Risk factors associated with 30-day readmission and length of stay in patients with type 2 diabetes

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ABSTRACT

Aims: Patients with type 2 diabetes mellitus (type 2 DM) are at greater risk of poor hospital outcomes. The purpose of this study was to determine the impact of type 2 DM on 30-day hospital readmission and length of stay (LOS).
Methods: We studied all inpatient admissions in Pennsylvania during 2011 using data from the Pennsylvania Health Care Cost Containment Council. Outcomes included 30-day readmission and inpatient LOS. We estimated the impact of type 2 DM on readmission and LOS, and identified risk factors for readmission and prolonged LOS.
Results: Among inpatient admissions, patients with diabetes were more likely to be readmitted (AOR = 1.17, $P < 0.001$) and have longer LOS (0.19 days, $P < 0.001$) compared to patients without diabetes. Among those with diabetes, several factors were associated with readmission, including demographics, source of admission, and comorbidities. Patients with diabetes were more likely to be readmitted for infectious complications (9.4% vs. 7.7%), heart failure (6.0% vs. 3.1%), and chest pain/MI (5.5% vs. 3.3%) than patients without diabetes.
Conclusions: Diabetes is associated with risk of 30-day readmission and LOS, and several patient-specific factors are associated with outcomes for patients with diabetes. Future studies may target risk factors to develop strategies to reduce readmissions and LOS.

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1. Introduction

Diabetes is one of the most common chronic conditions in the United States and was associated with $176 billion in direct medical costs in 2012 (American Diabetes Association, 2013). Patients diagnosed with diabetes have medical expenditures that are more than double otherwise similar people without diabetes. The majority of expenditures for diabetes patients in 2012 was for inpatient hospitalizations, with patients with diabetes averaging longer lengths of stay (LOS) and higher average costs per hospitalization than patients without diabetes (American Diabetes Association, 2013; Fraze, Jiang, & Burgess, 2010; Howell, Coory, Martin, & Duckett, 2009). Moreover, among patients with diabetes who were hospitalized, at least 30% were subsequently readmitted, accounting for over 50% of total hospitalizations and hospital costs (Jiang, Stryer, Friedman, & Andrews, 2003; Rubin, 2015). With the increasing cost burden of diabetes on the health care system, readmissions and LOS have been implicated as indicators of hospital performance and efficiency, as well as suggested as targets for cutting health care costs (Rubin, 2015).

Others have argued, however, that a readmission rate is not a valid quality of care measure (Joynt & Jha, 2012). Some readmissions are not preventable, and may be more reflective of hospitals with poor or minority populations or populations with a high burden of mental illness. Others have raised concerns that hospitals may reduce readmission by keeping patients in observation units (Gerhardt et al., 2014; Zuckerman, Sheingold, Orav, Ruhter, & Epstein, 2016). Despite these controversies, the implementation of the Affordable Care Act and the establishment of the Hospital Readmissions Reduction Program (HRRP) in 2010 have made readmissions an important quality of care measure (Benbassat & Taragin, 2000). Hospitals with readmission rates higher than expected

are penalized with a total Medicare reimbursement cut of up to 1% (Centers for Medicare Medicaid Services & Services, 2012), which provides an incentive to avoid potentially preventable readmissions. However, reducing readmission rates and decreasing LOS require identifying high-risk patient populations so that potentially modifiable factors within that population can be addressed. The purpose of this study was to determine risk factors associated with 30-day hospital readmission and increased LOS for patients with and without diabetes.

2. Methods

2.1. Data

This was a retrospective cohort study using administrative data from the Pennsylvania Health Care Cost Containment Council (PHC4) from 2011 to 2012. PHC4 collects detailed discharge data including demographics, diagnosis and procedure codes, and source of admission for all hospital discharges occurring in all Pennsylvania hospitals (Sirio, Sessa, & McGee, 1996). The retrospective study was approved by the institutional review board of Penn State College of Medicine and complied with the Helsinki Declaration of 1975, as revised in 1983.

Type 2 DM was identified International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes (250.x0 and 250.x2). Admission for patients with type 1 diabetes were identified using ICD-9-CM codes (250.x1 and 250.x3) and were excluded from the analysis ($n = 12,673$). After excluding 150,348 patients for missing covariates or outcome data and 5234 patients who expired during their index admission, there were 831,291 admissions for patients without diabetes and 249,289 admissions for patients with type 2 DM included in the final analysis (Fig. 1).

