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Factors Related to 30-Day Readmission among Hispanics with Type 2 Diabetes

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By

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Dissertation Committee

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APPROVAL PAGE, DISSERTATION

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TITLE OF
DISSERTATION: FACTORS RELATED TO 30-DAY READMISSION AMONG HISPANICS WITH TYPE 2 DIABETES

DISSERTATION

COMMITTEE:

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Abstract

Background: Medicare spends $17 billion yearly on 30-day readmissions. Hispanic adults have a higher prevalence of diabetes (12.6%) compared to non-Hispanic whites (9.4%). Those with a diagnosis of diabetes have the 17% higher rate (14-23%) for 30-day readmission. Little research has been conducted on Hispanics with diabetes relative to 30-day readmissions.

Aims: Among Hispanics with type 2 diabetes: 1) measure the incidence of 30-day readmission by sociodemographic, behavioral and clinical factors;2) identify independent factors associated with 30-day readmission among Hispanic adults with type 2 diabetes accounting for potential covariates; 3) compare the ability of the Hispanic Diabetic Study Model plus ED, to the LACE model.

Methods: The overall 30-day readmission rate for the three years of 14.7% (N=5985) and for those in the study cohort of 9.5% (N=3865). The Hispanic-Diabetic model plus ED had ACU of 0.67 with a high specificity of 99.5% and low sensitivity of 5%. However, the PPV (positive predictive value) was 57.4%, much better than 9.5%.

Findings: The readmission rate in the cohort declined from 11.8% to 9.5% over time indicate studied hospital has purposefully worked to decrease 30-day readmissions and have been successful among Hispanics with diabetes. Employment status: only 15% were employed, disabled (20%) had an adjusted odd of 2.43, retired (49%, adj 1.68) increased odds of readmission. The number of ED visits prior to admission was the strongest predictor ranging from an adjusted odd of 6.04 for 1 visit to 14.56 for 3 visits. The length of stay OR=1.75 for 4-6 days or an increase of 5% odds for every day in the hospital and smoking marginally increased odds of readmission. Receiving a consult for a home health aide at discharge was an important factor. Surprisingly, the diabetes complications code decreased the odds of 30-day readmission even though HgA1C above 9% did slightly increase odds. The majority were Spanish-speaking (69%), and 70% of all participants were seen by a diabetes nurse practitioner.

Implications: Identified key factors of 30-day readmission among Hispanics with diabetes may lead to future targeted interventions effective in reducing readmissions in this population.

Dedication

This dissertation is dedicated to my daughters, Aida and Alma, who with their love and optimism allowed me to push through the challenges. My daughter Alma was diagnosed with Type 1 Diabetes in 2014, almost six years after I was specialized in the field, and gave a deeper sense of drive, on a personal level for the specialty. I also want to thank my mother, who has taught me through example, the power of determination and resilience: she is the woman who showed me the value integrity, honesty, and hard work. At the forefront of this work are my patients, who kindled my purpose and demonstrated the importance of my work to bring better care to them. Today, hospitals are struggling; with high medical costs and many patients who are uninsured or underinsured the odds are against them, yet they still work to provide the best care possible.

Acknowledgment

My Ph.D. study would not have been accomplished if it was not for the help of many dedicated and great people in my life. I am thankful for my supportive family, amazing friends, professional colleagues, and mentors who inspired and guided me while I was completing my studies.

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CHAPTER ONE

Introduction

The prevalence of type 2 diabetes in the United States has more than tripled, increasing from 3% in 2000 to 9% in 2017 or 30.3 million people (Centers for Disease Control and Prevention [CDC], 2017). The American Diabetes Association (ADA) recently estimated the cost of diabetes at $327 billion in 2017, a 33% increase in the last 5 years. (ADA, 2018). This equates to a per capita health cost 2.3 times higher for those with disease compared to those without (ADA, 2018). Additionally, diabetics account for 25% of all hospital and nursing home stays. (Hass, 2014)

Adult Hispanics are 1.7 times more likely to become diabetics than non-Hispanic Caucasians (CDC, 2017). Therefore, a disproportion of hospital admissions with be among Hispanics with type 2 diabetes especially in regions where a large proportion of the population is Hispanic. Having a large proportion of Hispanic diabetic patients may pose a problem to hospitals and providers due to language barriers, cultural tradition related to food and exercise, and possible differences in decision-making among the family (Corrigan & Martin, 1992; Katzmarzyk, & Staiano, 2012).

Therefore, this study aims to identify, explore, and describe factors related to 30-day readmission among a large sample of Hispanic adults with type 2 diabetes. Findings can serve as a foundation for designing potential interventions to reduce these readmissions. Chapter one reviews the scope and significance of 30-day readmission among Hispanics adults with type 2 diabetes.

Scope and Significance

Despite advanced efforts in preventative medicine, diabetes remains the seventh leading cause of morbidity and mortality in the United State (CDC, 2017). Fortunately, the overall death rate from diabetes has decreased significantly over the past 20 years because of advancements in medicine (McBean et al., 2004). The prevalence of diabetes is expected to increase by 54%, which means by 2030 54.9 million people will be diagnosed with type 2 diabetes (Rowly, Bezold, Artikan, Byrne, & Krohe, 2017). This is a critical issue to consider for future generations as more people become diabetic.

Hispanic-Americans are the fastest growing segment of the population in the United State (Rowly et al., 2017) and they have a higher prevelence of diabetes. Among U.S. Hispanics, 12.6% have type 2 diabetes compared to 7.1% of Caucasian non-Hispanics (CDC, 2017). The Hispanic diabetic population is also younger than diabetics of other ethnicities (CDC, 2017). By 2030, the number of Hispanics with type 2 diabetes is expected to increase 93%, reaching 13.1 million people (Rowly et al., 2017). This will result in concurrent health care cost increases. By contrast, African-Americans, the second largest minority group in the U.S., are expected to see a 51% increase in diabetes diagnosis.

Providing hospital care for patients with a 30-day readmission can be very expensive for hospitals. The Centers for Medicare and Medicaid Services (CMS) reduce hospital reimbursement if a Medicare participant is readmitted within 30 days (McIlvennan, Eapen, & Allen, 2015). The CMS reports U.S. hospitals paid $528 million in penalties for patients readmitted within 30 days of discharge in 2017 (Boccuti & Casillas, 2017). Twenty percent of Medicare beneficiaries experience 30-day readmissions, costing Medicare more than $17 billion annually (Zohrabian, Kapp, & Simoes, 2018; McIlvennan et al., 2015). The CMS also monetarily penalizes hospitals with higher-than-expected readmissions by withholding additional reimbursement funds (Zohrabian, Kapp, & Simoes, 2018; National Quality Forum 2015-2017). Also, increasing 30-day readmissions negatively affects a hospital's quality of care rating if that figure is above the accepted rate for specific diagnoses (McIlvennan et al., 2015). Thirty-day readmission rates for type 2 diabetes are 14 to 23% in comparison to all other hospitalized patients at 8.5to 13.5% (Ostling et al., 2017). The present study aims to address this issue.

Potential Factors Related to 30-day Readmission

A diagnosis of type 2 diabetes often complicates hospitalizations associated with diagnoses such as myocardial infarction, congestive heart failure, or pneumonia, (Jiang et al., 2005). Enomoto and colleagues reported that length of hospitalization is five days or longer among patients with type 2 diabetes compared to non-diabetics who stay on average two days or less. Also, they reported diabetics have a 17% greater chance of readmission within 30 days compared with non-diabetic patients hospitalized (Enomoto et al., 2017). Few studies have focused on hospitalizations among Hispanics with type 2 diabetes, and even fewer have examined their 30-day readmissions rate and causes (Dungan, 2012; Spanakis & Golden, 2014). Reasons for increased hospitalizations among Hispanics may be related to both social determinants of health and health care access. Income is highly associated with mortality and morbidity. One in five Hispanics (20%) live at or below the poverty level (CDC, 2017). Low income combined with living in poorer neighborhoods with less access to nutritious food, having lower levels of educational attainment, lower English literacy, and also less health literacy, all have been identified as risk factors for readmission and can affect diabetes management. These factors, especially immigrant status, in turn can lead to decreased primary care health access which may mean poorer glucose control leading to rehospitalization. Disparities in social determinants may also mean higher rates of undiagnosed diabetes. A study examined differences in health care services usage among diabetics by ethnicity using propensity scoring to adjust for notable sociodemographic and behavioral differences between Hispanics and non-Hispanics (Lai et al., 2017). Even with these adjustments, Hispanics who are hospitalized for other illnesses, have an increased risk of being diagnosed with diabetes for the first time (Lai et al., 2017). Lai and colleagues showed Hispanics had less office visits with a provider, had more prescribed medication but less medication was purchased or used. These factors are reflected in the higher than average hospital costs for Hispanics $3918 compared to $ 2846 non-Hispanics (t (116) =5.99, p=0.001) (Lai et al., 2017).

For Hispanic patients, the hospital stay may not be long enough or the care is insufficiently coordinated so they are not confident in monitoring and managing their glucose levels and diet on discharge. Patients newly diagnosed with diabetes are at increased risk for readmission (Rubin, 2015). Post-discharge, if they do not have an identified primary care provider to see soon after discharge, they are also at increased risk for readmission (Dungan, 2012; McIlvennan et al., 2015). One study identified that Hispanics from lower socioeconomic levels with diabetes in their study had the higher risk for 30-day hospital readmission (Rubin, 2015).

Study Population

This study will use data from a community hospital that serves the South Region of San Diego County. This region includes the Health Service Areas of Coronado, National City, Chula Vista, Sweetwater, and South Bay. Due to its proximity to the Mexican border, this area has a high proportion of Hispanics. Of its nearly half million residents, 60% or just over 300,000 are Hispanic, the largest proportion of Hispanic in San Diego County (SD County 2018). The most recent community health needs assessment identified that diabetes related hospitalizations, emergency department discharges, and deaths among Hispanics were disproportionately higher in this region compared to Hispanic in other regions. (SD County 2014).

Although some studies examining risk factors for 30-day readmission among type 2 diabetics have examined factors such as sociodemographic and race/ethnicities, in general these studies contained very small samples of Hispanic patients (Aponte & Nokes, 2017; Rubin et al., 2014; Dungan, 2012; Enomoto et al., 2017; Jiang et al., 2005; Robbins &Webb, 2006; Rubin, 2015). Since data will come from a community hospital in an area serving a large Hispanic population, it will be able to focus solely on 30-day hospital readmission risk factors among Hispanics with type 2 diabetics.

Purpose

This retrospective case control study aims to identify factors associated with 30-day readmission among Hispanics with type 2 diabetes.

Research Aims

The following research aims was addressed:

Specific Aim 1: Measure the incidence of 30-day readmission among Hispanic adults with type 2 diabetes in a community hospital.

Specific Aim 2: Identify factors associated with 30-day readmission among Hispanics with type 2 diabetes.

Specific Aim 3: Compare the ability of two different models to predict 30-day hospital readmissions among Hispanic diabetics:

- Model 1: LACE score index
- Model 2: Model developed from the study data which includes novel variables added into the LACE index.

Summary

This chapter focused on the problem of 30-day readmission among Hispanic adults with type 2 diabetes. This problem is amplified by the increasing prevalence of type 2 diabetes in the United States, particularly among Hispanics, and the rise in the proportion of Hispanics in the population. The 30-day readmission of Hispanic with type 2 diabetes presents a major health care and economic problem for patients and hospitals, especially those with high Hispanic populations. Factors that the literature describes as particularly relevant to 30-day readmission include Hispanic ethnicity, increased length of stay during the primary hospitalization, non-Caucasian race, low social-economic status, age, low levels of education, lack of access to care, higher comorbidity and cultural barriers.

The scope and significance of 30-day readmissions among Hispanics with type 2 diabetes along with lack of research in the area of identifying factors that may predict 30-day readmissions provides justification for the proposed study. In the next chapter, a review of the literature explores factors contributing to 30-day readmissions among Hispanics with type 2 diabetes and presents a conceptual framework for the study.

Chapter 2

Review of Literature

Introduction

Chapter 1 discussed the scope of the problem of diabetes among the Hispanic community, its consequences and its causes, as well as the health care costs. This chapter will describe the literature on hospital 30-day readmissions in general with a particular focus on those studies that may have included a significant subset of Hispanic patients. This will be followed by a review of studies focused on early readmission of patients with diabetes, again with a focus on the sub-population of Hispanics. Other literature will then be reviewed to cover factors for inclusion in the proposed study that have not been included in the hospital readmission studies of diabetes. Lastly a conceptual framework for the proposed study will be presented. The chapter ends with a summary and clear justification for the proposed study.

General 30-day Readmission Studies

As previously described diabetes is one of the fastest growing chronic diseases with Hispanic Americans having the fastest rising prevalence. Therefore, the number of patients admitted with diabetes, as a primary or secondary diagnosis, is likely to grow above the current 7.2 million hospital discharges with a diabetes diagnosis (Centers for Disease Control and Prevention[CDC], 2017). Diabetes can not only complicate hospitalization, but also involve the need for coordinated care post-hospital discharge. Understanding the risk factors that result in Hispanics being re-hospitalized is important to develop better targeted hospital discharge interventions to save hospital's money and to improve patient outcomes.

Kaiser Readmission Study

A study of 30-day hospital readmission using all 18 hospitals in the Northern California Kaiser system identified diabetes as the second leading cause of readmission at 30%, just after hypertension at 36%. Readmissions related to heart failure and cardiovascular disease were lower in this study, at 20% and 19% respectively (Feigenbaum et al., 2012). The Feigenbaum et al. (2012) study was limited due to the fact that everyone was eligible for Kaiser insurance as well as the lack of variation in race/ethnicity of those studied, 67% were non-Hispanic white and only 9% were Hispanic.

Nevertheless, Feigenbaum et al. (2012) provided important data regarding preventing 30-day readmissions among patients with type 2 diabetes. Feigenbaum et al. (2012) showed that 47% of the 30-day readmissions may have been preventable, 36% were moderately preventable, and 11% were completely preventable. The researchers narrowed preventable factors of 30-day readmissions into the following three categories: 1) quality of care during hospital stay 30-day readmission; 2) ineffective discharge process increased 30-day readmission; and 3) missing or late follow-up care after discharge from the hospital increased 30-day readmission (Feigenbaum et al., 2012).

Feigenbaum et al., (2012) found preventable readmissions were caused by sub-optimal management of a chronic condition (80%), transitions of care problems (73%) and lack of referral for advance care planning and end-of-life care (41%). Feigenbaum et al., (2012) suggested since diabetes can be difficult to manage, especially among those hospitalized, this may indicate the need for better care coordination for patients with diabetes during hospital stay and post discharge using current and new tactics.

Predictive Models for 30-day Readmission

Kansagara and colleagues (2011) systematically reviewed 7843 studies, with the number of participants ranging from 173 to 3 million, to investigate factors predicting readmission risks among hospitalized patients. Fourteen of these studies only chose patients 65 and older and half of these studies only accepted Medicare participants and Veterans. Of these 30 studies, the majority (23) were performed in the US and seven others were conducted in five other western countries.

Kansagara and colleagues (2011) found 26 models that predicted readmission risks in 30 different studies. All 26 models included comorbidities and previous hospitalizations, but variables that were not addressed, that could be useful markers, were social determinants of health, mental health, functional status, and disease severity.

They reported that one model was unique in that it addressed preventable readmissions. Fourteen models measured risk for readmission using retrospective hospital data. Five models used prospective data (up to discharge) during recent hospitalizations (*c*-statistic=0.68-0.83). Nine models with large populations did not statistically predict readmission (*c*-statistic =0.55-0.65). They concluded that seven models could be used early in a hospital stay for early intervention (*c*-statistic =0.56-0.72). A c-statistic less than 0.5 is not significant, 0.7-0.8 is modest or acceptable, and greater than 0.8 indicates good discriminative ability. Six of the models compared functional and social variables within the same group of patients thus improving discrimination related to readmission (Kansagara et al., 2011). A simple Canadian model had good predictability (*c*-statistics =0.68) of 30-day readmissions, using comorbidities, length of stay, and prior hospitalization (Kansagara et al., 2011). A polypharmacy variable was used in an Irish model with strong predictability (*c*-statistics =0.7). Another model found inclusion of medical comorbidity, prior hospitalization, and creatinine level at discharge increased risk of readmission among heart failure patients

(Bradley et al., 2013; Kansagara et al., 2011). The Center for Medicare and Medicaid Services (CMS) tested three models and found poor predictability for 30-day readmissions for myocardial infarction (*c*-statistics=0.63), pneumonia (*c*-statistics =0.63) and congestive heart failure (*c*-statistics=0.61) (Kansagara et al., 2011).

Most models did not significantly predict 30-day readmission (5-79%) (Kansagara et al., 2011). The systemic review of 34 studies showed that while one model may serve as a strong predictor of readmission for one condition, it may be a poor predictor for another. Also, to increase a model's predictability, the model must focus on a specific population. For example, even though comorbidity may fit in a model, social determinants maybe a better fit for disadvantaged populations (Kansagara et al., 2011).

