PREDICTING HOSPITAL READMISSIONS IN PATIENTS WITH DIABETES:
IMPORTANCE OF DIABETES EDUCATION AND OTHER FACTORS

by

Darwin E. Asper

A Dissertation Submitted to the Faculty of
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Doctor of Philosophy

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This dissertation was prepared under the direction of the candidate's dissertation advisors, Dr. Lucy M. Guglielmino and Dr. J. Daniel Morris, Department of Educational Leadership, and has been approved by the members of his supervisory committee. It was submitted to the faculty of the College of Education and was accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

SUPERVISORY COMMITTEE:

Lucy M. Guglielmino, Ed.D.
Dissertation Co-Chair

J. Daniel Morris, Ph.D.
Dissertation Co-Chair

Valerie C. Bryan, Ed.D.

Michele Acker-Hocevar, Ph.D.

Robert E. Shockley, Ph.D.
Chair, Department of Education

Valerie J. Bristor, Ph.D.
Interim Dean, College of Education

Barry T. Rosson, Ph.D.
Dean, Graduate College

July 7, 2009

Date
VITA

Darwin Edward (Dar) Asper II, son of Darwin E. and Dorothy Asper, was born March 29, 1961, in Wichita, Kansas. He graduated Woodland Park High School in Woodland Park, Colorado, in 1979. In 1984 he attended the University of Northern Colorado in Greeley, Colorado, where he earned a Bachelor of Arts degree in Exercise Physiology. He met Sandy Sailer during his course work at UNC and they married after he graduated. They moved to Florida and within 5 years had two children, Jeff and Julie. While working full-time at Martin Memorial Medical Center in Stuart, Florida, he earned a Master’s degree in education, with a major in Exercise Physiology from Florida Atlantic University in Boca Raton, Florida. Darwin then went to work at Jupiter Medical Center as the Director of Wellness. He was fortunate enough to work with an outstanding staff, including his longtime friend and colleague, Brian W. Findley. After accepting a dare from Brian to at least try a doctoral course, Darwin, like Brian, endeavored to pursue a doctoral degree in Educational Leadership: Adult and Community Education at Florida Atlantic University. During the course of this pursuit, their professional directions split, but they remained classmates and close friends through the end of the degree journey.
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The foremost acknowledgement is to my Lord and Savior, Jesus Christ, who has taught me that I can do everything through him who gives me strength, Phil. 4:13.

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A very special thank you and deep gratitude goes to my wife, Sandy Asper. She has sacrificed a great deal for this endeavor and gave me tremendous support, space and time to work. Our children, Jeff and Julie, provided additional encouragement and inspiration by understanding when my participation in their activities took a backseat to this project.

I would also like to thank all my family and numerous friends in Florida and North Carolina who have supported me with inspiring words of encouragement and thoughtful prayers. A great deal of thanks is owed to my mother and father and my wife’s mother and father who have been tremendously supportive in many ways.
ABSTRACT

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The objective of this study was to determine whether 11 independent variables or combinations of variables help to predict a diabetes-related hospital readmission for patients with diabetes within 60 days from discharge. The variables were categorized into four main groups: (a) patient characteristics, (b) lifestyle, (c) biomarkers, and (d) disease management aspects. A convenience sample of 389 historical medical records of patients who were admitted to a rural hospital in northeastern North Carolina with a diagnosis of, or relating to, diabetes was studied. After comparing predictive discriminant analysis (PDA) and logistic regression (LR), PDA performed better and was chosen to analyze a convenience sample of patients admitted to the hospital for a diabetes-related diagnosis from January, 2004 to December, 2006. The best overall subset accurately classified 27
cases with six predictors that included (a) systolic blood pressure, (b) smoking status, (c) blood glucose range, (d) ethnicity, (e) diabetes education, and (f) diastolic blood pressure.