Analyses controlled for several patient level variables, including demographics (age, gender, and race/ethnicity), primary payer (Medicare, Medicaid, commercial, and other), admission source (referral, hospital transfer, other facility, and other), type of admission (elective, urgent, and emergent), and comorbidities. Comorbidities were assigned using ICD-9-CM codes as previously described (Quan et al., 2005).

Two outcomes were studied: 30-day readmission and total LOS. Readmission was assessed as readmission within 30 days to any Pennsylvania hospital for any diagnosis. Patients who were readmitted more than once within 30 days following an index admission were only counted as one readmission event. LOS was measured as the total length of admission to the hospital for the index admission. Patients who died during their index admission were excluded from the analysis since they were not eligible for a readmission.

The most common primary readmission diagnoses for patients without type 2 DM were compared to readmission diagnoses for patients with type 2 DM. Primary diagnoses for readmitted patients were determined using ICD-9-CM codes and grouped by similar etiology. Since data were completely de-identified, this was an IRB exempt study.

2.2. Statistical analysis

Statistical analysis was performed primarily to determine whether a diagnosis of type 2 DM was significantly associated with readmission and LOS after controlling for important covariates. Additional analyses were performed to determine which factors were significantly associated with 30-day readmission and increased LOS among patients with type 2 DM. Univariate analysis using χ^2 tests for binary and categorical variables and t-tests or Wilcoxon rank-sum tests for continuous variables were performed to determine whether there were differences in characteristics across disease and readmission groups.

Logistic regression was used to model the effects of type 2 DM on 30-day readmission after controlling for demographic and other characteristics. LOS was fit to a generalized linear model assuming a gamma family of distributions and log link function. This model was chosen because LOS was highly skewed and did not meet the normality
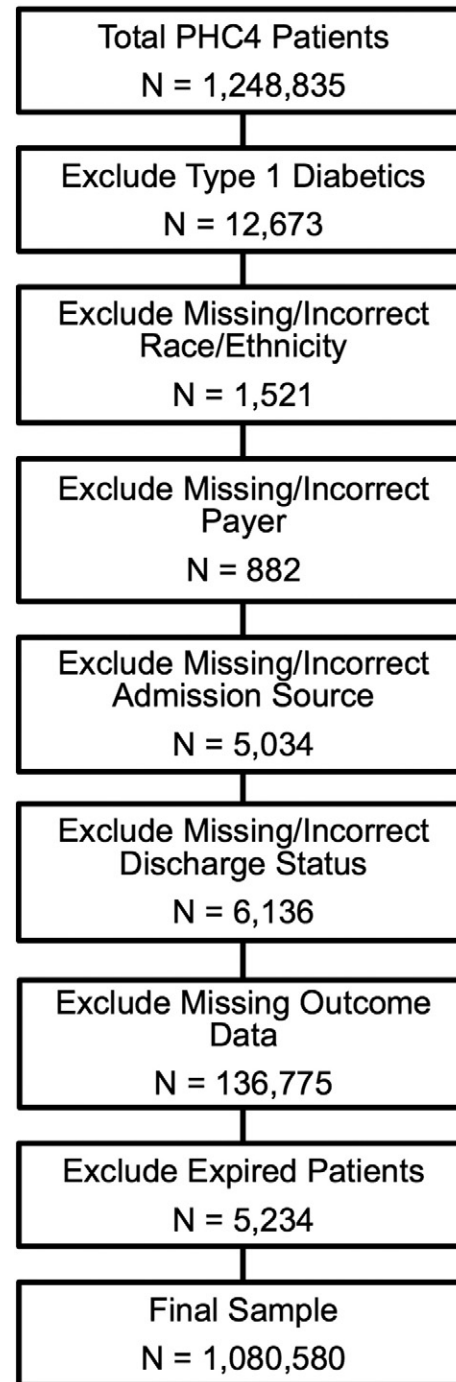

Fig. 1. Determination of study cohort. This figure documents how the final study sample was selected after all exclusions were applied.

assumption of the classical linear regression model. We report the marginal effects from the generalized linear models, which show the effect of a one-unit change in the independent variable on the outcome.

A regression model may not adequately control for covariates if a significant imbalance in covariates exists between patients with type 2 DM and all other patients. Therefore, a propensity score matching analysis that dealt with potential covariate imbalance was performed. The propensity score models for 30-day readmission and LOS were estimated using logistic regression with type 2 DM as the dependent variable and covariates as previously described. Using the estimated propensity scores from this model, patients with type 2 DM were matched 1:3 to patients without diabetes using a k-nearest neighbor match with a max–min common support restriction.