Complexity of Diabetes Care Possibly Affecting Readmission

Managing diabetes is challenging because diabetes is a chronic and complex illness that is influenced by a variety of personal factors. Furthermore, physical functioning and cognitive abilities are extremely important for performing needed self-care activities. For example, patients who are unable to perform insulin injections due to stroke or vision changes may be more at risk for hyper- or hypoglycemia (Dungan, 2012). The diabetic patient's level of education, experience, and skills have a direct effect on self-care maintenance; motivation to get involved in their own care is either intrinsic or extrinsic (Dungan, 2012; Stellefson et al., 2013). A patient's cultural beliefs and values also are important in this initial stage. For example, if the patient believes his aunt lost her eyesight from insulin, this belief would directly affect his willingness to be put on insulin in the hospital and its use at home (Galanti, 2014). Self-care maintenance also involves the patient's level of confidence to become involved in his or her own care (Stellefson et al., 2013). Woolf and Braveman (2011) reported that race and ethnicity, level of education, and income affect health status and health disparities among those with type 2 diabetes and increases the odds of 30-day readmissions. Indiviudals with lower socioeconomic status may need more education and coaching to achieve good glycemic control.

30-day Readmission for Patient with Diabetes Studies

Several studies have found a higher risk of 30-day readmissions among patients with type 2 diabetes than among non-diabetic patients. Rubin (2015) reported 30-day readmissions were higher among patient with diabetes compared to non-diabetics (15.3% vs. 8.4% respectively, $p < 0.001$) and similar findings have been reported in similar studies (14.4–22.7% vs. 8.5–13.5%) (Sonmez, Kambo, Avtanski, Lutsky & Poretsky, 2017). Jiang et al., (2005) and Feigenbaum et al. (2012) reported around 30% of patients with type 2 diabetes have multiple 30-day readmissions.

Diabetes Early Readmission Risk Indicator (DEERI)

Rubin and colleagues focused on developing a Diabetes Early Readmission Risk Indicator (DEERI) to identify patients at highest risk for readmission (2016). Over 44,000 discharges among slightly more than 17,000 patients in Boston, MA over an eight-year period were used for the study. They used 60% of the cohort as the training sample and 40% to validate the tool. Twelve percent of the population of this study were Hispanics and 19% did not speak English. The 30-day readmission rate for this cohort was 20.4%. They examined 46 predictor variables for building their risk tool. The final DEERI contained 10 predictor variables that were the most significant predictors of hospital readmission. These consisted of two socio-economic status (SES) variables: zip code within 5 miles of the hospital and employment status. The latter had the highest associated odds ratios of all model variables with disabled status odds ratio (OR) of 1.94 (95% CI 1.63, 2.32) and unemployed status OR 1.52 (95% CI 1.28, 1.80). Two model variables related to diabetes on admission: use of insulin, and presence of stage three or higher macrovascular disease. Another admission variable, presence of anemia, also stayed in the model. Two variables related to prior hospital discharges were in the model: prior discharge within 90 days of admission and if within the prior year the patient was discharged against medical advice. The remaining three variables related to clinical laboratory values of serum sodium, creatinine, and hematocrit. The c-statistic for the model was 0.70 indicating a good but not strong model. The model had a mean 30-day prediction of 39% for the highest quintile of scores and predicted about 38% of 30-day readmissions.

Rubin and colleagues (2018) sought to validate the DEERI tool with a different population of nearly 106,000 discharges among 19,000 patients. This population had a 30-day readmission rate of 18%. They obtained similar results with the exception that A1C and cholesterol levels were significant predictor variables but their inclusion in the model did not improve the c-statistic of 0.634. Rubin and colleagues conducted a third study among patient with diabetes with cardiovascular disease (2017). This study had very similar findings as to significant predictors, however education became a significant predictor variable. This study's population included 9% Hispanics.

Jiang, Stryer, Friedman, and Andrews (2003) used utilization review and healthcare cost data of over 648,000 patients with diabetes hospitalized in California, Missouri, New York, Tennessee, and Virginia in 1999. Their study showed Hispanics diabetics had increased odds for 30-day readmission (OR=1.2 ;1.18-1.23) compared to white non-Hispanic diabetics controlling for age, sex, payer, location, and income. They reported a rehospitalization rate for Hispanics of 37.2% compared to 34% for non-Hispanic blacks and 31% for non-Hispanics whites. Their study also showed higher rate of 30-day readmission among those insured by Medicare (OR=1.48; 1.45-1.50) or Medicaid (OR=1.63; 1.60-1.66) as well as families living in low income area. There was a high rate of comorbidities among these hospitalized diabetic patients: 90% had cardiovascular disease, 40% had lower extremity disease, and 25% had renal disease.

Their study findings are consistent with others have found that Hispanics and non-Hispanic blacks with diabetes have the highest rates for 30-day readmission, end stage renal disease, cost of hospitalization, and are less likely to have had a HgA1C drawn within hospital saty, a yearly eye exam, a podiatry exam or to self monitor their glucose levels (Dugan, 2012). Therefore, Hispanics and non-Hispanic blacks with diabetes more likely to have poor glycemic controlled (Jiang et al., 2005; Dungan, 2012).

Enomoto and associates (2017) did a retrospective study using the Pensylvania Healthcare Cost Containment Council data from 2011-2012 related to 30-day readmission and length of stay (LOS) among type 2 diabetics. Patient with diabetes were 17% more likely to be readmitted within 30-days post discharge from the hospital, (AOR=1.17, $P<0.001$) and had a longer length of stay (LOS) (0.19 days, $P<0.001$) and were more likely to stay longer than 5 days (AOR=1.71, 95% CI; 1.66-1.75) (Enomoto et al., 2017). Their study showed 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/myocardial infarction (MI) (5.5% vs. 3.3%) than patients without type 2 diabetes.

Enomoto and associates (2017), like previous studies, identified advanced age, male gender, non-white race (black), Medicare insurance, transfer another hospital increased the rate of 30-day readmission among patients with diabetes. Diabetes increased the number of comorbidities similarly to Dugan (2012) such as MI, stroke, malignancy, liver and renal failure. Enomoto and colleagues (2017) study was limited to Pensylvania, decreasing its genralizability. Even though their findings were similar to other studies, they may not be generalizable to a largely Hispanic population. It has been suggested due to importance the attenction has been placed to decrease 30-day readmmission among patient with diabetes each medical center should run their own study to evaluate causes of 30-day readmission uniqe to their population.

Social Determinants of Health

Understanding the social determinants of health is critical for understanding the root cause for health problems and developing effective health interventions (Walker, Gebregziabher, Martin-Harris, & Egede, 2014). Healthy People 2020 highlights the importance of social determinants of health. Having access to high quality healthcare, nutritional food, higher education, health literacy, and living in a safe neighborhood with quality housing are social determinants of health that directly and indirectly affect type 2 diabetes management (Castañeda et al., 2015; Hill, Nielsen, & Fox, 2013). Adverse social determinants of health have been associated with the increased incidence of type 2 diabetes. A low level of education and poor living conditions, including unsafe neighborhoods and communities, negatively impact a patient's health, especially those with chronic, complex conditions like type 2 diabetes (Woolf & Braveman, 2011). Woolf & Braveman (2011) noted that to close the gap on health disparities, these root causes must be addressed.

In 2004, Brown and colleagues sought to explain the mechanisms of connecting socioeconomic factors and social determinats of health in patient with diabetes (Brown et al., 2004; Walker et al., 2014). They found that individual, household, and neighborhood socioeconomic status were predictors of general and specific diabetes outcomes. Moreover, social determinants of health, including race, ethnicity, income, education level, language ability and health literacy, and insurance status affect the quality of care processes and outcomes in type 2 patient with diabetes (Woolf & Braveman, 2011). Unfortunately, there are a limited number of Hispanic health care providers who may be able to provide care in a Hispanic patient's preferred language and may have a better understanding of cultural issues that are promoters or barriers to self-care and treament (Castañeda et al., 2015).

Other social determinants such as psychosocial influences are also important when investigating diabetes self-care (Brown et al., 2004; Hill et al., 2013; Walker et al., 2014). Brown et al. (2004) explained that individuals with type 2 diabetes are affected by the environmet in which they were born, live, play, work, and age. They believed that the individual's enviroment dictated their diabetes outcome. These are associated with glycemic control both directly and indirectly through self-care, access to care, and processes of care.

In studying Hispanics in Southern California, immigration is a social determinant of health that cannot be ignored. In the last 40 years, Hispanics, from Mexico specifically, were the largest population of immigrants into the United States (Greieco, 2010). Type 2 diabetes rates in Mexico have risen significantly from 6.7% in 1994 to 14.4% in 2006 (Barquera et al., 2013). Afable-Munsuz and colleagues (2013) reported on the relationship between generations of immigrants, acculturation, and their risk of diabetes. Relative to first-generation Mexican-American adults, the odds of second-generation Mexican-American adults having type 2 diabetes is 1.8, [95% CI 1.4, 2.4) and increases to 2.1, 95% CI (1.4, 3.1) in the third-generation (Afable-Munsuz et al., 2013). This is especially important to the area of San Diego, adjacent to the border, which has a large population of Hispanic adults with type 2 diabetes.

A significant proportion of these Hispanic immigrants are undocumented which restricts their access to health care and jobs. Due to these factors, they suffer from lower income, lack of transportation and have high life stressors including hunger and homelessness (Chavez, 2012; Keusch, Wilentz & Kleinman, 2006). All of these result in underutilization of health care and when accessed, an inability to pay for drugs, including insulin which has become quite expensive. Horton and Barker (2010) reported a lack of access to proper medical care for young Mexican-Americans could cause long-term negative social effects, which they call “stigmatized biologies”.

Nurses, Diabetes-NPs, and Hospitals as Determinants of Care

In addition to patient, family, and social determinants of health, researchers have found that nurses, diabetes nurse practitioners, other healthcare providers, and hospitals greatly impact patients with diabetes’ initial, maintenance, and long-term status as they live with this chronic illness. Although nurses and diabetes nurse practitioners must be cognizant of patient, family, and social determinants and health-care sytem affecting diabetic patients, diabetes nurse practitioners greatest impact is at the bedside administering care, juggling to achieve precise and cost-effective treatment that is specific to each patients’ needs among type 2 diabetics. Diabetes nurse practitioners play a major role in improving the life of patients with diabetes during their hospitalization; and after discharge. Kaplan and his colleagues (1987) noted that positive social support increases diabetic patients’ satisfaction and also has a positive impact on improving A1C, especially among females (Kaplan et al., 1987). Nurses and diabetes nurse practitioners are the professionals focused on providing this social support. One study demonstrated that diabetes nurse practitioners obtained good long-term glycemic control and high patient satisfaction while providing diabetes management to hospitalized patients for cardiovascular diagnosis (Li et al., 2017)

In many cases, patients insured or unisured receive their diabetes diagnosis in the hospital for the first time while admitted for other diagnosis (Dugan, 2012). Studies suggest that to decrease 30-day readmissions related to type 2 diabetes, hospitals must create cost effective quality improvement and supportive interventions while patients are still in the hospitals (Jack et al., 2009; Dugan, 2012). Researchers agree that patients' self-management begins with good glycemic control in the hospital (Moghissi et al., 2009; Dugan, 2012). Good glucose management during hospitalization decreases the risk of 30-day hospital readmission (Dugan, 2012), During hospital stays, hyperglycemic episodes cause an increased risk of complications and mortality, with or without, prior diagnosis of diabetes (Corsino et al., 2017). Evidence shows that excellent glycemic control during the hospital stay affects the patient's self-management even after discharge from the hospital (Moghissi et al., 2009; Dugan, 2012; Corsino et al., 2017).

These facts provide evidence for assigning a diabetes team to monitor and manage blood glucose to ideal levels of euglycemia. This should greatly decrease length of stay and 30-day readmission (Moghissi et al., 2009; Dugan, 2012; Corsino et al., 2017). On the other hand, very poor glycemic control (HbA1c > 10%) may lead to impaired immune function associated with post-operative infection and increased readmission among surgical diabetic patients (Dungan, 2012; Furnary, Wu & Bookin, 2004; Rogers et al., 2008; Turina, Fry & Polk, 2005).

Another important hospital system factor is the replacement of primary care providers with hospitalists who only care for patients in the hospital. The hospitalists' job ends upon patient discharge, which may decreases type 2 diabetics' medication compliance (Poghosyan et al., 2017; Jack et al., 2009). This may be problematic for two reasons. First, medication lists while in the hospital must be changed to decrease drug-drug interaction with inpatient treatment during hospital stay. Medications that should be taken at home may have wider safety margins given less medical supervision at home. Sometimes hospital' medication discahrge lists are not changed to reflect what the patient should take at home causing patients to take potentially harmful medications or dosages which in turn can trigger mistrust and nonadherence to medical recommendations (Poghosyan et al., 2017). Lack of medication reconciliation can be a combination of a system-problem and a provider problem as can the fact many of these patients lack knowledge about their hospital diagnosis, understand the purpose of all thier medications (Jack et al., 2009). Secondly, follow-up visits missing critical information increase when type 2 diabetic patients are transferred to subsequent nursing home facilities or other providers affecting the quality of complex diabetes management and the patient's safety (Poghosyan et al., 2017; Jack et al., 2009).

The Affordable Care Act improved accessibility to care and helped patients obtain health insurance at a lower price. However, a high deductible for prescription medication remains an issue when patients have to pay full price for insulin at the pharmacy counter since insulin has no generic form (Lipska et al., 2014). In 2002 a vial of insulin cost $40, today it cost nearly $300, 7.5 times more. One study found one in four patients on insulin reported cost-related underuse which correlated with poorer glycemic control (Harkert, 2018). Out of pocket cost for patients with private insurance in one endocrinologist office's study has increased by 89% in 10 years (Lipska et al., 2014). A decrease in the price of prescription drugs, in this case insulin, would improve HgA1C levels and medicinal adherence, which positively affects wellbeing and decreases the possibility of 30-day readmission (Dugan, 2012). Diabetes nurse practitioners and other providers must strike a balance between prescribing the best medication for their patients and what they can afford.

Cost effective quality improvement interventions, such as having an inpatient diabetes team, lead to decreased emergency room visits for patients with type 2 diabetes-related complications (Jack et al., 2009). Also, follow-up visits with providers, such as diabetes nurse practitioners or primary care physicians who are familiar with the patient’s case during the hospital stay, and immediately after discharge, would likely have a huge impact on decreasing 30-day readmissions related to type 2 diabetes, and imrove patient satisfaction scores (Jack et al., 2009; Wachter, 2004; Moore et al., 2003).

Most studies related to 30-day readmission have focused on specific diagnoses like congestive heart failure or diabetes; or on high risk groups like elderly patients (Anderson et al., 2005; Phillips et al., 2004; Jack et al., 2009). Elderly patients are more likely to be readmited within 30 days from discharge because of advanced age and living with diabetes complications (Coleman et al., 2006; Jack et al., 2009). Few studies have focused on important aspects of discharge planning such as access to care; the ability to follow-up with a diabetes nurse practitioner or primary care physician in a timely manner post hospital discharge idealy within 10-14 days after discharge (Jack et al., 2009) smooth transition of care after discharge with clear discharge instructon in patiet-approprate language and delivery system (Jack et al., 2009); or increase patients′ ability to care for themselves after discharge because of their complex treatment regimen of type 2 diabetes with creating excelent teaching envorinment during hospital stay (Coleman et al., 2006).

Some hospitals have implimented transition-of-care teams (Dugan, 2012). This service allows the patient after discharge to keep a continuous flow of care between discharge and primary care visit in the event the patient cannot get an appointment with primary care immediately after discharge (Garnica, 2017; Kripalani, Jackson, Schnipper & Coleman, 2007; Kripalani et al., 2014).

Other Factors Affecting Readmission

One way to improve 30-day readmission among patient with diabetes is with better glucose management during their hospital stay (Dugan et al, 2012). Researchers and endocrinologists have shown increased rates of morbidity and mortality, and higher health care costs are associated with uncontrolled blood glucose during hospitalization (Moghissi et al., 2009; Dugan, 2012). Moghisssi et al., (2009) defined hyperglycemia as blood glucose over 180 mg/dl and hypoglycemia as below 70 mg/dl. Hyperglycemia was noted in 32.3% of all critically ill patients and 22-46% of all non-critically ill patients (Clement & Braithwaite, 2004; Corsino et al., 2017).

Family has both a direct and an indirect effect on diet, exercise, and self-care management among adults with type 2 diabetes (Wen, Shepherd & Parchman, 2004). Healthcare providers must involve the family in the management and support of patient with diabetes, especially with elderly patients with type 2 diabetes (Wen, et al., 2004). To improve diabetes self-management, Wen and colleagues recommend diabetes interventions focus on family support directed towards patient self-care, self-efficacy, and removing barriers to care. Sharifirad et al., (2013) showed type 2 diabetes patients' glycated hemoglobin A1C improved with family support and increased self-efficacy.