In an effort to simplify the prediction process, the subsets of two predictors were examined. The results of the analysis returned four subsets of 2-predictor variable combinations that correctly classified cases for readmission. Each of the four subsets has two predictors that are statistically and practically significant for predicting readmissions for a diabetes-related problem within fewer than 60 days. These combinations are the predictor subsets of (a) smoking status and being treated by a specialist or non-specialist physician, (b) a religious affiliation or a lack thereof and smoking status, (c) gender and smoking status, and (d) smoking status and ethnicity.
DEDICATION

This manuscript is dedicated to my family, particularly to my understanding and patient wife, Sandy, who has put up with many years of family time interruptions, and to my son, Jeff, and daughter, Julie, who have also sacrificed many times to allow me to work on this goal. I also dedicate this work to my parents and my wife’s parents and family who have continually supported this effort financially and prayerfully.

"The end of a matter is better than its beginning, and patience is better than pride." Eccl. 7:8
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INTRODUCTION

Healthcare is the largest industry in the United States and employs over 14 million persons (U.S. Department of Labor, 2008). Healthcare access and cost are a pervasive concern for most U.S citizens and often are headlined in the media. Government policymakers endeavor to reduce costs, increase access and provide coverage for all, while researchers seek funding to search for cures and better treatments. In the United States, chronic diseases are the leading causes of death and disability. The most prevalent chronic diseases are heart disease, cancer, stroke, chronic lower respiratory disease, and diabetes, which together, account for 1.7 million or 70% of all deaths in the U.S. each year. These diseases also cause major limitations in daily living for nearly 25 million Americans. Even though chronic diseases are the most prevalent and costly health problems, many are often preventable and manageable. Practicing healthy lifestyle behaviors such as a proper diet of nutritious foods, participating in regular physical activity, abstaining from tobacco use, and limiting alcohol intake can avoid or manage the deleterious effects of diabetes and other chronic diseases (American Diabetes Association [ADA], 2008; Center For Disease Control, 2008).

In 2008, the Center for Disease Control listed diabetes as the fifth leading cause of death, excluding accidents, in the United States; and more than 23 million Americans have the disease today (ADA, 2008). Those unfamiliar with the disease may consider
diabetes a single disease; it is actually a cluster of diseases described by high levels of blood glucose resulting from faulty insulin secretion, insulin function, or both (ADA, 2008). Diabetes is often associated with serious complications, known as co-morbidities, that often lead to premature death. There is no cure for diabetes, and the prevalence is projected to 366 million worldwide by 2030 (Wild, Roglic, Green, Sicree, & King, 2004). It is estimated that the incidence of diabetes in the United States will increase to 36.4 million by 2030 (Narayan Venkat, Boyle, Geiss, Saaddine, & Thompson, 2006). Ethnicity and age play a role in prevalence of the disease. American Indians and Alaska Natives aged 20 years or older have the greatest prevalence among races surveyed, followed by non-Hispanic Blacks, Hispanics, Asians and non-Hispanic Whites (ADA, 2008).

Diabetes is historically categorized into two categories, Type 1 and Type 2. Until recently, Type 1 was considered a childhood disease and was usually diagnosed before age 40. Nearly 50% of all people diagnosed with Type 1 diabetes are younger than 20 years of age. Type 2 is the most common form, with half of all cases diagnosed in persons over 55 years of age. As with other chronic diseases, persons with diabetes can take measures to reduce the likelihood of developing the disease (ADA, 2008; Center for Disease Control, 2008).

Promoting healthy lifestyles and reducing healthcare costs through effective management of chronic conditions has been a challenge among a variety of diseases, including diabetes (American Diabetes Association, 2008; Leichter, August, & Moore, 2003; Maldonado, Chong, Olehl, & Blasubramanyan, 2003). Diabetes, with its complex interaction with other health threats, is particularly challenging for a considerable portion
of the population. Attention to biomarkers such as blood glucose and blood pressure can help patients manage and control the disease in order to reduce acute episodes, chronic side affects and unnecessary hospital admissions (Rubin, Dietrich, & Hawk, 1998).

Management of diabetes is ideally a team effort. Main players include the physician, diabetes educator, and the patient, while friends and family members play an important supporting role. Much of the disease management responsibility falls to the patient; therefore effective patient education is pivotal (Friberg & Hansson-Scherman, 2005).

