealing with competing priorities and may not have adequate data or educational resources that may be available in the hospital. Effective hand-offs to the provider in the outpatient setting help to minimize confusion.⁵⁰

Inpatient Glycemic Management Teams

Limited data in some,⁵¹ but not all,⁵² studies suggest that the involvement of a diabetes specialist team reduces readmissions. Results may depend upon the individual components of the program and attention to discharge needs. Inpatient diabetes management teams generally incorporate some component of diabetes education. Education is ideally delivered over multiple visits, and therefore, early identification of patient needs and appropriate consultation is desirable.⁵³ Where certified

diabetes educators are unavailable, diabetes nurse champions can be trained on each unit to facilitate education efforts. In the outpatient setting, nursing education has resulted in improved HbA1c and adherence to medication and glucose monitoring, so the potential benefits are not limited to readmission.⁵⁴⁻⁵⁶

While diabetes education in the hospital generally focuses on survival skills,⁴⁷ more detailed self-management education is typically deferred to the outpatient arena. Further study is needed in hospitalized patients, but more advanced self-management education may be useful on an individualized basis. In the case of CHF, self-management education has been associated with improved readmissions,⁵⁷ so such a relationship in patients with diabetes would not be unprecedented.

Post-Discharge Support

Following discharge, negative attitudes toward insulin are common and contribute to a high rate of nonadherence to insulin post-discharge, particularly in the absence of contact with a diabetes educator.⁵⁸ In a nonrandomized interventional study, indigent patients with ketosis-prone diabetes who participated in an outpatient diabetes treatment program that included free access to insulin, 24 h per day voicemail-pager access to a staff, and frequent phone calls and scheduled visits were less likely to be readmitted with DKA than those who did not participate (16% versus 43%, $p = .001$).⁵⁹ More research is clearly needed in this respect.

Conclusions

Diabetes, like other chronic medical conditions, is associated with increased risk of hospital readmission. However, diabetes is not always the main priority for providers in the inpatient setting, and opportunities for optimization of care may be missed without a systematic approach. Preliminary studies suggest that acute and chronic glycemic control may be of importance when diabetes is the primary diagnosis or whether it is a comorbidity. Prospective interventional studies targeting interventions for improving glycemic control in the hospital and after discharge are needed to determine whether glycemic control impacts the frequency of readmissions. In the meantime, efforts to reduce readmissions should be multifactorial and encompass both general and diabetes-specific measures.

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