Mayberry and Osborn (2012) performed a mixed-methods study to examine the effects of family support on patients' diabetes medication adherence and glycemic control. Their results revealed family members with more knowledge of type 2 diabetes self-care were better able to support the patient in self-care management and medication adherence in the long run decreasing 30-day readmission and complications related to diabetes. In contrast, patients with non-supportive families were less likely to adhere to diabetic medications, resulting in worsening glycemic control. Interestingly, excessive support from family had a negative impact on diabetes self-care (Wen et al., 2004; Mayberry & Osborn, 2012). Well-informed families who did not participate in healthy behaviors themselves, often sabotaged the diabetic patient's self-care (Mayberry & Osborn, 2012). In addition, Mayberry and Osborn (2012) tested the concept of “miscarried help” (Fales, Essner, Harris, & Palermo, 2014). “Miscarried help” refers to family members taking over all care tasks, which ultimately may lead to uncontrolled diabetes (Nelson, McFarland & Reiber, 2007; Sharifirad et al., 2013). It is important that providers discuss with family members the effects of supportive and non-supportive behaviors on the patient's self-care and health outcomes related to type 2 diabetes (Mayberry & Osborn, 2012).

One model for understanding diabetes and its management uses an approach of three stages. The initial diagnosis state usually lasts one month, but in some cases may be extended if the patient remains in a denial state. The patient also is vulnerable at this stage for a 30-day readmission. The next state is the diabetes maintenance phase which involves performing daily blood sugar testing, preparing healthy meals, taking medication as prescribed, and engaging in daily exercise to maintain a healthy weight to prevent further complications and 30-day readmission (Stellefson, Dipnarine, & Stopka, 2013). Also follow-up appointments to evaluate the effectiveness of treatment and decisions regarding insulin type, oral medication and dosage (Stellefson et al., 2013). This phase can interfere with school or work and requires planning and organizational skills. Follow-up appointments and phone calls improve patient satisfaction and decrease 30-day readmissions in this phase (Stellefson et al., 2013). The third and long-term state, starts at about five-year post diagnosis. In this stage complications often arise requiring patients continue follow-up visits to the primary health care provider for weight and medication management every three months, as well as eye examinations, and podiatrist appointments yearly. To achieve the desired health-within-illness state, it is necessary that the patient achieve overall physiological and psychosocial adaptation to diabetes (Whittemore & Roy, 2002).

Conceptual Model

Reviewing the past 15 years literature, with the greatest focus on the past ten years in regard to diabetes type 2 and 30-day readmissions, 30-day readmissions and race/ethnicity in type 2 diabetics, and finally 30-day readmission among Hispanics with diabetes type 2 formed the foundation of this study. Researchers such as Jiang et al. (2003), Dugan (2012), Feignbaume et al., 2012, Rubin et al., (2014, 2015, 2016, 2017, 2018), and Enomoto et al. (2017) mentioned several correlates to 30-day readmission among patients with diabetes, yet they pointed to the gap for future studies, that is narrowing studies to more specific groups and ethnicities in a geographic location to increase sensitivity and reliability of the predictive model related to 30-day readmission, such as Hispanic adults with diabetes. If a more specific predictive model can be developed, it could be applied to a similar population to implement future cost-effective quality improvement measures like having diabetes team and diabetes nurse practitioner in the hospital for patients with diabetes. Therefore, the conceptual framework for this study will attempt to identify and measure three aspects related to hospitalized Hispanic patients with type 2 diabetes related to: (1) social determinants of health; (2) personal and clinical factors; (3) healthcare and provider factors and their association, separately and in relation to each other and to 30-day readmissions. (See Figure 1)

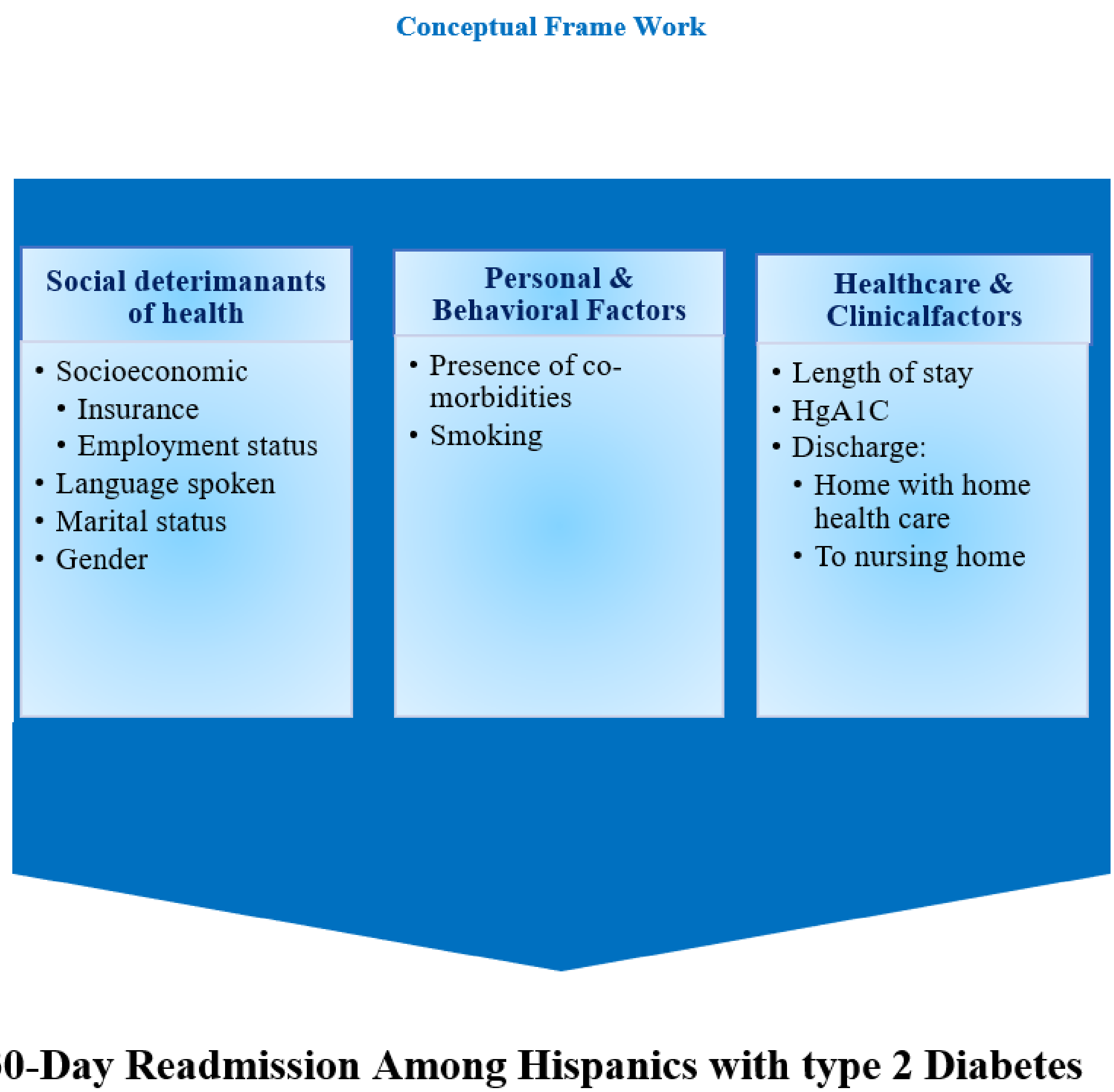

Figure 1: Illustration of conceptual model for 30-day readmission among Hispanic with type diabetes

Summary

This chapter began with the review of literature that explored general factors that may contribute to 30-day readmissions among Hispanics with type 2 diabetes. This review of diabetes mellitus literature was organized into a conceptual framework: e.g., social determinants of health, personal/clinical factors, nurses, diabetes nurse practitioner, and hospitals as determinants of care. Most studies have attempted to narrow the causes related to hospital 30-day readmission among high risk groups such as patient with diabetes. Interest in these studies has grown for two main reasons: (1) implementing transitional care interventions in an effort to reduce 30-day readmissions among chronically ill adults such as those with type 2 diabetes; and (2) to decrease costs associated with 30-day readmissions in patients with type 2 diabetes (Jack et al., 2009; Coleman, Parry, Chalmers & Min, 2006; Walker, Gebregziabher, Martin-Harris & Egede, 2014).

Assessment of 30-day readmissions among Hispanics with type 2 diabetes could help target the delivery of cost-effective quality improvement interventions to patients at the greatest risk. A gap exists between creating a standardized discharge intervention with a complete discharge and education plan, and follow-up reinforcement specific to adult Hispanics with type 2 diabetes.

Previous studies have studied a small, select number of factors related to 30-day readmissions. Most have conducted their work in hospitals with very limited numbers of minority or ethnic patients, especially Hispanic patient with diabetes.

The purpose of this study is to provide clinically applicable stratification of 30-day readmission risk among Hispanics with type 2 diabetes, with the goal of providing foundational information for efficacious discharge plans and interventions designed by team members together long before hospital discharge.

This study will consider all factors that the literature has presented as potential significant variables related to 30-day readmission among adult Hispanics with type 2 diabetes. Moreover, the study will be conducted in a setting with a preponderence of Hispanic diabetic patients.

Findings can be used to target the delivery of precious, resource-intensive, cost-effective, timely nursing, diabetes nurse practitioner, and physician interventions for adult Hispanic patients hospitalized for diabetes. Findings from this study will provide clinically relevant stratification of 30-day hospital readmission risks among a large sample Hispanic adults with type 2 diabetes.

Chapter 3

Research Methodology

Introduction

Around the globe, all healthcare systems seek to improve quality and costs constraint therefore there currently has increased attention on 30-day readmission rates. It is projected that Hispanic-Americans will experience the largest increase in diabetes diagnoses than any segment of the U.S. population (Aponte and Nokes, 2017). It follows that Hispanics then may also account for a significant proportion of 30-day readmission rates. As previously identified, little is known about factors related to 30-day readmission rates among Hispanics with type 2 diabetes. Knowing those factors may lead to more appropriate and targeted interventions aimed at this particular high-risk group, potentially resulting in cost savings to hospitals and decreased pain and stress for patients.

Purpose

The purpose of this retrospective case control study was to identify factors predictive like increasing or decreasing factors of 30-day readmission among Hispanics with type 2 diabetes by comparing the two groups.

Specific Aims

Specific Aim 1: Measure the incidence of 30-day readmission among Hispanic adults with type 2 diabetes in a community hospital.

Specific Aim 2: Identified factors associated with 30-day readmission among Hispanics with type 2 diabetes.

Specific Aim 3: Compare the ability of two different models to predict 30-day readmissions among Hispanic with type 2 diabetes:

- Model 1: LACE score index
- Model 2: Model developed from the study data which includes novel variables added into the LACE index.

Research Design

This retrospective case control study explored novel variables (variables that have not been used in any literature reviewed studies) to predict the factors related to 30-day readmission among Hispanic adults with type 2 diabetes. The potential study population were all Hispanic adults with type 2 diabetes admitted to a community hospital from beginning of 2015, through 2017 meeting study inclusion and exclusion criteria. Cases were individuals who were readmitted within 30 days of hospital discharge and controls were those without an early readmission. The use of a case-control design was the most efficient study design to identify adequate numbers for predictive modeling and yet limiting the amount of time needed in abstracting the study variables from the electronic medical record (EMR) electronic financial records (EFR), and Cerner chart review (Table 1).

Setting

This study used data from a 243 licensed bed community hospital in Southern California with medical and surgical beds that consistently treats a large number of Hispanics. The hospital serves the south region of San Diego County. According to the Community Health Need Assessment (CHNA) 2013 survey for this geographic region, over 45% of adults have a diabetes diagnosis and over 60% of diabetic patient self-report as Hispanic.

Study Population

The study population included self-identified Hispanic type 2 diabetics admitted to the selected community hospital between early 2015 to end of 2017. During this time period, there were nearly 8,000 Hispanic adults with type 2 diabetes admitted to the study hospital and approximately 15% experienced a 30-day readmission. Subjects eligible for this study will meet the following criteria:

Inclusion criteria:

- Admission between 2015 and 2017 with a diagnosis of type 2 diabetes, A diagnosis of diabetes as a secondary or primary diagnosis using the international Statistical Classification of Diseases and Related Health Problems (ICD-10) discharge diagnosis of E11.00, E11.65 (regardless of insulin use prior to hospital stay, new to insulin and oral anti-diabetic medication) was obtained based on descriptions by diagnosis-related group (DRG).
- Hispanic race/ethnicity- Self-identification obtained from electronic health record.
- Discharged from the hospital to home with either self-care or home health during the years 2015-2017.

Exclusion criteria:

- Pregnant patients
- Patients younger than 18 years of age
- Patients who died during the primary hospitalization.
- Patients who were transferred to another hospital, hospice/palliative care or long-term acute care and nursing home facilities.
- Patients leaving against medical advice.

Variables

Data variables for this study was obtained from three sources: 1) electronic medical record (EMR), 2) electronic financial records (EFR), and 3) Cerner chart review (Table 1).

LACE Index Score

The LACE index identifies patients who are at risk for readmission or death within 30-day of discharge using four measures: **L**ength of hospital stay; **A**cuity of admission; **C**omorbidity Index per LACE scale; **E**mergency department use within six months of admission. The LACE index was developed and validated on over 4800 patients from 11 hospitals in cities in Ontario, Canada. Van Walraven and colleagues (2010) considered 48 variables for their predictive model with four meeting their model specifications. These were length of stay ("L;" odds ratio [OR] 1.47, 95% CI 1.25 to1.73) acuity of the admission ("A;" OR 1.84, 95% CI 1.29 to 2.63), comorbidity ("C;" [OR 1.21, 95% CI 1.10 to1.33]), and emergency department use ("E;" OR 1.56, 95% CI 1.27 to 1.92). The model had moderate discrimination (C statistic 0.7025; 95% CI 0.6755–0.7295) and was well calibrated by Hosmer-Lemshow test. The model was externally validated using all 1 million admissions from Ontario. LACE scores range from 0 to 19. Risk of death or urgent readmission within 30 days based on the LACE score ranged from 25 for those with a 0 score to 44% for those with a score of 19.The LACE model had moderately good predictive value, c-statistics for training set was 0.711 (95% CI 0.674, 0.749) and for the validation set was 0.694 (95% CI 0.655, 0.732) with a good-fit assessed by the Hosmer-Lemeshow statistic (11.5, p = 0.18). Their study found that one-point increase in LACE index score increased odds of 30-day readmission by 18% [OR 1.18, 95% CI 1.14 to1.21] (van Walraven, et. al., 2010). Since this study, several studies have used the LACE index to predict hospital readmission in both general patients and in specific populations of patient, e.g. those with COPD. In addition, there are internet tools readily available for calculating LACE scores.

In a recent study, Damery and Combes (2017) examined whether the LACE index score is sensitive to predict 30-day readmission or if the addition of other clinical and sociodemographic variables would improve predictive ability of the LACE score in a British population. They used a large data of 92,000 patients from England for the years 2013 through 2014. The British study confirmed moderate discrimination found in the original LACE study with an area under the curve (AUC) of 0.806 (95% CI 0.801 to 0.812. A cut-off of 11 points was most predictive of readmission but only 25% of all those readmitted had a score of 11 or higher. However, they found use of **only two variables**: number of emergency room visits in the past six months and number of hospital admissions in the prior one year had better prediction than the LACE model [AUC=0.815; 95% CI 0.810 to 0.819] (Damery & Combes, 2017). This was a large study with a range of co-morbidities. It obtained similar statistics to the prior LACE study confirming the reproducibility of results but indicating that fewer variables or even good clinical judgement may be as good at predicting 30-day hospital readmission. (Damery& Combes, 2017).

The LACE Index is calculated using the following variables (see Appendix A for scoring criteria):

- **L**ength of hospital stay: Length of stay score that is calculated based on the how many days patient was in the hospital starts from one to seven that indicates length of stay over 14 days (L=1-7).

- **A**cuity of admission: The score for acuity of admission is calculated from if patient was admitted to the hospital via emergency room: Then A score is three, otherwise it is zero (A=0 or 3).
- **C**omorbidities: The C score is the number of all comorbidities that is named in the next paragraph. If patient has more than four comorbidities, he or she will receive five for box C. LACE comorbidities are previous myocardial infarction*, peripheral vascular disease*, cerebrovascular disease*, congestive heart failure*, diabetes without complication*, diabetes with end organ damage*, chronic pulmonary disease*, mild liver or renal disease*, any tumor* [including lymphoma or leukemia], dementia*, connective tissue disease*, AIDS*, Moderate or severe liver* or renal disease*, metastatic solids tumor* (*LACE comorbidities are not duplicated in study comorbidities)
- **E**mergency department visits in the prior six months: This is number of visits to the emergency room in the past six months including this admission if patient is in the hospital at the time of study. This number will not exceed four.