**Statement of Problem**

Diabetes is linked to an increased likelihood for a number of serious, sometimes life-threatening complications. Proper diabetes management can reduce the risk of complications and improve quality of life. It is widely known that diabetes patients who are educated on disease management techniques are more effective in maintaining proper diet, blood pressure, and blood glucose (Bray, Roupe, Harrell, Cummings, & Whesome, 2005; Christensen, Williams, & Pfister, 2004; Rubin et al., 1998). They are also more likely to make healthy lifestyle adjustments that result in positive changes, such as ideal body weight; they suffer fewer complications and do not experience frequent acute episodes that require emergency medical care or hospitalizations (American Diabetes Association, 2003; Eliason, 2003; Rimm et al., 1993; Landrum & Wienrich, 2006; Smith et al., 2000). However, little is known about which aspects of disease management and patient care factors or what combination of the factors may predict an acute situation that leads to unnecessary hospitalizations.
Purpose

The purpose of this study is to evaluate the contribution of patient demographics, (age, gender, ethnicity), lifestyle components (marriage status, religious affiliation or not and smoking status), biomarkers (blood glucose level, blood pressure), and disease management aspects (physician specialty or not and participation in a diabetes education program) to predict or moderate hospitalization readmissions for patients with diabetes.

Research Questions

The primary questions for the proposed study are:

1. What aspects of patient characteristics, lifestyle, biomarkers and disease management predict readmissions for conditions caused by or related to diabetes management?
2. Are there combinations of patient characteristics, lifestyle, biomarkers, and disease management aspects that predict readmissions caused by or related to diabetes management?

Significance

Diabetes is a lifelong condition with no cure. Eight percent of the United States population (23.6 million children and adults) has diabetes and the disease is the fifth leading cause of death among diseases (American Diabetes Association, 2008). In 2003, the American Diabetes Association (ADA) estimated the total annual economic cost of diabetes to be $174 billion. To help manage the disease, patients can be taught to modify their diet and to monitor their blood glucose and blood pressure. Lifestyle management to stop smoking and reduce obesity can also result in fewer hospitalizations. If predictions of repeated acute episodes causing unnecessary hospital readmissions can be identified, costs can be reduced to the individual and society (Gilmer, O’Connor, Manning, & Rush,
The information gained from this study could provide a foundation for designing appropriate interventions to reduce the need for acute care of individuals with diabetes.

**Limitations**

This research has potential for far-reaching effects. However, this study has inherent limitations that restrict its application to a larger population. The sample is from a rural area of the United States that experiences a higher than normal prevalence of diabetes (Dickson, Alexander, Earley, & Riddle, 2004). This population is also geographically situated in one of the poorest socioeconomic areas of the country. Low socioeconomic status has been historically associated with lower health literacy that translates into decreased health awareness (Bray et al., 2005; Dickson et al. 2004). Further, economically challenged segments of the population often have restricted access to healthcare, which the literature states directly affects health outcomes of patients with diabetes (Bray et al.). The relatively small sample size and disproportionate ratio of patients who had diabetes education to those who had not also represent limitations; only 14% (55) of the sample were instructed on diabetes self-care.

The current study includes marriage status and religious affiliation or lack thereof, but does not include data on the depth or influence of these factors. Similarly, information on diabetes education is limited to whether or not the patient reported receiving it. Type of diabetes education, frequency, and whether it was delivered by a certified instructor is not known. The patients’ self-efficacy for diabetes self-management, which could affect the readmission statistics, was not able to be measured (Anderson et al., 2000).
Delimitations

The study was conducted with the patient population of only one hospital. While the variables selected are cited by the literature as plausible predictors, data on other criteria that may also be predictors were not feasibly accessible at the time of the data collection.

Definitions

Several terms need definition to provide a common understanding of the specifics of this study. Further discussion occurs in Chapter 2.

*Diabetes:* The American Diabetes Association (ADA, 2008) defines diabetes as either the body’s failure to produce insulin (Type 1) or the body’s failure to properly use insulin combined with insulin deficiency (Type 2).

*Lifestyle components:* Certain behaviors are related to and can complicate the treatment of diabetes. The most commonly cited include overeating to the point of obesity, smoking and sedentary life-style.

*Biomarkers:* Certain quantifiable aspects of care can be managed to reduce complications of diabetes and related conditions. The pivotal biomarkers to monitor and manage in diabetes include body weight, blood pressure and blood glucose levels.

*Comorbidity:* The effects of other diseases that a patient may have that are related to the primary disease. For the purposes of this study, the other diseases related to diabetes are heart disease, blindness, kidney failure, and nerve damage.
Chapter Summary

Eight percent of the U.S. population has diabetes, a disease that is associated with an increased propensity for many comorbidities. Discovering what aspects of patient care affect disease management outcomes is important for the patient and the healthcare institution. Misaligned inpatient treatment strategies and faulty self-care technique often result in unnecessary and costly hospital readmissions. The concept of this research has the potential for far-reaching effects; however, the specificity of the sample limits the generalizability to the general population.

Chapter Two will present a review of literature that provides a basis for this study, Chapter Three details the methodology, Chapter Four lists the findings, and the final chapter includes discussion, conclusions, implications, and suggestions for further research.
REVIEW OF THE LITERATURE

This study investigated the relationship between unnecessary hospital readmissions of diabetes patients and the key aspects related to diabetes: patient demographics, lifestyle components, biomarkers, and disease management. The concept of the study is based in the interconnected dynamic relationship of diabetes care aspects with the predictability of emergency treatment or unplanned admissions into a hospital and the economic impact of suboptimal disease management of diabetes. The purpose of this study was to evaluate the contribution of patient demographics, (e.g., age, gender, ethnicity), lifestyle components (e.g., marriage status, religious affiliation or not and smoking status), biomarkers (e.g., blood glucose, blood pressure) and disease management aspects (e.g., physician specialty or not and patient participation in a diabetes education program) to predicting hospitalization readmissions for patients with diabetes.

This review of the literature will first provide background and context, including definitions of the two types of diabetes, an overview of prevalence of the disease, and an explanation of the economic impact of diabetes. It will present the demographic groups of patients with diabetes and their lifestyle components. The review of patient characteristics and lifestyle will consider age, gender, ethnicity, and patient controlled components that are known to directly affect diabetes such as smoking status and social support.
Essential biomarkers will be explained. Biomarkers such as blood glucose level and blood pressure level are indicators of the level of success of disease management efforts. The types of diabetes education available to assist in patient self-management are described, and the relationship between the physician specialty and avoidable readmission is also examined.

Examination of these factors may help predict future acute episodes of diabetes that lead to recidivistic hospital admissions. The economic impact of suboptimal hospital care and self-care practices resulting in recidivistic readmissions will be detailed.

Diabetes Overview

Currently in the U.S., diabetes affects 23.6 million children and adults or 8.0% of the population and is the nation’s fifth leading cause of death among diseases. The reported death rate is considered to be underestimated, however, due to the fact that diabetes is often not listed as the cause of death. The American Diabetes Association (2008) reports that of the 280,000 deaths related to diabetes in 2007, only 77,000 noted diabetes as the primary cause. While over 23 million people are diagnosed with the chronic disease, it is believed that 5.7 million people remain undiagnosed; and 57 million people are considered to have pre-diabetes (ADA, 2008). Many researchers posit that prevalence of diabetes will increase considerably over the next 3 to 5 decades with the largest increase occurring in those over 60 years of age (Narayan Venkat et al., 2006).

Definitions

There are two main types of diabetes, Type 1 and Type 2. The American Diabetes Association (2008) defines Type 1 diabetes as the body's failure to produce insulin, the hormone that is needed to convert sugar (glucose) to energy. It is estimated that 5 to 10%
of Americans who are diagnosed with diabetes have Type 1 diabetes. The ADA (2008) describes Type 2 diabetes, the most common form of diabetes, as the body’s failure to produce enough insulin or failure to use insulin to convert sugar to energy.

Previously known as juvenile diabetes, Type 1 diabetes is usually diagnosed in children and young adults. Type 2 diabetes was formerly known as adult onset diabetes. While obesity is strongly related to Type 2 diabetes, there are other causes that remain unidentified. Although genetics is considered to play a significant role in both types, the main cause still remains a mystery (Christensen et al., 2004). The quality of the patient’s self-care and attention to medical biomarkers may predict the extent of recurring acute episodes resulting in emergency room visits or hospitalizations (Smith et al., 2000).