Then added numbers from box "L" to box "A" to box "C" and box "E" calculate a "LACE" score. This LACE score $\geq$10 is indicative of high risk for a 30-day readmission based on previous researchers' study. (Robinson & Hudali, 2017).

Study variables not included in LACE Index

The literature review suggested measuring other variables besides LACE index score ones to increase specificity and validity. Variables such as, sex and age were included in most models but were not predictive of 30-day readmission when other variables were in the model (Kansagara et al., 2011). Variables like clinical data, severity of the illness, comorbidities and social-determinant of health increase predictability of 30-day readmission but were not measured in most studies (Kansagara et al., 2011). A few other variables, such as specific diagnosis group codes (Demary & Combes, 2017) or demographics such as gender (Demary & Combes, 2017), race/ethnicity (Demary & Combes, 2017) did not increase predictability of 30-day readmission but these variables have added benefit for increased validation based on the studied community hospital. Other variable (Kansagara et al., 2011) but insurance has been considered in some models.

- **Socio-demographic information:** age, gender, language, marital status, employment status including employed, unemployed, disability and retired, insurance including commercial/other insurances, Medicare and Medi-Cal (poverty criteria is defined as Medi-Cal eligibility). (Table 1).
- **Behavioral risk**: Smoking or alcohol drinking,
- **Comorbidities**: Myocardial infarction (MI), Cerebrovascular accident (CVA), peripheral vascular diseases (PVD), chronic pulmonary disease (COPD), Liver disease, dementia, connective tissue disease, diabetes with complications, cancer, renal disease (Table 3).
- **Clinical lab values** during hospitalizations specifically:
    - HgA1C measured on admission – a measure of blood glucose levels in the prior three months; >7% is considered uncontrolled

      Uncontrolled glycemia - defined as two or more consecutive days of blood glucose recordings above 180 mg/dl or a blood glucose less than 70 mg/dl at any time during the hospital stay (Table 2).
- **Discharges status**: 1) home alone, 2) home with home health

- **Consults**: Patient received consult to: 1) social worker/case manager, or 2) diabetes nurse practitioner and 3) diabetes educator (Table 4).

Identifying Study Participants

All Hispanic adults with type 2 diabetes who were admitted in 2015, 2016 and 2017 who met the inclusion and exclusion criteria were eligible for the study. Cases were those who were readmitted within 30-days of discharge. Controls were those who were not readmitted within 30-days. A patient was only eligible once for the study (e.g. if a subject was identified as a case in 2015, they could not be a case or control if readmitted in 2016 in order to maintain statistical assumptions of independence). Cases and controls were drawn fairly equally among the three years and over the 12 months to avoid time and seasonal effects.

Based on literature review, a sample size of 400 subjects (200 readmitted and 200 not readmitted) would adequate to develop a predictive model using a random 200 for developing the model and the other 200 for validating the model. (Vergouwe et al., 2005; Peduzzi et al.,1996).

Analytic Approach

Initial descriptive statistics were done on all study variables. For continuous variables, the distribution of the values was examined and either left the variable as a continuous measure or categorized it by natural cut-points from the distribution. Distributions also determined the best presentation for continuous variables as means with standard deviation for normally distributed variables or median and interquartile range for skewed data. Bivariate analysis between sociodemographic/behavioral characteristics, clinical characteristics, comorbidities and consult characteristics was performed.

Multivariable logistic regression modeling in order to adjust for potential confounding between those readmitted and those not readmitted. Any variables showing association with 30-day readmission were considered for the multivariable regression. Variables were retained in the model if they had a p-value $\leq$ 0.05 or changed the effect estimate by 10%.

A split-sample design was used to develop and then test the study predictive model (study model). A random selection of 49% Derivation group and validating the model within validation group (51%) was comprised the sample for creating the study's model for predicting readmission (see Figure 1). Bivariate logistic regression analysis between variables and 30-day readmission was calculated. Any variable with a $p<0.10$ was included in the initial regression model. Backward stepwise regression approach was used to identify variables which produced the best area under the curve (AUC). The area under the curve (AUC) and calibration statistic (C-statistic) was calculated for the model with all qualified variables and then dropping variables above $p<0.05$. These were compared for best fit. In addition, the Hosmer-Lemshow test was calculated to assess model stability (Giancristofaro and Salmaso, 2007). After the study model was defined, it was tested in the other half of the study sample, the validation group. The same AUC, C-statistics, and Hosmer-Lemshow test was calculated. These statistics were compared between the derivation and validation samples. Sensitivity, specificity, and positive predictive values were calculated for the models.

The LACE scoring was applied to the entire sample and the previously described statistics for the studied model was calculated. A comparison of the statistics between the two was made to assesse predictive ability between the two models.

Protection of human subjects

The study methodology received approval from both the institutional review boards (IRB) for the University of San Diego and the participating hospital.

An initial dataset identifying qualifying participants with a type 2 diabetes diagnosis and meeting the study inclusion and exclusion criteria was made by hospital data system personnel. This dataset with patient identifiers remained on the premises of the hospital. A copy of this dataset was on the researcher's computer which was passworded but free of specific identifiers, such as the complete medical record number. This de-identified dataset was used to input abstracted data only available in the patient's medical record on the Cerner server. The principal investigator's computer was kept in a locked office/cabinet when not in use by the researcher. By securing the data in safe place and de-identifying the data, this study posed minimal risk to the potential subject's health and welfare. Precautions was taken to protect patient privacy in accordance with the Health Insurance Portability and Accountability Act (HIPPA). Access to patient identifiers was limited to the primary investigator (working for the same hospital).

Study timeline

The initial data file was received by the second week of January, 2019 and took over 5 months to identify the study sample of single individuals and, randomly choose a single admission among those with multiple admissions and to obtain information from the Cerner health record. The completion of data collection and data cleaning was done by end of May, 2019. The preliminary analyses were begun in June, 2019.

Ethical issues

No ethical issues were encountered during the conduct of this study.

CHAPTER 4

RESULTS

The purpose of this retrospective case-control study was to identify predictive factors related to 30-day readmission among Hispanic adults with type 2 diabetes. The population of Hispanic adults was selected because 69% of the patients served by the community hospital speak Spanish. Further, related data from this hospital indicated over 62% of patients with a primary or secondary diagnosis of diabetes admitted in 2017 self-defined as Hispanic.

Description of the Sample

From 2015 to 2017, the years of this study, the rate of 30-day readmission among all patients with diabetes admitted (14.7%-22.2%) to the study hospital ranged from 11.8% in 2015 to 9.4% in 2017.

Initially, there were 7,920 patients hospitalized with a primary or secondary diagnosis of type 2 diabetes (as defined by ICD-10) who self-defined as Hispanic from early 2015 to the end of 2017. After excluding those that did not meet study criteria due to death during hospitalization, were discharged to nursing home, or left against medical advice, there were 5,985 patients meeting study criteria. However, 15% of Hispanics with diabetes type 2 were admitted multiple times during the study period. After randomly choosing only one admission for patients admitted multiple times, the final study sample was 3,865.

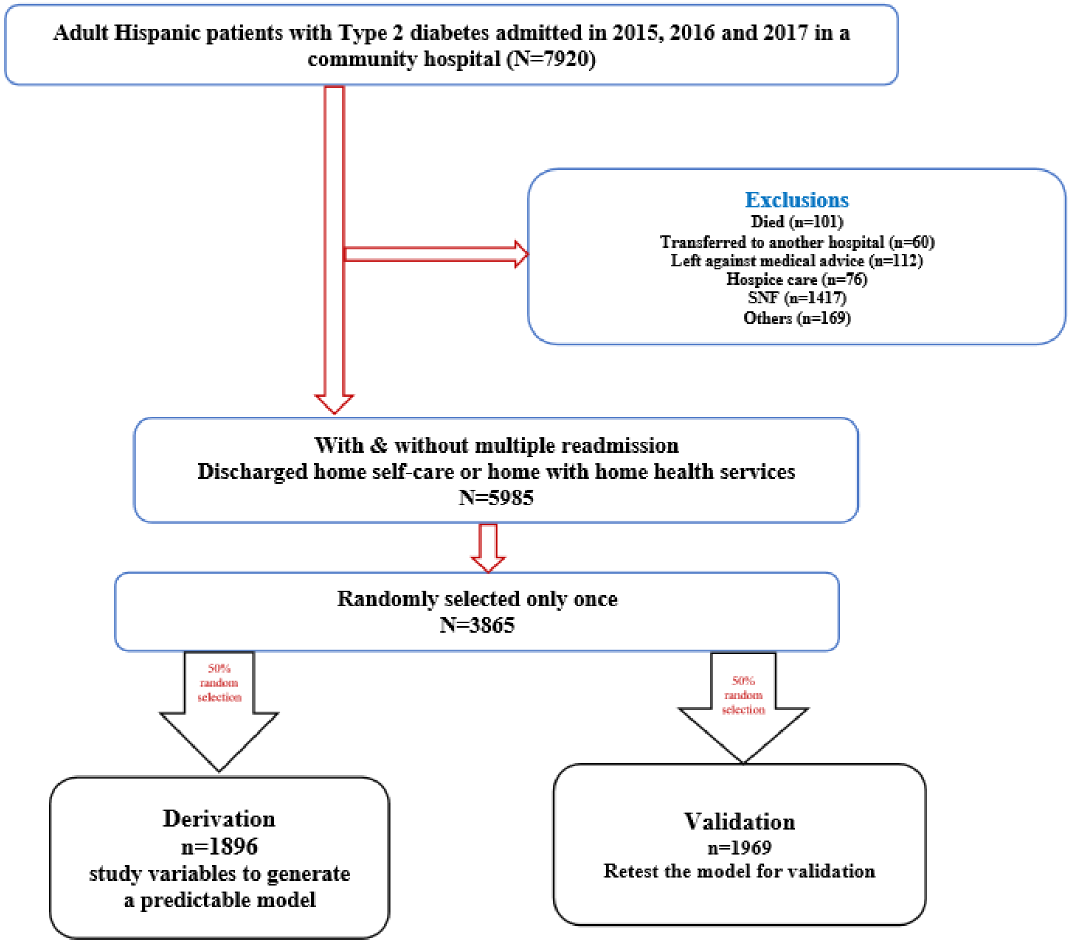

Figure 1: *Illustration of sample selection procedure.*

Research Aim 1

Research Aim 1 was to measure the incidence of 30-day readmission among Hispanic adults with type 2 diabetes in a community hospital by sociodemographic, behavioral characteristics and clinical factors.

Sociodemographic and Behavioral Characteristics

The overall readmission rate of the study sample was 9.5%. The mean age of the sample was 65 years (SD=14.6) (Table 1). Compared to the 69% being Spanish speaking only subjects, the 31% who spoke English-only had a statistically non-significant 19% increased odds of 30-day readmission (OR =1.19; 95% CI, 0.95-1.50). Unsurprisingly, over half the sample was insured by Medicare and one-third by Medi-Cal. Nearly half were retired with another 20% disabled and only 15% employed.

Differences in sociodemographic, clinical data, specific comorbidities, consults, and hospital discharge disposition were compared by 30-day readmission status. The bivariate analysis of sociodemographic characteristics showed gender, age, language spoken, and marital status were not statistically significant associated with 30-day readmission (Table 1). Those with Medi-Cal and Medicare had a 50 to 59% increased odds of early readmission, respectively (Table 1). Compared to those who were employed, the retired and unemployed had a 65-69% increased odds and those who were disabled had nearly 2.5 times the odds of early readmission (OR =2.49; 95% CI, 1.60-3.90). Male gender and unmarried status increased the odds of 30-day readmission by 12-22% (OR =1.12; 95% CI, 0.90-1.39 and 1.22; 95% CI, 0.98-1.51 respectively) Smoking status was also marginally associated with 30-day readmission (OR =1.39; 95% CI, 0.99-1.94) (see Table 1).

Table 1: Bivariate association between behavioral and sociodemographic characteristics by 30-day readmission status

Variable	Total Sample (*N*=3865) n (%)	Not Readmitted (n = 3496) n (%)	Readmitted (n=369) N (%)	Odds ratio (95% CI)
Age Mean (SD)	65 (14.61)			
Gender	3865	3496(90.5)	369(9.5)	
Male	1872 (48.4)	1684 (48.2)	188 (50.9)	1.12 (0.90-1.39)
Female	1993 (51.6)	1812 (51.8)	181 (49.1)	Reference
Language				
Spanish	2646 (68.6)	2406 (69.0)	240 (65.0)	Reference
English	1212 (31.4)	1083 (31.0)	129 (35.0)	1.19 (0.95-1.50)
Marital Status				
Unmarried	1985 (51.4)	1779(51)	206(55.8)	1.22 (0.98-1.51)
Married	1875(48.6)	1712(49.0)	163(44.2)	Reference
Insurance				
Medi-Cal	1340(34.7)	1211(34.6)	129(35.0)	1.50(1.01-2.24)
Medicare	2043(52.9)	1835(52.5)	208(56.4)	1.59(1.08-2.35)
Other insurance	482(12.5)	450(12.9)	32(8.7)	Reference
Employment				
Employed	458(14.6)	430(15.2)	28(8.9)	Reference
Unemployed	526(16.7)	474(16.7)	52(16.5)	1.69(1.05-2.72)
Retired	1539(48.9)	1390(49.1)	149(47.2)	1.65(1.08-2.50)
Disability	623(19.8)	536(18.9)	87(27.5)	2.49(1.60-3.90)
Smoker	363(9.4)	318(9.1)	45(12.2)	1.39 (0.99-1.94)
Non-Smoker	3502(90.6)	3178(90.9)	324(87.8)	Reference

LACE Criteria

Length of stay (LOS) was a statistically significant predictor of 30-day readmission. The mean LOS for the sample was 4 days (SD = 3.7) with length of stay 4.11(3.64) for those not readmitted and 5.63(5.43) for the readmitted group (*P*<0.001) (Table 2). The LOS as a categorical variable showed 2.3% staying 14 or more days, 13% staying 7-13 days, 28% staying 4-6 days and 57% staying 3 or fewer days. Patients staying 14 or more days had nearly 4 times higher odds of 30-day readmission (OR= 3.72; 95% CI, 2.22-6.21) compared to those who stayed 3 days or fewer. Patient staying 7-13 days had 75% higher odds of 30-day readmission (OR= 1.75; 95% CI, 1.29-2.39), and those staying 4-6 days had 45% higher odds of readmission (OR=1.45, 95% CI, 1.13-1.89) compared to those stayed 3 days or fewer (see Table 2).

Acuity of admission. The second component of LACE, acuity of admission, was rated high if admission was through the emergency department and low if admission was directly from a primary care office. In this sample, the vast majority of admissions were through the emergency department, 91.5%. Therefore, this component of the LACE index was not statistically associated with 30-day readmission (see Table 2).

Comorbidity. The third component of LACE is comorbidity. The LACE comorbidity index (CI) is calculated based on several components and points can range from 0 to 6 (See Chapter 3). All subjects in this study earned at least 1 point since they all had diabetes. Less than one-fourth had one other comorbidity. No subjects met the criteria to earn 6 points. The odds of being readmitted increased with an increasing number of comorbid conditions although this was not statistically significant until a subject earned 4 or 5 points. Those with 5 points had an odds ratio for readmission of 1.75 (95% CI,1.26-2.43) (See Table2).

Emergency department visits. The last component of the LACE index score is the number of emergency department (ED) visits in the past six months exclusive of the ED visit leading to the current admission. Zero to three visits were scored as the actual number of associated ED visits, but four or more visits were all scored as four. Not much variance was detected in the data. This was likely due to a large portion of study patients receiving care through the ED because they have no primary care physicians and because ED visits require no copayment and feature same-day patient care. The odds of 30-day readmission increased when using the ED for their treatment. Out of whole sample, 2% of diabetics used the ED more than four times prior to their admission which increased their readmission odds 12 times compared to the one who did not have ED visit prior to their admission. One-fourth of patient with one ED visit before their admission had 10 times higher odds of 30-day readmission (see Table 2).

Other clinical characteristics

A HgA1C, a measure of blood glucose levels in the prior three months, more than 7% is considered uncontrolled diabetes. The mean HgA1C was 7.54% (SD = 1.90) and the means by readmission status were not different (see Table 2). HgA1C was also analyzed as a categorical variable divided into three groups: 1) less than 7%, 2) 7-9% and 3) over 9%. As categorical data, 19% of all diabetic admissions had a HgA1C above 9% which was marginally associated with a higher rate of 30-day readmission (OR=1.29; 95% CI, 0.95-1.76). One-third of the sample had an intermediate level of HgA1C (7-9%) which was not associated with readmission (OR=1.01; 95% CI, 0.77-1.32) (see Table 2).