**Economic Impact of Diabetes**

Diabetes is a complex and costly lifelong disease with no cure in sight. Brandle et al. (2003) state the worldwide prevalence of diabetes is increasing, as is the demand for and cost of medical care. In 2007 the estimated economic cost of diabetes in the U.S. was $174 billion. Twenty percent of these healthcare dollars is spent on diabetes care, and one in ten dollars is used on health care directly attributable to complications of diabetes. But the cost does not stop here; the loss to the nation in economic productivity is nearly $60 billion dollars. Interestingly these astounding totals are incomplete because the cost associated with undiagnosed diabetes, nearly 25%, and the uncompensated care and loss of productivity of family members of patients with diabetes are not included (Fradkin & Rodgers, 2008).

Many persons with diabetes can live healthy lives with proper personal and medical disease management; however, a percentage of persons with diabetes will
experience episodes of acute illness that require emergency treatment and often hospitalization. Unnecessary readmissions to the hospital are unfortunately common and costly in terms of quality of life for the patient and in financial terms for both the patient and the healthcare system (Ashton, Kuykendall, Johnson, Wray, & Wu, 1995). The ADA (2008) and Fradkin and Rodgers (2008) suggest that medical costs are 11% higher in patients with diabetes compared to those without.

Patient Demographics

Although some risk conditions for diabetes are beyond the patient’s control, such as age, gender, and ethnicity, each play an important role in the disease process.

Age

Diabetes affects only 0.22% or 186,300 of the U.S. population under 20 years of age. Nearly eleven percent (10.7%) or 23.5 million adults over 20 have diabetes. It is clear that as age increases, so does the propensity for diabetes. The largest age demographic of those who have diabetes is over 60 years of age, as reflected in Table 1 (ADA, 2008).

<table>
<thead>
<tr>
<th>Age</th>
<th>Under 20</th>
<th>Over 20</th>
<th>Over 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage in this age group with diabetes</td>
<td>0.22</td>
<td>10.7</td>
<td>23.1</td>
</tr>
<tr>
<td>Number in this age group with diabetes</td>
<td>186,300</td>
<td>23.5 million</td>
<td>12.2 million</td>
</tr>
</tbody>
</table>
Persons who are age 60 or older make up over half (12.2 million) of the persons with diabetes in the over-20 U. S. population (ADA, 2008).

Gender

Among those aged 20 years old or older, more men (11.2% or 12.2 million) than women (10.2% or 11.5 million) have diabetes. Research of Gucciardi, Chi-Yan Wang, DeMelo, Amaral and Stewart (2008) suggests that men and women with diabetes have different psychosocial, behavioral, and clinical characteristics that can affect attitudes and behavior toward self-care and health outcomes. Their results demonstrated that women were likely to perceive a higher level of support from their diabetes health care team and to recognize the beneficial aspects of self-management, whereas men had lower expectations of the benefits of self-management.

Ethnicity

Diabetes and its associated serious conditions constitute a greater threat to particular populations (ADA, 2008). Maldonado et al. (2003) and the American Diabetes Association (2008) emphasize that ethnicity is a risk factor for diabetes. Non-Hispanic Whites are the least affected population (8.7%). Hispanic/Latino Americans including Mexican Americans and Puerto Rican Americans are over 1.7 times as likely to have diabetes as non-Hispanic Whites, while non-Hispanic Blacks have a slightly higher incidence of 1.8 times as likely as non-Hispanic Whites. By far the ethnic group with the greatest prevalence is the American Indians and Alaska Natives. Nearly 15% of American Indians and Alaska Natives aged 20 years or older have been diagnosed with diabetes, and they are 2.2 times as likely to have diabetes as non-Hispanic Whites (ADA, 2008; Berg & Wadhwa, 2002). Many studies have investigated cultural effects of
ethnicity in various disease management programs (Berg & Wadhwa, 2002) and discuss the possibility that ethnicity may help predict disease management compliance when considering related factors of access to healthcare, education level or socioeconomic status (ADA, 2008; Maldonado et al., 2003).