Table 2: Bivariate logistic regression Clinical characteristics of the study sample overall and by 30-Day readmission status

Variable	**Total Sample** ***N*=3865** **n (%)**	**Not Readmitted** **n= 3496** **n (%)**	**Readmitted** **n =369** **n (%)**	**Odds Ratio (95% CI)**
LOS mean (SD)	4 (3.7)	4.11(3.64)	5.63(5.43)	
LOS $\geq$ 14 days	89 (2.3)	68(1.9)	21(5.7)	3.72 (2.22-6.21)
LOS 7-13 days	495 (12.8)	432(12.4%)	63(17.1)	1.75 (1.29-2.39)
LOS 4 -6 days	1079 (27.9)	963(27.5)	116(31.4)	1.45 (1.13-1.86)
LOS $\leq$ 3 days	2202 (57.0)	2033(58.2)	169(45.8)	Reference
A-Acuity		3496(90.5	369(9.5)	
Low Acuity	328 (8.6)	297(8.6)	31(8.5)	Reference
High Acuity	3495 (91.4)	3160(91.4)	335(91.5)	1.02 (0.69-1.50)
C-Comorbidity				
Diabetes type 2	915 (23.9)	842 (24.4)	73(19.9)	Reference
DM+1 cm	929 (24.3)	855 (24.7)	74 (20.2)	1.0 (0.71-1.40)
DM+2 cm	727 (19.0)	661 (19.1)	66 (18.0)	1.15 (0.81-1.63)
DM+3 cm	583 (15.2)	518 (15.0)	65 (17.8)	1.45 (1.02-2.06)
DM+$\geq$4 (severe)	669 (17.5)	581 (16.8)	88 (24.0)	1.75 (1.26-2.43)
ED visit past 6 m.				
No visits	3569 (92.3)	3322 (95)	247 (66.9)	Reference
1 visit	213 (5.5)	124 (3.5)	89 (24.1)	10.0 (7.14-13.05)
2 visits	44 (1.1)	28 (0.8)	16 (4.3)	7.69 (4.10-14.40)
3 visits.	24 (0.6)	14 (0.4)	10 (2.7)	9.61 (4.22-21.85)
4 or more visits	15 (0.4)	8 (0.2)	7 (1.9)	11.80 (4.23-32.72)
HgA1C (Mean)	7.54 (1.9)	7.53(1.89)	7.65(2.04)	
>9.1%	567 (18.6)	500 (18.2)	67 (22.2)	1.29 (0 .95-1.76)
7-9%	1035 (33.9)	937 (34.0)	98 (32.5)	1.01 (0.77-1.32)
<7%	1454 (47.6)	1317 (47.8)	137(45.4)	Reference

Comorbidities

Comorbidities were identified based on the index admission ICD10-CM codes. Adults with diabetes are more at risk for cardiovascular diseases. The data showed congestive heart failure (CHF) increased the odds of 30-day readmission 36% (OR=1.36; 95% CI, 1.08-1.71) compared to those without CHF. In addition to type 2 diabetes, the presence of other added comorbidities that increased the odds of 30-day readmission in the bivariate analysis were liver disease 55% (OR=1.55; 95% CI, 1.10-2.18) connective tissue disease 95% (OR=1.95; 95% CI, 1.01-3.77), and renal disease 24% (OR=1.24; 95% CI, 1.0-1.53) (see Table 3).

Comorbidities like cerebrovascular disease (CVA) and myocardial infarction (MI) did not increase 30-day readmission in the bivariate analysis. No patients were coded with moderate to severe liver disease nor HIV/AIDS. Presence of a discharge code for diabetes complications, decreased the odds of readmission by 25%.

Table 3: Bivariate logistic regression Clinical DX ICD-10 Characteristics of the Study Sample Overall and by 30-Day Readmission Status

Variable	Total Sample *N*=3865 n (%)	Not Readmitted n = 3496 n (%)	Readmitted n=369 n (%)	Odds ratio (95% CI)
Comorbidities				
MI	294 (7.7)	265 (7.7)	29 (7.9)	1.04 (0.70-1.55)
CVA	347 (9.1)	316 (9.1)	31 (8.5)	0.92 (0.63-1.35)
PVD	568 (14.9)	507 (14.7)	61 (16.7)	1.16 (0.87-1.56)
CHF	1088 (28.5)	962 (27.8)	126 (34.4)	1.36 (1.08-1.71)
COPD	774 (19.2)	667 (19.0)	77 (21.0)	1.12 (0.86-1.46)
Liver disease	317 (8.3)	274 (7.9)	43 (11.7)	1.55 (1.10-2.18)
Dementia	178 (4.7)	156 (4.5)	22 (6.0)	1.35 (0.85-2.14)
Connective tissue Disease	65 (1.7)	54 (1.6)	11 (3.0)	1.95 (1.01-3.77)
Diabetes with Complications	1329 (34.8)	1223 (35.4)	106 (29.0)	0.75 (0.59-0.94)
Cancer	261 (6.8)	233 (6.7)	28 (7.6)	1.15 (0.77-1.73)
Renal Disease	1538 (39.8)	1374 (39.4)	164 (44.4)	1.24 (1.0-1.53)

Consult characteristics

Diabetic patients frequently had consults to be seen by case managers, diabetes educators, and diabetic nurse practitioners. For these three types of consults, the most frequent was with a diabetes nurse practitioner who saw slightly more than 70% of patients. The type of consult that occurred was not associated with 30-day readmission.

However, the presence of a consult for a home health aide at discharge was associated with 30-day readmission. Nearly 23% of those readmitted were discharged with a home health aide consult compared to only 15% who were not experience readmission. Almost one fourth of subjects who were discharged to home used home health services (23%) versus three-fourths going home with self-care (77%). Discharge disposition with home health aide increased the readmissions odds by 68% compared to those who were discharged home on self-care (OR=1.68, 95% CI, 1.29-2.20) (see table 4).

Table 4: Bivariate logistic regression Consults characteristics of the study sample overall and by 30-Day readmission status

Variable	**Total Sample** *N*=3865 n (%)	**Not Readmitted** n = 3496 n (%)	**Readmitted** n= 369 n (%)	**Odds ratio (95% CI)**
Case manager	1507 (39.0)	1360 (38.9)	147 (30.8)	1.04 (0.85-1.26)
Diabetes NP	2721 (70.4)	2457 (70.3)	264 (71.5)	1.06 (0.85-1.31)
Diabetes Educator	1076 (27.8)	963 (27.6)	111 (30.1)	1.13 (0.90-1.38)
Home w. HH	622 (16.1)	536 (15.3)	86 (23.3)	1.68 (1.29-2.20)
Home self-C.	3243 (83.9)	2960 (84.7)	283 (76.7)	Reference

Research Aim 2

Research Aim 2 was to identify independent factors associated with 30-day readmission among Hispanic adults with type 2 diabetes accounting for potential covariates. The presence of any difference in baseline characteristics between the cohort who experienced 30-day readmission and those not readmitted was analyzed by multivariable logistic regression using any variable in Tables 1-4 with a $p \leq 0.1$ Only ten independent variables met these criteria for the multivariate modeling (see Table 5).

This multivariable model contained 10 variables. The full model was statistically significant with omnibus chi square (X^2) 64.82, 10 degree of freedom, $P<.001$. The Hosmer-Lemeshow goodness of fit chi square (X^2) 7.58 with $P=0.48$, indicating the model was a good fit for the data (Hosmer & Lemeshow, 2000). Employment status variables had the strongest predictive values in the model with disability having the highest odds (OR=2.43; 95% CI, 1.51-3.90) followed by unemployed and retirement status. Discharge with a home health care consult increased the odds of readmission 59% (OR=1.59; 95% CI 1.19-2.13). After accounting for covariates, only liver disease remained a small risk factor for readmission (OR= 1.60; CI 95%, 1.10-2.36) although a code of diabetes complications marginally decreased the odds of readmission (OR=0.77; 95% CIO 0.59-1.01).

Table 5: Multivariable Logistic Regression Results of the final study variable by 30-Day readmission

Variables	B	S.E.	Wald	df	*p*	OR (95% CI)
Constant	-3.115					
HH VS. Self-Care	0.464	0.148	9.850	1	0.002	1.59 (1.19-2.13)
Unemployed	0.534	0.256	4.361	1	0.037	1.71 (1.03-2.82)
Disability	0.887	0.242	13.426	1	0.001	2.43 (1.51-3.90)
Retired	0.518	0.233	4.949	1	0.026	1.68 (1.06-2.65)
CTD	- 0.556	0.379	2.147	1	0.143	1.74 (0.83-3.66)
CHF	0.193	0.131	2.176	1	0.140	1.21 (0.94-1.57)
DM Complications	-0.258	0.136	3.605	1	0.058	0.77 (.59-1.01)
Liver Disease	0.472	0.196	5.767	1	0.016	1.60 (1.10-2.36)
Index Length of Stay	0.045	0.013	11.682	1	0.001	1.05 (1.02-1.07)
Smoking	0.339	0.186	3.331	1	0.068	1.40 (0.98-2.02)

CTD = Connective tissue disease; CHF = congestive heart failure; DM= diabetes mellitus

Research Aim 3

Research Aim 3 was to compare the ability of a model developed from the study variables, the Hispanic Diabetic Study Model, to a LACE model to predict 30-day readmission among Hispanic adults with type 2 diabetes.

The study sample was randomly selected into two groups: derivation and validation. The derivation group size was n=1896 (49%) and the validation group size was n=1969

(51%). Both groups had the similar demographic and clinical characteristics. The derivation group was used to develop a predictive model for 30-day readmission and then the stability of the model was tested in the validation group. The number of missing cased for the Hispanic Diabetic Model is 743(19%) and with LACE model 42(1.1%).

Developing the predictive models

In order to test the predictive ability, the derivation group was examined comparing the Hispanic Diabetic Study variables, the LACE model, the LACE index score as a categorical variable and finally the Hispanic Diabetic Study plus a key identified variable from LACE. The betas from the derivation group models were applied to the validation dataset. To establish the stability of the estimates.

***The Hispanic Diabetic Study Model*:** This model started with the 10 variables from the model derived in Research Aim #2. Using backward stepwise regression, the least predictive variables were eliminated to obtain the most predictive model. (See Table 6 for relative magnitude of the variables)

LACE Models

The LACE models used the published variables and definitions from the literature. Since all subjects had diabetes, comorbidities scoring was modified with 1 meaning one comorbidity in addition to diabetes, similarly for 2 through 4. The 'LACE Model' grouped length of stay as three groups with a stay of 3 days or less as the reference group. In this model, all other LACE criteria were as published.

Results

The LACE index score

In this study the mean LACE index score was 7.74 (SD = 2.61) with a range from 0 to 16. For the total sample, for every point increase in the LACE score, the odds of readmission was 1.09 (95% CI. 1.03-1.15). Using the published LACE cut-score of 9, 8.6% of those with a score of 9 or less were readmitted within 30 days compared to 14.7% with those with scores greater than 9. The odds for readmission for a score above 9 was 1.83 (95% CI, 1.41, 2.37). Using the cut-off score produced the poorest AUC (0.56) and therefore, no further analysis using the LACE cut-off was pursued.

Predictive Models

The relative magnitude of the predictive variables is presented in Table 6. Emergency department visits in the prior 6 months had the largest odds ratios followed by disability status.

The **Hispanic Diabetic Study Model** final multivariable predictive model included five variables employment status (unemployed, retired, or disabled), smoking, admission length of stay, consult with home health aide and diabetes complications (see Table 7). This model accurately identified 90% of all the cases with a sensitivity of 0% and specificity of 99% with overall accuracy (the true positives + true negatives/ sample size) of 73% (Zhu, Zeng & Wang, 2010). The Hispanic Diabetic model predicted cases compared to the actual 30-day readmission cases was able to predict 71.6% correctly and 28.5% incorrectly among derivation group and to predict 73.6% correctly and 26.4% incorrectly among validation group. This Hispanic Diabetic model was only moderately predictive of 30-day readmission with an area under the curve (AUC) of 0.06-0.63 with adequate calibration per the Hosmer-Lemeshow goodness chi-square of X^2 well above p=0.05

The **LACE Model** included all of the LACE variables. Emergency department visits in the prior 6 months had the largest effect size by far (See Table 6). All eight independent variables accurately identified 90% of all the cases with a sensitivity of 9.4% and specificity of 99% between both groups and an overall accuracy of the model is 90%. The LACE model was able to predict 89.6% of the cases correctly and 10.4% incorrectly among derivation group and to predict 89.4% correctly and 10.6% incorrectly among validation group demonstrating stability of the model. The LACE model had a better AUC than the Hispanic Diabetic Study of 0.67-0.69 which showed stability between the two sets with adequate calibration (See Table 8).

The **Hispanic Diabetic Study model plus ED visits** in the last 6 months had similar model statistics to the LACE model. This model had a sensitivity slightly lower than the LACE model of 5.2% but a higher specificity of 99.5% with overall accuracy of 73%. The Hispanic Diabetic Study plus ED visits model predicted 72.4% of the cases correctly and 27.7% incorrectly among derivation group and to predict 73.5% correctly and 26.5% incorrectly among validation group demonstrating stability of the model and consistency of the data with the model. This model had similar AUC to LACE (See Table 8). However, the positive predictive value (i.e., of the people the model identified as being at risk for readmission, the percent who were actually were re-admitted) was 55.7% compared to 52.1% for the LACE model. Figure 1 is a comparison of the ROC curves for all three models.

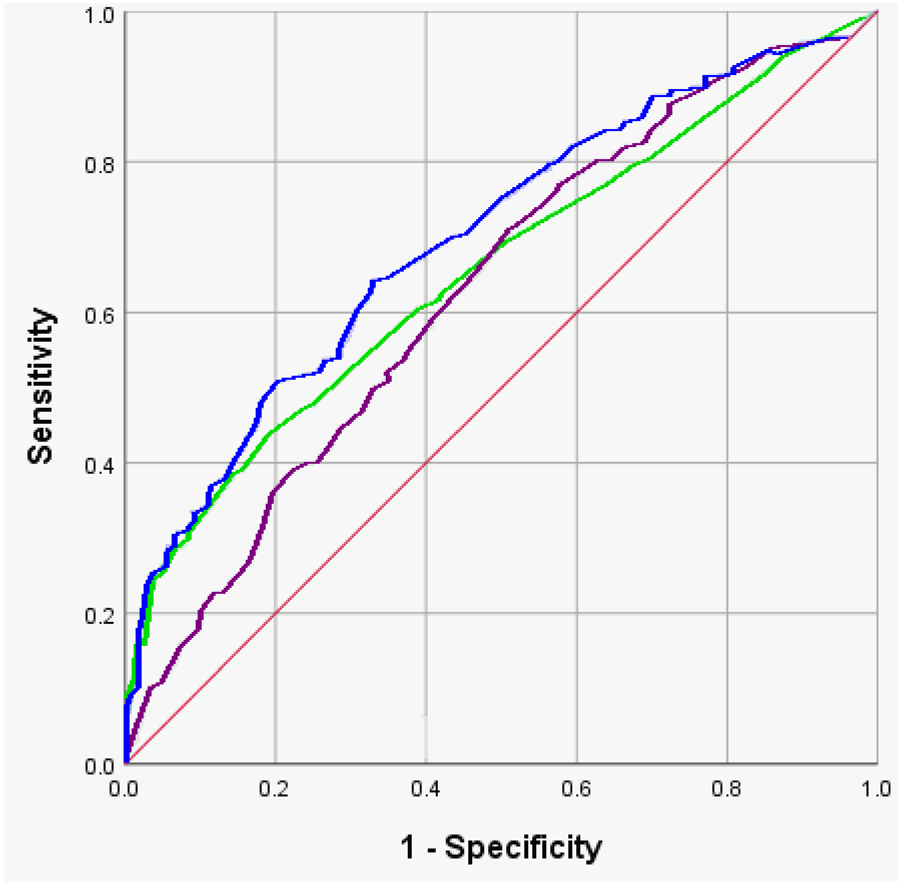

Figure 5: Area under the Curve for three different predictive models
Purple = Hispanic Diabetes Study; Green = LACE; Blue = Hispanic Diabetes + ED visits

Table 6: Odds ratios for variables associated with 30-day readmission for Diabetes Study Model and LACE Model using the derivation group

Variable	Hispanic Diabetes Study Model		Lace Models
Home health	1.65	**Length of stay**	1.042
Unemployed	1.39	LOS > 14 days	1.26
Disability	2.29	LOS 7-13 days	1.34
Retired	1.69	LOS 4 -6 days	1.75
DM Complications	0.68	**Acuity**-high	0.61
Index LOS	1.03	**Comorbidity**	
Smoking	1.55	DM+1 cm	0.76
		DM+2 cm	1.10
		DM+3 cm	1.38
		DM+≥4 (severe)	1.31
		ED visit past 6 m.	
		1 visit	6.04

		2 visits	10.42
		3 visits.	14.59
		4 or more visits	3.21

Table 7: Predictive model statistics for the three models from the Derivation Set

	Hispanic Diabetes Study Model	LACE model	Hispanic Diabetic Study + ED
Constant	-2.883	-2.238	-2.882
Variables [Beta (S.E)]			
Home health*	0.503 (0.210)		0.476 (0.220)
Unemployed	0.328 (0.365)		0.152 (0.376)
Disability *	0.827 (0.336)		0.355 (0.324)
Retired	0.526 (0.316)		0.526 (0.316)
DM Complication*^	-0.390 (0.197)		-0.528 (0.207)
Index LOS	0.033 (0.023)		0.018 (0.024)
Smoking	0.436 (0.265)		0.312 (0.279)
Length of stay			
LOS > 14 days		0.237 (0.186)	
LOS 7-13 days		0.295 (0.240)	
LOS 4 -6 days		0.561 (0.433)	
Acuity-high		-0.492 (0.257)	
Comorbidity			
DM+1 cm		-0.275 (0.261)	
DM+2 cm		0.091 (0.256)	
DM+3 cm		0.320 (0.257)	
DM+≥4 (severe)		0.268 (0.248)	
ED visit past 6-months			
1 visit Ϯ		1.798 (0.244)	2.073 (0.270)
2 visits Ϯ		2.344 (0.476)	2.245 (0.566)
3 visits Ϯ		2.680 (0.691)	2.323 (0.790)
4 or more visits Ϯ		1.165 (1.133)	___

* = $p<0.05$; ^ = only applies to Hispanic Diabetic model; Ϯ = $p \leq 0.001$

Table 8: Area under the Curve and Calibration for predicting 30-day readmission for three predictive models in the derivation and validation data sets

Set	Area under the Curve (95% CI)	Calibration (Hosmer-Lemeshow)
Hispanic Diabetic Study:		
Derivation	0.60 (0.58-0.67)	0.83
Validation	0.63 (0.60-0.70)	0.68
LACE model:		
Derivation	0.69 (0.61-0.70)	0.80
Validation	0.67 (0.70-0.79)	0.91
Hispanic Diabetic Study + ED visits:		
Derivation	0.67 (0.65 – 0.75)	0.94
Validation	0.69 (0.73-0.81)	0.79

Summary

The 30-day readmission rate for Hispanic diabetics in this study was 9.5%. Few of the social-demographic variables tested in the Hispanic Diabetic Study's conceptual framework were predictive of readmission except employment status. A history of smoking was also an important predictor along with longer length of stay. Interestingly, having a code for a diabetes complication decreased the risk for readmission.

Among the predictive models, the best predictive model included the study variables plus the number of ED visits in the prior 6 months. However, even though this was the best model its AUC was only around 0.67. It had excellent specificity but poor sensitivity 5% although the positive predictive value was 57.4%.

CHAPTER 5

DISCUSSION

The purpose of this retrospective study was to identify predictive factors related to 30-day readmissions among Hispanic adults with type 2 diabetes admitted to a community hospital in Southern California and to evaluate whether there can be a predictive model to identify those most at risk for a 30-day readmission. The study hospital primarily serves Hispanic adults of lower socioeconomic bracket as reflected by the study data showing the majority were insured by public insurers, Medicare (53%) and Medi-Cal (35%), with only a minority (12.5%) covered by other insurance or commercial payers. This chapter discusses the study findings, strengths, limitations, and implications for future clinical, education, policy implication and nursing research.

Study findings for Aims 1 and 2

The study cohort had an overall 30-day readmission rate of 9.5% and 14.7% for the 3 years if those with multiple admissions are included. Among the independent predictors represented in the study's conceptual framework, only few factors were identified as predictive of 30-day readmission. Employment status was associated with the highest odds for readmission. Only 15% of the cohort were employed. Those who were disabled (20%) had an adjusted 2.43 (95% CI 1.51-3.90) increased odds of readmission followed by those who were retired (49%) with an adjusted odd of 1.68 (95% CI ;1.06-2.65). If the person was a smoker, it marginally increased odds of readmission (adj. OR 1.40; 95% CI 0.98-2.20). Among the healthcare and clinical factors studied, the number of visits to emergency room in the prior 6 months was the strongest predictor ranging from an adjusted odd of 6.04 for 1 visit to 14.56 for 3 visits. This was followed by length of stay OR=1.75 for 4-6 days or an increase of 5% odds for every day in the hospital. Receiving a consult for a home health aide at discharge was an important factor (adj. OR = 1.59; 95% CI 1.19-2.13). Surprisingly, having a diabetes complications code in this study decreased the odds of 30-day readmission (adj. OR = 0.77; 95% CI 0.59-1.01) even though HgA1C above 9% did slightly increase the odds of 30-day readmission.

Findings that were investigated but did not appear to be independently associated with language spoken, several co-morbidities, and consults with diabetes nurse practitioners or diabetes educators. The majority of the cohort were designated as Spanish-speaking, nearly 69%, and 70% of all participants were seen by a diabetes nurse practitioner.

Some results are similar to those found in other studies of 30-day hospital readmission among those with diabetes and are not. Of note, the overall 30-day readmission rate for the three years of 14.7% and for those in the study cohort of 9.5%, is much lower than those of other published studies. In fact, over the three years of the study, the readmission rate in the cohort declined from 11.8% to 9.5%. Rubin (2015) reported 30-day readmissions were higher among patients with diabetes compared to those without (15.3% versus 8.4% respectively, $p < 0.001$), and comparable findings have been reported in similar studies (14.4–22.7% vs. 8.5–13.5%; Sonmez, Kambo, Avtanski, Lutsky, & Poretsky, 2017). The decreasing rate of readmissions over time indicate this hospital has purposefully worked to decrease 30-day readmissions and have been successful among Hispanics with diabetes.

Rubin and colleagues (2016) examined 30-day readmission risk factors among diabetics. Their population was 12% Hispanic and they did not find Hispanic ethnicity associated with readmission nor language spoken. Like this study, employment status was an important predictor of readmission although the odds ratio in this study are 16 to 25% higher. Two other studies also found employment status associated with 30-day readmission in general (Jiang et al. 2005; Feigenbaum et al. 2012).

Although clinical factors such as HgbA1C on admission and co-morbidities were investigated only one was important in a surprising direction. Although an HgbA1C >9 was marginally associated with readmission (OR 1.29; 95% CI 0 .95-1.76), it was not important after accounting for covariates. Other co-morbidities that are higher risk factors for readmission in the general population, such as CHF and COPD, were not important in this specific population. The fact that having diabetes complication code among this study of Type 2 diabetics decreased odds for re-admission may mean hospital care may appropriately targeted care to these patients, and therefore, it may have been successful in preventing them from experiencing an early readmission.

This hospital had an innovative approach to caring for diabetic patients and achieving glycemic control through with the use of diabetes nurse practitioners. diabetes nurse practitioners were utilized for glycemic management by providing education at bedside. Over 70% of study participants had a diabetes nurse practitioner consult which probably limited the ability to assess any effect of these practitioners to prevent readmissions. Also, this study was limited to those who entered the hospital already with a diagnosis for Type 2 diabetes. A prior study showed an early primary diagnosis of diabetes during an admission helped facilitate proper medication reconciliation for precise diabetes medication to fit patients' levels of knowledge, and the ability to carry out self-medical management at home (Jack et al., 2009). This study found effective use of a diabetes team was linked to decreased ED visits for patients with type 2 diabetes-related complications. The fact that those with a diabetes complication code had a reduced readmission may be a proxy indicator of an effective functioning diabetic team.

The rate of readmission among the high acuity group (admitted from ED) and low acuity group (admitted from PCP office) was not an important factor in predicting readmission (OR 1.02; 95% CI 0.69-1.50) since the vast majority of admissions were through ED (91.4%) regardless of severity of condition. This is an important finding. The original LACE predictive model was developed and tested in Canada and the United Kingdom were admission to the hospital from the ED versus a primary care office may be a good proxy measure of severity of illness (van Wal raven et. al., 2010; Damery & Combes 2017). The Emergency Medical Treatment and Labor Act makes the use of emergency department much more attractive to all immigrants regardless of their status. All patients will receive care at ED even if they cannot afford the copay unlike in doctor's offices, therefore, immigrants have a disincentive to receive care at primary care offices (Ortega, Rodriguez, and Vargas Bustamante, 2015).

Lastly, those discharged home had a higher rate of 30-day readmission. This finding echo that of a re-admission study post-pancreatomy that found increased odds of readmission with a home health consult although the readmitted patients were less severe than those readmitted without such a consult (Sanford et al., 2014). The degree of severity on readmission was not assessed in this study, so that aspect could not be evaluated. However, the fact that those discharged with a home health consult had a higher rate of readmission may indicate the hospital recognized these individuals had increased care needs but efforts to provide them with extra resources and surveillance were insufficient to keep these higher risk patients from being re-admitted. Also unknown is if the home health care consults actually took place prior to readmission and the timing of the receipt of needed services. These are potential subjects of future research.

Study findings for Aim 3 – Predictive models

Finding a predictive model that could target those individuals at highest risk of early readmission would be beneficial for both hospitals and patients and their families. However, to date, most predictive models for hospital readmission have performed fairly poorly (Kansagra, 2011). The LACE model was original developed and tested in Canada and validated in the United Kingdom with very different health care and payment systems which may threaten its validity in the U.S. health care system (van Wal raven et. al., 2010; Damery & Combes 2017). Many U.S. hospitals are using the LACE model or the LACE index score >9 to identify high risk readmission patients with LACE calculators readily available on the internet. In this study, The LACE index score among Hispanics with type 2 diabetes failed to predict 30-day readmission. One reason as already cited previously may have been the fact, particularly in this community, the vast majority of patients are admitted through the ED and therefore, the 'A' for acuity in LACE is not an important predictor. Among the LACE variable, the number of ED visits in the prior 6 months had the highest predictive odds between 7.61 to 11.80. Testing of the predictive ability LACE model and the Hispanic Diabetic Study plus ED visits in the prior 6 months provided similar results although the latter model was slightly better. The AUC for this model was only around 0.67 with a high specificity of 99.5% and low sensitivity of 5%. However, a more important statistic is the positive predictive value (PPV), the proportion who are readmitted among those who are identified as at risk for readmission. The PPV was 57.4%, much better than 9.5%.

Strengths and Limitations of the Study

This study has some strengths and limitations. This research study utilized a large sample of three years of data to identify important readmission factors and to develop and test a predictive model for readmission. This is the first study to explore 30-day readmissions solely among Hispanic adults with type 2 diabetes. No other study has used such a large sample of a specific minority population. It provides evidence that the LACE model for predicting 30-day readmission among this specific population is not useful and in particular, the **acuity** variable may not indicate severity within the present U.S. health care structure but particularly for a hospital serving a large Hispanic population. The citizenship status of participants in this cohort is unknown but given the high probability for mixed status, and evidence that regardless of status, Hispanics may prefer using the ED over care in a primary care office, ED use may be a proxy for lack of a regular primary care provider, and not acuity. However, the number of ED visits in the prior 6 months was the factors associated with the highest increased odds of readmission.

Limitations of study include a fairly low re-admission rate, 9.5%, among the study cohort when compared to other published rates. There was also a trend toward decreased re-admission during the three study years, indicating the hospital had initiated successful efforts to decrease readmission among patients with diabetes that included introduction of diabetes nurse practitioners. Having a diabetes nurse practitioner see the patient was not associated with reduced readmission but this could be due to the fact that they saw 70% of the study participants. Additionally, for the predictive modelling of the Hispanic Diabetic Study and the model adding ED visits, 19% of subject were missing at least one of the variables although for the LACE variables less had 1% of subjects had missing variables.

The data from this retrospective study relied primarily on routinely collected administrative and clinical data and therefore, was unable to capture finer classification of study concepts such as ethnicity or social determinants of health. For example, the cultural backgrounds of the Hispanic in the study cohort could not be classified as Hispanic-Mexicans or; Hispanic-Puerto Ricans. Some studies have found education level and health literacy to be important in readmission (Bailey et al., 2015) but these variables were not available. Additionally, it is unclear exactly how the language variable was asked. Does it mean Spanish-speaking only or preferred language is Spanish? This study was unable to explore other potentially important social determinants of health such as neighborhood due to validity issues with given address zip codes or other variables such as home ownership.

Implications for Nursing and Nursing Education

The rate of diabetes has exponentially increased in the United States in the past decades. Hispanics have lowest health insurance coverage and as a result are less likely to receive care from usual sources (Weinick, Jacobs, Stone, Ortega, & Burstin, 2004). Fifty-seven percent of undocumented Hispanic immigrants have barriers to healthcare (Ortega, Rodriguez, & Vargas Bustamante, 2015; Vargas Bustamante, et al., 2012).

Hispanics, in comparison to other Americans, have less access to high quality evidence-based care for management of chronic diseases like diabetes (Ortega, Rodriguez, and Vargas Bustamante, 2015).

The rate of Hispanic nurses in the workforce has slowly increased from 3.4% in 2013 to 5.3% in 2017 (Smiley et al. 2018) which is considerably below the national proportion of Hispanics of 18% or the 28% in California. It is crucial that targeted efforts to recruit and retain continue in order to achieve better language-concordant care which hopefully will lead to improve outcomes in this population.

It is important that future nurses be trained not only for general nursing care, but also for specific chronic care management during their nursing curriculum to help meet the care needs of a growing population of diabetic patients. The numbers of Hispanic adults with diabetes is increasing.

Increased use of nurse practitioners in the hospital and specially to work with patients with chronic conditions, like those with diabetes, advanced lung disease like COPD and CHF improves patient care (Holstein, B.A. 2018; Li et al 2017). Their ability to diagnose and prescribe provides them a unique advantage, and because they come from the nursing philosophy of care, they view care provision with holistic approach which incorporates not only the spiritual and emotional spheres in addition to the physical one but also the larger social context of patients lives including their family and community (Sangster-Gormley, Frisch , & Schreiber, 2013). The role of nursing in the care of those with diabetes ranges from bedside care of basic needs, like improved blood glucose levels and teaching, to communicating with the physician or diabetes nurse practitioner. Recognizing patients' diabetes self-care weakness and strengths on day one of admission expedites care for these patients. Utilizing nurse case managers, diabetes nurse educators, and home health nurses improves care quality and patient satisfaction. Precise diabetes medications reconciliation is a delicate job that improves the discharge process, decreases length of stay and helps decrease 30-day readmission among diabetic patients (Drincic, Pfeffer, Luo, & Goldner, 2017).

Recommendations for Nursing Research

This study was unique in its examination of different factors related to 30-day readmission among Hispanic adults with type 2 diabetes. The study hospital had a unique model of including diabetes nurse practitioners as part of the care team and they may have played a role to the low readmission among Hispanic with diabetes. Further research should be aimed at examining the effectiveness of diabetes nurse practitioners to improve patient care outcomes, patient satisfaction, and reduce 30-day readmission rates, objectives that could not be accomplished by this study.

Another area to explore is to confirm the strength of the relationship between number of ED visits in the prior 6 months and readmission and explore the meaning of this variable. Is it a marker for the lack of a regular primary care provider or something else? Are the forces in using the ED purely financial? Once these are known then, interventions aimed at the sources of ED use may be effective when someone on admission has been ideated as using the ED one or more time in the past six months.

Advances in technology and in hospitals abilities to collect data, have made this an exciting time for nursing research. Meaningful studies that use already collected data from hospital financial and electronic medical records may generate predictive models to decrease 30-day readmission using more sophisticated analytic approaches beyond the scope of this study, such as neural networks and machine learning (Jamei et al, 2017; Min, Yu, & Wang, 2019). At minimum, if severity of illness is an important predictor of readmission, researchers should explore a better proxy variable, other than admission from the ED in healthcare situations where the ED is the primary route to admission for all patients. Lastly, it would be possible to use the Hispanic Diabetic Study + ED visits prospectively to identify patients on admission at higher risk for readmission and test whether the provision of more targeted interventions at these individuals reduced readmission.

Policy Implications

The changing Hispanics demographics in the United States presents a number of challenges to health care policy makers, clinicians, organizations, and other stakeholders. Studies have demonstrated that Hispanics tend to have worse patterns of access to, and utilization of, health care than other ethnic and racial groups. Under the Affordable Care Act (ACA) 95% of uninsured Hispanics qualified for Medicaid or tax credits by 2015 (US Dept. Health Hum. Serv., 2014). In fact, between 2013 and 2017, Hispanic adults between the ages of 19 to 64 had the highest absolute decrease in the gap of percent uninsured compared to non-Hispanic whites from 25.4% to 16.5% points (Chaudry, Jackson & Glied, 2019). The implementation of the Affordable Care Act (ACA) of 2010 may have ameliorated some of these disparities. However, even with the ACA, it is expected that Hispanic will continue to have problems accessing and using high-quality health care, especially in states that are not expanding Medicaid eligibility as provided by the ACA. I identify four current policy dilemmas relevant to Hispanic' health and ACA implementation. First, there is a need to provide primary care services for those with undocumented citizenship status. This requires a policy solution for those who have lived and worked in the U.S. for many years without legal status. The financing of primary care through emergency rooms makes no fiscal sense and it detrimental to the needed continuity of care of improve disease management of those with chronic illnesses, such as diabetes. Secondly, even for those individuals who are here legally, the current suggests changes to the 'public charge' regulations may encourage these individuals to refuse public health insurance they are entitled and eligible for out of fear accepting it will jeopardize their ability to become citizens. Lastly, there is a need to increase the diversity of the healthcare workforce especially with individuals with a Hispanic background in order to improve linguistic and culturally congruent care to this fastest growing segment of the American population.