Although non-Hispanic Blacks experience higher rates of diabetes-related complications than non-Hispanic Whites, this may possibly be due to factors other than ethnicity, including heredity, financial barriers, inadequate healthcare, and cultural beliefs (Berg & Wadhwa, 2002). Access to healthcare is a problem for many, especially African Americans and Hispanics. Other factors within these two ethnic groups including cultural traditions, language barriers, and socio-demographic factors contribute significantly to poor metabolic control (Montague, Nichols, & Dutta, 2005). Bernal, Woolley, Schensul, and Dickinson (2000) reported that not understanding the English language well is the major barrier for self-efficacy in self-managing diabetes. Certain segments of African American women were reported to experience 32% to 82% non-adherence to proper medical nutrition due to their belief structure and cultural lifestyle (Montague et al., 2005). These women were typically in lower socio-economic groups and were believed to live for the present and tended to disregard the preventive health measures such as exercise and weight control, which are important components of disease management (Anderson et al., 2000). Bernal et al., (2000) report that not understanding the English language well is the major barrier for self-efficacy in self-managing diabetes. Clearly these studies indicate that ethnicity can be indicator in metabolic control.
Patients’ Lifestyle Components

Many aspects of the patient’s lifestyle can have large effects on the disease state. Patients that have the support of family and friends have demonstrated better outcomes. Lifestyle habits play an important role in the self-management aspect of treatment of diabetes. Arranging for and engaging in social support and reducing and avoiding smoking are among life-style factors that can greatly increase the outcome of managing diabetes.

Social Support

Family and social support is a multidimensional concept that is believed to influence the health outcomes of individuals. The availability and quality of a support system directly affects an individual’s ability to adapt to changes associated with chronic illnesses such as Type 2 diabetes (Trief, Ploutz-Snyder, Britton & Weinstock, 2004). Findings from a study by Tang, Brown, Funnell, and Anderson (2008) suggest that social support, as a broad notion, performs a significant function in diabetes-specific quality of life and self-management. In their study, social support emerged as a predictor that improved diabetes-specific quality of life and enhanced performance on 5 of the 7 self-care behaviors they examined.

However, research has produced mixed results. While Trief et al. (2004) suggest that there is a positive relationship between marital status and health outcomes of individuals with diabetes, Chlebowy and Garvin (2006) find no significant prediction in glycemic control and social support. They state that one cause of the variations in findings may be due to different operational definitions of social support and different measurement scales for social support in other studies. Further, a positive support
structure consisting of family has demonstrated better disease adaptation and treatment adherence, while negative aspects affect the patients’ ability to self-manage their disease (Jones et al., 2008).

Religion and faith can play an important part in dealing with diabetes. Boltri et al. (2006) found that religion is an important component in managing diabetes in African American women. Polzer and Miles (2007) found that there were three separate categories relating to spirituality and managing diabetes among African Americans. Their research demonstrated that the notion of spirituality and self-management might vary among African Americans. Religious affiliation was a characteristic central to defining membership in their ethnic and social group. Edified by their spiritual beliefs, particularly biblical scripture and spiritual practices, participants in this study embraced dissimilar positions on their role versus God’s in diabetes self-management. On one end of the spectrum, the participants believed God was in the background supporting them and helping them manage their self-care, while the other end of the spectrum chose to hand over their responsibilities of self-care entirely to God.

This study will examine martial status or a religious affiliation or a lack thereof to determine their significance as predictors for recidivistic admissions.

*Smoking Status*

In today’s society, it is widely accepted that cigarette smoking is strongly related to the health risks of many diseases. Persons who smoke cigarettes often have other lifestyle risk factors for cancer and cardiovascular disease that include sedentary life-style, overweight or obesity, high blood pressure, and high cholesterol (Eliasson, 2003; Rimm et al., 1993).
Solberg, Desai, O’Connor, Bishop, and Devlin (2004) reported that diabetic patients that smoke had a higher probability to describe their health as fair or poor and often felt depressed. When compared to nonsmokers, smokers did not check blood glucose levels as often, were more sedentary, experienced fewer diabetes care visits, and had fewer hemoglobin (HbA1c) laboratory blood tests and foot and dental examinations. These patients also reported receiving and desiring less support from family and friends specific to diabetic self-management activities and were less likely to consider smoking cessation than what has been observed in other population groups.