Conclusion

Diabetes care is complex, particularly in the hospital setting. It requires a team of experts from when the patient arrives at the hospital until the time, they return home in order to ensure the patient receives the best possible care and practices but also to reduce readmissions which are costly both to patients, families, and health care system.

This study investigated predictive factors contributing to 30-day readmissions among Hispanic adults with type 2 diabetes. It identified sociodemographic factors found in other studies as well as the intuitively obvious factor of increased length of stay as predictors. However, it did not confirm that identified spoken language of Spanish was a large predictor for readmission. It did find that the addition of a simple question or data point, the number of times the patient was seen in the emergency department in the last 6 months, may be most crucial to potentially preventing readmission. This study's findings contribute additional understanding of 30-day hospital readmissions among Hispanic patients with type 2 diabetes.

References

Afable-Munsuz, A., Mayeda, E. R., Pérez-Stable, E. J., & Haan, M. N. (2013). Immigrant generation and diabetes risk among Mexican Americans: The Sacramento Area Latino Study on Aging. *American Journal of Public Health*, 103(5), 45–52.

Aguilar-Salinas, C., Velazquez-Monroy, O., & Gomez-Perez, F. (2003). Characteristics of atients with Tytpe 2 diabetes in México. *Diabetes Care*, 26(7), 2021–2026.

American Diabetes Association. (2017). Statistics About Diabetes. Overall Numbers, Diabetes and Prediabetes Economic costs of diabetes in the U.S. in 2015 Statistics About Diabetes: American Diabetes Association. www.diabetes.org/diabetes-basics/statistics/

American Diabetes Association. (2018). Economic costs of diabetes in the U.S. in 2017. *Diabetes Care*. (3); dci180007. doi.org/10.2337/dci18-0007

Anderson C, Deepak BV, Amoateng-Adjepong Y, Zarich S. (2005). Benefits of comprehensive inpatient education and discharge planning combined with outpatient support in elderly patients with congestive heart failure. *Congest Heart Fail*.11(3)15-21.

Aponte, J., Nokes, KM. (2017). Electronic health literacy of older Hispanics with diabetes. *Health promotion international*. 32(3): 482–489. doi.org/10.1093/heapro/dav112

Barquera, S., Campos-Nonato, I., Carlos Aguilar-Salinas, C., Lopez-Ridaura, R., Armando Arredondo, A., Juan River, D. (2013). Diabetes in Mexico: cost and management of diabetes and its complications and challenges for health policy. *Globalization and Health*. 9:3. http://www.globalizationandhealth.com/content/9/1/3

Boccuti, C., & Casillas, G. (2017). Aiming for Fewer Hospital U-turns. The Medicare hospital readmission reduction program. Policy brief. *kaiser family foundation issue brief*, 1–10. doi.org/10.2193/2006-345

Bradley, E. H., Curry, L., Horwitz, L. I., Sipsma, H., Wang, Y., Walsh, M. N., Goldmann, D., Neal White, N., Ileana L. Piña, I., Krumholz, H. M. (2013). Hospital strategies associated with 30-day readmission rates for patients with heart failure. *Circulation: Cardiovascular Quality and Outcomes*, *6*(4), 444–450. doi.org/10.1161/CIRCOUTCOMES.111.000101

Brown, A. F., Ettner, S. L., Piette, J., Weinberger, M., Gregg, E., Shapiro, M. F., Karter, A. J., Safford, M., Waitzfelder, B., Prata, P. A., Beckles, G. L. (2004). Socioeconomic position and health among persons with diabetes mellitus: A conceptual framework and review of the literature. *Epidemiologic Reviews*, *26*(March), 63–77. https://doi.org/10.1093/epirev/mxh002

Castañeda, H., Holmes, S. M., Madrigal, D. S., Young, M.-E. D., Beyeler, N., & Quesada, J. (2015). Immigration as a Social Determinant of Health. Annual Review of Public Health, 36(1), 375–392. https://doi.org/10.1146/annurev-publhealth-032013-182419

Centers for Disease Control and Prevention. (2017). National diabetes statistics report: Estimates of diabetes and its burden in the United States. Atlanta, GA: Centers for Disease Control and Prevention. *US Dep Heal Hum Serv*: 2009-2012. doi:10.1177/1527154408322560.

Centers for Medicare and Medicaid Services. (2016). National health expenditures 2016 highlights. Available online: https://www.cms.gov/Research-StatisticsData-and-Systems/Statistics-Trends-and-Reports/ NationalHealthExpendData/Downloads/highlights.pdf.

Centers for Medicare and Medicaid Services. (2017). Racial and ethnic disparities in diabetes prevalence, self-management, and health outcomes among Medicare beneficiaries. https://www.cms.gov/About-CMS/Agency-Information/OMH/Downloads/March-2017-Data-Highlight.pdf

Chaudry, A., Jackson, A., & Sherry A. Glied, S. A. (2019). Did the Affordable Care Act reduce racial and ethnic disparities in health insurance coverage? Commonwealth Fund. (8). https://doi.org/10.26099/d8hs-cm53

Chen, J. Y., Ma, Q., Chen, H., & Yermilov, I. (2012). Newbundled world: quality of care and hospital readmission in diabetes patients. Journal of Diabetes Science and Technology, 6(3), 563–571.

Clement S, Braithwaite SS, Michelle F., Magee, M.F., Ahmann, A.**,** Smith, P. E., Rebecca, G., Schafer, R.G., Hirsch, I. B. (2004). Management of Diabetes and Hyperglycemia in Hospitals.pdf. Diabetes Care, 27(2), 553–591. https://doi.org/10.2337/diacare.27.2.553

Coffman, J.M., Rosenoff, E., Grumbach, K. (2001). Racial/ethnic disparities in nursing. Health Aff., 20:263–72.

Coleman, E. A., Parry, C., Chalmers, S., & Min, S. (2006). The Care Transitions Intervention: Results of a Randomized Trial. Arch Intern Med, 166, 1822–1828.

https://doi.org/10.1001/archinte.166.17.1822.

Corrigan, J. M., & Martin, J. B. (1992). Identification of factors associated with hospital readmission and development of a predictive model. *Health Services Research*, *27*(1), 81–101.

Corsino, L., Dhatariya, K., and Umpierrez, G. (2017). Management of diabetes and hyperglycemia in hospitalized patients. In *Endotext [Internet]*. MDText. com, Inc. https://www.ncbi.nlm.nih.gov/books/NBK279093/

Cotter, P. E., Bhalla, V. K., Wallis, S. J., & Biram, R. W. S. (2012). Predicting readmissions: Poor performance of the LACE index in an older UK population. *Age and Ageing*, *41*(6), 784–789. https://doi.org/10.1093/ageing/afs073

County of San Diego Health and Human Services Agency (HHSA) . (2012). https://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/documents/CHS-ChronicDiseaseAtlas_Diabetes_2012.pdf

Dabelea, D., Mayer-Davis, E. J., Saydah, S., Imperatore, G., Linder, B., Divers, J., Bell, R., Badaru, A., Talton, J.W, Crume, T., Liese, A. D., Merchant, A.T., Lawrence, J.M., Reynolds, K., Dolan, L., Liu, L. L., Hamman R. F. (2014). Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. *JAMA - journal of the American medical association*, *311*(17), 1778–1786. doi.org/10.1001/jama.2014.3201

Damery, S., & Combes, G. (2017). Evaluating the predictive strength of the LACE index in identifying patients at high risk of hospital readmission following an inpatient episode:

A retrospective cohort study. *BMJ Open*, *7*(7), 1–8. https://doi.org/10.1136/bmjopen-2017-016921

Drincic, A., Pfeffer, E., Luo, J., & Goldner, W.S. (2017). The effect of diabetes case management and Diabetes Resource Nurse program on readmissions of patients with diabetes mellitus. *Journal of Clinical and Translational Endocrinology*.*8*(4), 29–34. doi:10.1016/j.jcte.2017.03.003

Dungan, K. M. (2012). The effect of diabetes on hospital readmissions. Journal of Diabetes Science and Technology, 6(5), 1045–1052.

Eby, E., Hardwick, C., Yu, M., Gelwicks, S., Deschamps, K., Xie, J., & George, T. (2015). Predictors of 30-day hospital readmission in patients with type 2 diabetes: a retrospective, case–control, database study. *Current medical research and opinion*, *31*(1), 107–114. doi.org/10.1185/03007995.2014.981632

Enomoto, L. M., Shrestha, D. P., Rosenthal, M. B., Hollenbeak, C. S., & Gabbay, R. A. (2017). Risk factors associated with 30-day readmission and length of stay in patients with type 2 diabetes. *Journal of diabetes and its complications*, *31*(1), 122–127. doi.org/10.1016/j.jdiacomp.2016.10.021

Fales, J. L., Essner, B. S., Harris, M. A., & Palermo, T. M. (2014). When helping hurts: Miscarried helping in families of youth with chronic pain. *Journal of Pediatric Psychology*, *39*(4), 427–437. https://doi.org/10.1093/jpepsy/jsu003

Feigenbaum, P., Neuwirth, E., Trowbridge, L., Teplitsky, S., Barnes, C. A., Fireman, E., Dorman, J., Bellows, J. (2012). Factors contributing to all-cause 30-day readmissions. a structured case series across 18 hospitals. *Med Care*. *50*(7), 599–605.

Fraze, T., Jiang, H., & Burgess, J. (2010). Hospital Stays for Patients with Diabetes, 2008. (Retrieved from Rockville, MD).

Friedman, B., & Basu, J. (2004). The rate and cost of hospital readmissions for preventable conditions. Medical Care Research and Review, 61(2), 225–240.

Furnary, A. P., Wu, Y., & Bookin, S. O. (2004). Effect of Hyperglycemia and Continuous Intravenous Insulin Infusions on Outcomes of Cardiac Surgical Procedures: the Portland Diabetic Project. *Endocrine Practice*, *10*(Supplement 2), 21–33. https://doi.org/10.4158/EP.10.S2.21

Galanti, G.A. (2014) Caring for Patients from Different Culture (5th ed.) Philadelphia, University of Pennsylvania press

Garnica, P. (2017). Transition of Care for Patients with Diabetes. *Current Diabetes Reviews, 13*(3), 263–279. https://doi.org/10.2174/1573399813666161123104407

Garrison, G., Mikesell, C., Matthew, D. (2007). Medical school graduation and attrition rates. Anal Brief. 7(2):1–2.

Gebreegziabher, Y., McCullough, P. A., Bubb, C., Loney-Hutchinson, L., Makaryus, J. N., Anand, N., Divakaran, V., Akhrass, P., Alam, A., Gizycki, H.v., McFarlane, S. I. (2008). Admission hyperglycemia and length of hospital stay in patients with diabetes and heart failure: A prospective cohort study. Congestive Heart Failure, 14(3), 117–120.

Giancristofaro, R. A., & Salmaso, L. (2007). Model performance analysis and model validation in logistic regression. *Statistica*, *63*(2), 375-396.

Green, L. W., Brancati, F. L., & Albright, A. (2012). Primary prevention of type 2 diabetes: Integrative public health and primary care opportunities, challenges and strategies. *Family practice*. 29(1).doi.org/10.1093/fampra/cmr126

Greenberg, B. H., Abraham, W. T., Albert, N. M., Chiswell, K., Clare, R., Stough, W. G., Gheorghiade, M., O'Connor, C.M., Sun, J.L., Yancy, C. W., Young, J.B., Fonarow, G. C. (2007). Influence of diabetes on characteristics and outcomes in patients hospitalized with heart failure: a report from the organized program to initiate lifesavingtreatment inhospitalizedpatientswithheart failure(OPTIMIZE-HF). American Heart Journal, 154(2). 271–278.

Gregg, E. W., Li, Y., Wang, J., Rios Burrows, N., Ali, M. K., Rolka, D., Williams, D. E., Geiss, L. (2014). Changes in Diabetes-Related Complications in the United States, 1990–2010. New England Journal of Medicine, 370(16), 1514–1523. https://doi.org/10.1056/NEJMoa1310799

Grieco, P. (2009). Race and Hispanic Origin of the Foreign-Born Population in the United States: 2007. Washington, DC: US Census Bureau; 2009. American Community Survey report no. ACS-11.

Herkert, D., Vijayakumar, P, Luo, J., Schwartz, J. I., Rabin, T.L., DeFilippo, E., Lipska, K.J. (2018). Cost-related insulin underuse among patients with diabetes. *JAMA Intern Med.* 12(3). doi: 10.1001/jamainternmed.2018.5008. [Epub ahead of print] PubMed PMID: 30508012.

Holstein, B.A. (2018). Managing chronic disease in affordable primary care. https://doi.org/10.1016/j.nurpra.2018.03.007

Hill, J., Nielsen, M., & Fox, M. H. (2013). Understanding the social factors that contribute to diabetes: a means to informing health care and social policies for the chronically ill. *The Permanente Journal*, *17*(2), 67–72. https://doi.org/10.7812/TPP/12-099

Hosmer, D.W., Lemeshow, S.13 September (2000)
Print ISBN:9780471356325 |Online ISBN:9780471722144 |DOI:10.1002/0471722146

Jack, B. W., Chetty, V. K., Anthony, D., Greenwald, J. L., Sanchez, G. M., Johnson, A. E., Forsythe, S.R., O'Donnell, J. K., Paasche-Orlow, M. K., Manasseh, C., Martin, S., Culpepper, L. (2009). A reengineered hospital discharge program to decrease rehospitalization. *Annals of Internal Medicine*, *150*(3), 178–187. https://doi.org/10.7326/0003-4819-150-3-200902030-00007

Jamei, M., Nisnevich, A., Wetchler, E., Sudat, S., & Liu, E. (2017). Predicting all-cause risk of 30-day hospital readmission using artificial neural networks. *PloS one*, *12*(7), e0181173.

Jencks, S. F., Williams, M.V., Coleman, E. A. (2009). Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 360. 1418-28

Jiang, H. J., Stryer, D., Friedman, B., & Andrews, R. (2003). Multiple hospitalizations for patients with diabetes. *Diabetes Care*, 26(5), 1421–1426.

Jiang, H. J., Andrews, R., Stryer, D., & Friedman, B. (2005). Racial/ethnic disparities in potentially preventable readmissions: The case of diabetes. *American Journal of Public Health*, *95*(9), 1561–1567. https://doi.org/10.2105/AJPH.2004.044222

Jiménez-Cruz, A., & Bacardi-Gascon, M. (2004). The fattening burden of type

2 diabetes on Mexicans: Projections from early growth to adulthood. *Diabetes Care*, *27*(5), 1213–1215. https://doi.org/10.2337/diacare.27.5.1213

Kansagara, D., Honora Englander, H., Salanitro, A., David Kagen, D., Cecelia Theobald, C., Michele Freeman, M., Kripalani, S. (2011). Risk Prediction Models for Hospital Readmission A Systematic Review. *Journal of the American Medical Association*, 306(15), 1688–98. doi:10.1001/jama.2011.1515.

Kaplan, R. M., & Hartwell, S. L. (1987). Differential effects of social support and social network on physiological and social outcomes in men and women with Type 2 diabetes mellitus. *Health Psychology*, *6*(5), 387–398.

Katzmarzyk, P. T., & Staiano, A. E. (2012). New race and ethnicity standards: elucidating health disparities in diabetes. *BMC Medicine*, *10*, 42. doi.org/10.1186/1741-7015-10-42

Kreilkamp, R. (2014) Application of the LACE risk assessment tool at Chinese hospital. the Advisory Board Group. http://www. Avoid readmissions. com/wwwroot/user files/documents/ 55/ lace- risk- assessment tool. pdf (accessed 1st March 2014).

Kripalani, S., Jackson, A. T., Schnipper, J. L., & Coleman, E. A. (2007). Promoting effective transitions of care at hospital discharge: A review of key issues for hospitalists. *Journal of Hospital Medicine*, *2*(5), 314–323. https://doi.org/10.1002/jhm.228

Kripalani, S., Theobald, C. N., Anctil, B., Vasilevskis, E. E., (2014) Reducing hospital readmission: Current strategies and future directions. *Annu Rev Med*, 65:471–485.

doi:10.1146/annurev-med-022613-090415

Lai, L. L., Alfaifi, A., & Althemery, A. (2017). Healthcare disparities in Hispanic diabetic care: A Propensity Score-Matched Study. *Journal of Immigrant and Minority Health*. *19*(5). 1001–1008. https://doi.org/10.1007/s10903-016-0505-0

Li, S., Roschkov, S., Alkhodair, A., O'Neill, B. J., Chik, C. L., Tsuyuki, R. T., Gyenes, G. T. (2017). The effect of nurse practitioner-led intervention in diabetes care for patients admitted to cardiology services. *Can J Diabetes*. 2. 41(1):10-16. doi:10.1016/j.jcjd.2016.06.008. Epub 2016 Sep 19. PubMed PMID: 27658765.

Lipska, K. J., Ross, J. S., Van Houten, H. K., Beran, D., Yudkin, J. S., & Shah, N. D. (2014). Use and Out-of-Pocket Costs of Insulin for Type 2 Diabetes Mellitus From 2000 Through 2010. *JAMA : The Journal of the American Medical Association*, *311*(22), 2331–2333. https://doi.org/10.1001/jama.2014.6316

Mayberry, L. S., & Osborn, C. Y. (2012). Family support, medication adherence, and glycemic control among adults with Type 2 diabetes. *Diabetes Care*, *35*(6), 1239–1245. https://doi.org/10.2337/dc11-2103

McBean, A. M., Li, S., Gilbertson, D. T., & Collins, A. J. (2004). Differences in diabetes prevalence, incidence, and mortality among the elderly of four racial/ethnic groups: Whites, Blacks, Hispanics, and Asians. *Diabetes care*, *27*(10), 2317–2324. doi.org/10.2337/diacare.27.10.2317

McCurley, J. L., Gutierrez, A. P., & Gallo, L. C. (2017). Diabetes Prevention in U.S. Hispanic adults: A systematic review of culturally tailored interventions. *American journal of preventive medicine*, *52*(4), 519–529.

doi.org/10.1016/j.amepre.2016.10.028

McIlvennan, C. K., Eapen, Z. J., & Allen, L. A. (2015). Hospital readmissions reduction program. *Circulation*, *131*(20), 1796–1803. doi.org/10.1161/CIRCULATIONAHA.114.010270

Min, X., Yu, B., & Wang, F. (2019). Predictive modeling of the hospital readmission risk from patients’ claims data using machine learning: A case study on copd. Scientific Reports, 9(1), 2362. doi:10.1038/s41598-019-39071-

Moghissi, E. S., Korytkowski, M.T., DiNardo, M., Einhorn, D., Hellman, R., Hirsch, I. B., Silvio, E. I., Faramarz Ismail-Beigi, F., Kirkman, S. M., Umpierrez, G. E., (2009). American Association of Clinical Endocrinologists and American Diabetes Association Consensus Statement on Inpatient Glycemic Control. *Diabetes Care*. 32(6). 1119–31, doi:10.2337/dc09-9029.

Moore C, Wisnivesky J, Williams S, McGinn T., (2003). Medical errors related to discontinuity of care from an inpatient to an outpatient setting. J Gen Intern Med;18:646–51. [PubMed: 12911647][PMID: 12911647]

Moss, S. E., Klein, R., & Klein, B. E. K. (1999). Risk factors for hospitalization in people with diabetes. *Archives of Internal Medicine*, *159*(17), 2053–2057. doi.org/10.1001/archinte.159.17.2053

National Quality Forum. All-Cause admissions and readmissions measures 2015-2017. http://www.qualityforum.org/Publications/2017/04/All-Cause_Admissions_and_Readmissions_2015-2017_Technical_Report.aspx. Accessed December 12, 2017.

Nelson, K. M., McFarland, L., Reiber, G. (2007) Factors influencing disease self-management among veterans with diabetes and poor glycemic control. J Gen Intern Med.22. 442–7. [PMCID: PMC1829424] [PubMed: 17372790]

Ortega, A. N., Rodriguez, H. P., and Vargas Bustamante, A. (2015). Policy dilemmas in Latino health care and implementation of the Affordable Care Act. *Annual review of public health*, *36*, 525–544. doi:10.1146/annurev-publhealth-031914-122421

Ostling, S., Wyckoff, J., Ciarkowski, S. L., Pai, C.-W., Choe, H. M., Bahl, V., & Gianchandani, R. (2017). The relationship between diabetes mellitus and 30-day readmission rates. *Clinical diabetes and endocrinology*, *3*(1), 3. doi.org/10.1186/s40842-016-0040-x

Pallant, J. (2007). SPSS Survival Manual, New York, New York: Open University Press

Parappil, A., Depczynski, B., Collett, P., & Marks, G. B. (2010). Effect of comorbid diabetes on length of stay and risk of death in patients admitted with acute exacerbations of COPD. Respirology, 15(6), 918–922.

Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., Feinstein, A. R. (1996). A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol; 49: 1373–9.

Phillips, C. O., Wright, S.M., Kern, D.E., Singa, R.M., Shepperd, S., Rubin, H.R., (2004). Comprehensive discharge planning with postdischarge support for older patients with congestive heart failure: a meta-analysis. JAMA;291:1358–67. [PubMed: 15026403][PMID: 15026403]

Poghosyan, L., Norful, A. A., Fleck, E., Bruzzese, J.-M., Talsma, A., & Nannini, A. (2017).

Primary Care Providers' Perspectives on Errors of Omission. *The Journal of the American Board of Family Medicine*, *30*(6), 733–742. https://doi.org/10.3122/jabfm.2017.06.170161

Rivera, J.A., Barquera, S., Campirano, F., Campos, I., Safdie, M., Tovar, V. (2002). Epidemiological and nutritional transition in Mexico: rapid increase of non-communicable chronic diseases and obesity. Public Health Nutr.5 (1A):113-122.

Robbins, J.M., &Webb, D. A. (2006). Diagnosing diabetes and preventing rehospitalizations: The urban diabetes study. Medical Care, 44(3), 292–296.

Robinson, R., & Hudali, T. (2017). The HOSPITAL score and LACE index as predictors of 30 day readmission in a retrospective study at a university-affiliated community hospital. *PeerJ*, *5*, e3137. https://doi.org/10.7717/peerj.3137

Rogers, S. O., Ramos, M., Khalpey, Z., Lipsitz, S., Steinberg, J., Panizales, M. T., & Zinner, M. (2008). Relationship of perioperative hyperglycemia and postoperative infections in patients who undergo general and vascular surgery. *Annals of Surgery*, *248*(4), 585–590. https://doi.org/10.1097/SLA.0b013e31818990d1

Rowley, W. R., Bezold, C., Arikan, Y., Byrne, E., & Krohe, S. (2017). Diabetes 2030: Insights from Yesterday, Today, and Future Trends. *Population Health Management*, *20*(1), 6–12. doi.org/10.1089/pop.2015.0181

Rubin, D.J., Donnell-Jackson, K., Jhingan, R., Golden, S. H., Paranjape, A. (2014) "Early Readmission among Patients with Diabetes: A Qualitative Assessment of

Contributing Factors." *Journal of Diabetes and Its Complications*. 28(6) 869–73. Elsevier Inc.doi:10.1016/j.jdiacomp.06.013.

Rubin, D. J. (2015). Hospital Readmission of Patients with Diabetes. *Current Diabetes Reports*, 15 (4). doi:10.1007/s11892-015-0584-7.

Rubin, D.J., Handorf, E. A., Golden, S.H., Nelson, D. B., McDonnell, M. E., Zhao, H. (2016) "Development and Validation of a Novel Tool To Predict Hospital Readmission Risk Among Patients With Diabetes." *Endocrine Practice*. doi:10.4158/EP161391.OR.

Rubin, D. J., Golden, S. H., McDonnell, M. E., & Zhao, H. (2017). Predicting hospital readmission risk of patients with diabetes hospitalized for cardiovascular disease: a retrospective cohort study. *Journal of Diabetes and Its Complications*, *31*(8), 1332–1339.

Rubin, D.J., Recco, D., Turchin, A., Zhao, H., Golden, S.H. (2018) External validation of the Diabetes Early Risk Indicator (DEERI). *Endocrine Practice*. 24(6).527-41.

Sangster-Gormley, E., Frisch, N., &Schreiber, R. (2013). Articulating new outcomes of nurse practitioner practice. *Journal of American Association of nurse practitioner, 25* (12), 653-8. doi: 10.1002/2327-6924.12040

Secretary's Advisory Committee on Health Promotion and Disease Prevention Objectives for 2020. Healthy People 2020: An Opportunity to Address the Societal Determinants of Health in the United States. July 26, 2010. Available from:

http://www.healthypeople.gov/2010/hp2020/advisory/SocietalDeterminantsHealth

.htm

Schneiderman, N., Llabre, M., Cowie, C. C., Barnhart, J., Carnethon, M., Gallo, L. C., Giachello, A. L., Heiss, G., Kaplan, R. C., LaVange, L.M., Teng, Y., Villa-Caballero, L., Avilés-Santa, M.L. (2014). Prevalence of diabetes among hispanics/latinos from diverse backgrounds: The Hispanic Community Health Study/Study of Latinos (HCHS/SOL). *Diabetes Care*, *37*(8), 2233–2239. doi.org/10.2337/dc13-2939

Sharifirad, G. R., Tol, A., Mohebi, S., Matlabi, M., Shahnazi, H., Shahsiah, M. (2013). The effectiveness of nutrition education program based on health belief model compared with traditional training. *J Educ Health Promot*. 2(15).3. doi:10.4103/2277-9531.112684

Smiley, R.A., Lauer, P.B., Bienemy C, Berg, J.G., Shireman, E., Reneau, K.A., & alexander, M. (2018). The 2017 National Nursing Workforce Survey. Journal of Nursing Regulation , 9(3, S1), S1-88.

Sonmez, H., Kambo, V., Avtanski, D., Lutsky, L., & Poretsky, L. (2017). The hospital readmission rates in patients with versus those without diabetes mellitus at an urban teaching hospital. *Journal of Diabetes and Its Complications*, 6–10. https://doi.org/10.1016/j.jdiacomp.2017.07.006

Spanakis, E. K., & Golden, S. H. (2014). NIH public access. *Curr Diab Rep*. *13*(6), 1–18. doi.org/10.1007/s11892-013-0421-9.Race/Ethnic

Stefan, M.S., Pekow, P.S., Nsa, W., Priya, A., Miller, L.E., Bratzler, D.W., Rothberg, M.B., Goldberg, R.J., Baus, K., Lindenauer, P.K. (2013). Hospital performance measures and 30-day readmission rates. *Journal of General Internal Medicine*, *28*(3), 377–385.

Stanford, D. E., Olsen, M.A., Bommarito, M.K., Shah, M., Fields, C.R., Hawkins, W.G., Jaques, D.P., Linehan, D.C., (2014). *Association of Discharge Home with Home Health Care and 30-Day Readmission after Pancreatectomy*. https://doi.org/10.1016/j.jamcollsurg.2014.07.008

Stellefson, M., Dipnarine, K., & Stopka, C. (2013). The Chronic Care Model and Diabetes Management in US Primary Care Settings: A Systematic Review. *Preventing Chronic Disease*, *10*(1), 120180. https://doi.org/10.5888/pcd10.120180

Unites States Department of Health and Human Services. The Affordable Care Act and Latinos. Washington, DC: US Dept. Health Hum. Serv; 2012. Last reviewed October, 2014http://www.hhs.gov/healthcare/facts/factsheets/2012/04/aca-and-latinos04102012a.html

United States Census. (2018). https://www.census.gov/quickfacts/fact/table/chulavistacitycalifornia,southbaycityflorida/PST045218

van Walraven, C., Dhalla, I. A., Bell, C., Etchells, E., Stiell, I. G., Zarnke, K., Austin, P.C., Forster, A.J. (2010). Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. *CMAJ: Canadian Medical Association Journal* 182(6):551_557 DOI 10.1503/cmaj.091117

Vargas Bustamante, A., Fang, H., Garza, J., Carter-Pokras, O., Wallace, S.P., Rizzo, J.A., and Ortega, A. N. (2012). Variations in healthcare access and utilization among

Mexican immigrants: the role of documentation status. J Immigr Minor Health.14, 146–55. [PubMed: 20972853]

Vergouwe, Y., Steyerberg, E.W., Eijkemans, M.J. C., Habbema, J.D.F., (2005). Substantial effective sample sizes were required for external validation studies of predictive logistic regression models. J Clin Epidemiol; 58: 475–83.

Wachter, R.M., (2004). Hospitalists in the United States—mission accomplished or work in progress? N Engl J Med;350:1935–6. [PubMed: 15128892][PMID: 15128892]

Walker, R. J., Gebregziabher, M., Martin-Harris, B., & Egede, L. E. (2014). Relationship between social determinants of health and processes and outcomes in adults with Type 2 diabetes: Validation of a conceptual framework. *BMC Endocrine Disorders*, *14*(1), 1–10. https://doi.org/10.1186/1472-6823-14-82

Wen, L. K., Shepherd, M. D., & Parchman, M. L. (2004). Family Support, Diet, and Exercise Among Older Mexican Americans With Type 2 Diabetes. *The Diabetes Educator, 30*(6), 980–993. https://doi.org/10.1177/014572170403000619

Whittemore, R., & Roy, C. (2002). Adapting to diabetes mellitus: A theory synthesis. *Nursing Science Quarterly*, *15*(4), 311–317. https://doi.org/10.1177/089431802320559236

Weinick, R., Jacobs E, Stone L, Ortega A, Burstin H. (2004). Hispanic healthcare disparities: challenging the myth of a monolithic Hispanic population. Med Care. 42; 313–20. [PubMed: 15076807]

Woolf, B. S. H., & Braveman, P. (2011). Where Health Disparities Begin : Health Affairs, 30(10), 1852–1859. https://doi.org/10.1377/hlthaff.2011.0685

World Health Organization, Commission on Social Determinants of Health. (2018). Closing the Gap in a Generation: Health equity through action on the social determinants of health. Available from: **http://www.who.int/social_determinants/en**

Zhu, W., Zeng, N., & Wang, N. (2010). Sensitivity, specificity, accuracy, associated confidence interval and ROC analysis with practical SAS implementations. *NESUG proceedings: health care and life sciences*, *19*, 67.

Zohrabian, A., Kapp, J. M., & Simoes, E. J. (2018). The economic case for US hospitals to revise their approach to heart failure readmission reduction. *Annals of Translational Medicine*, *6*(15), 298.

Appendix A

LACE Index Scoring Tool for Risk Assessment of Death and Readmission

Step 1. Length of Stay

Length of stay (including day of admission and discharge): _________ days

Length of stay (days)	Score (circle as appropriate)
1	1
2	2
3	3
4-6	4
7-13	5
14 or more	7

L

Step 2. Acuity of Admission

Was the patient admitted to hospital via the emergency department?
If yes, enter "3" in Box A, otherwise enter "0" in Box A

A

Step 3. Comorbidities

Condition (definitions and notes on reverse)	Score (circle as appropriate)
Previous myocardial infarction	+1
Cerebrovascular disease	+1
Peripheral vascular disease	+1
Diabetes without complications	+1
Congestive heart failure	+2
Diabetes with end organ damage	+2
Chronic pulmonary disease	+2
Mild liver disease	+2
Any tumor (including lymphoma or leukemia)	+2
Dementia	+3
Connective tissue disease	+3
AIDS	+4
Moderate or severe liver disease	+4
Metastatic solid tumor	+6
TOTAL	

If the TOTAL score is between 0 and 3 enter the score into Box C. If the score is 4 or higher, enter 5 into Box C

C

Step 4. Emergency department visits

How many times has the patient visited an emergency department in the six months prior to admission (not including the emergency department visit immediately preceding the current admission)? ___________
Enter this number or 4 (whichever is smaller) in Box E

E

Add numbers in Box L, Box A, Box C, Box E to generate LACE score and enter into box below. If the patient has a LACE score that is greater than or equal to 10, the patient can be referred to the virtual ward. (Note: A *virtual ward* uses the systems and staffing of hospital care, but without the physical building: staff provide preventative care for patients in their own homes. If your hospital does not support a virtual ward, proceed to treat patient as a high risk individual.)

LACE

Appendix A (second page)

Note that there are other risk assessments in the environment and this is just one example.

Condition	Definition and/or notes
Previous myocardial infarction	Any previous definite or probable myocardial infarction
Cerebrovascular disease	Any previous stroke or transient ischemic attack (TIA)
Peripheral vascular disease	Intermittent claudication, previous surgery or stenting, gangrene or acute ischemia, untreated abdominal or thoracic aortic aneurysm
Diabetes without microvascular complications	No retinopathy, nephropathy or neuropathy
Congestive heart failure	Any patient with symptomatic CHF whose symptoms have responded to appropriate medications
Diabetes with end organ damage	Diabetes with retinopathy, nephropathy or neuropathy
Chronic pulmonary disease	??
Mild liver disease	Cirrhosis but no portal hypertension (i.e., no varices, no ascites) OR chronic hepatitis
Any tumor (including lymphoma or leukemia)	Solid tumors must have been treated within the last 5 years; includes chronic lymphocytic leukemia (CLL) and polycythemia vera (PV)_
Dementia	Any cognitive deficit??
Connective tissue disease	Systemic lupus erythematosus (SLE), polymyositis, mixed connective tissue disease, moderate to severe rheumatoid arthritis, and polymyalgia rheumatica
AIDS	AIDS-defining opportunistic infection or CD4 < 200
Moderate or severe liver disease	Cirrhosis with portal hypertension (e.g., ascites or variceal bleeding)
Metastatic solid tumor	Any metastatic tumour