Risks are compounded for persons with diabetes that smoke. The effects of smoking not only adversely alter heart rate, blood pressure and carbon monoxide levels but also affect other metabolic processes related to insulin. Cigarette smoking decreases fasting insulin levels and increases insulin resistance. This confounds the typical management strategy by complicating the metabolic process the patient is attempting to manage (Eliasson, 2003).

While it is established that smoking affects metabolic processes, evidence of smoking is also manifested by the HbA1c result. Research has demonstrated that diabetic smokers have higher HbA1c levels than diabetic patients who do not smoke. Clearly, diabetic patients who smoke have a higher risk for acute diabetes episodes as well as an increased propensity to exacerbate other serious conditions or comorbidities related to this disease such as kidney and heart disease (Eliasson, 2003; Solberg et al., 2004).

Disease Management and Education

An important key to the long-term health of a person with diabetes is the ability to self-manage (ADA, 2003; Berg & Wadhwa, 2002; Christensen et al., 2004). Persons
with diabetes can learn how to regulate their blood glucose by using the self-management skills taught by their physician, nurse or diabetic educator (Sedor, 2006). However, there may be instances where blood glucose readings may reach extreme levels, often leading to acute illness that requires emergency medical care. To prevent acute illness and prevent or delay chronic diabetes side-effects, the patients must closely manage their condition with direction from a healthcare team. The healthcare team directs care and often provides much of the education vital for self-care (Christensen et al., 2004).

**Biomarkers**

Diabetes is a complex metabolic disorder in which the body is unable to use glucose properly. The disease management team uses many tools or biomarkers to evaluate current disease state and disease progression. A great deal of information can be gleaned about the diabetic patient’s state by focusing on two biomarkers, blood glucose and blood pressure levels. If these important measures of the disease process and care are managed, the outcomes (as measured by acute episodes, chronic side effects, or hospital readmissions) are greatly improved. (Consensus Development Conference, 2006; Gifford, Schrier, Estacio, & Jeffers, 2000; Ravid, Brosh, Ravid-Safran, Levy, & Rachmani, 1998)

*Blood glucose values.* Of the tools used to manage diabetes, blood glucose values provide the most information and are imperative in managing diabetes (ADA, 2008). Considering the acute and chronic aspects of diabetes, it is recommended that the blood glucose be measured regularly by the patient throughout the day to ascertain fluctuations in blood glucose caused by food intake, exercise, stress, or medication. It should also be
measured three to four times a year by the physician using the Hemoglobin A1c lab test (Berg & Wadhwa, 2002; Clement et al., 2004; Harris, 2001).

Patients measure their blood using a small handheld device. A small drop of blood is required. *Milligrams per deciliters* (mg/dl) is the traditional measure of blood glucose in the United States. In persons without diabetes, the blood glucose level is automatically regulated by the body within the optimal range of 70-130 mg/dl. Using this value as a target, patients are urged to adjust food intake, activity, and/or medication to maintain or regain proper blood glucose values (ADA, 2008).

National diabetes experts from the American College of Endocrinology and the American Association of Clinical Endocrinologists convened to review the importance of glycemic control and clinical pathways for patients with diabetes. These experts compiled research reviews and observational data and developed a position statement on glucose management of hospitalized patients. They concluded that a strict glycemic objective of 80-110 mg/dl was necessary to decrease mortality, infection, and kidney failure as well as decrease length of the hospital stay (Consensus Development Conference, 2006; Sedor, 2006). Tragically, when a patient with diabetes is hospitalized for reasons other than diabetes, the management of diabetes “is generally considered secondary in importance compared with the condition that prompted the admission” (Clement et al., 2004, p. 553). Controlling blood glucose while hospitalized can set the patient on a solid footing upon discharge and potentially save considerable human and economic costs (Ashton et al., 1995; Miller et al., 2006).

Since diabetes education and blood glucose management are often ignored while in the hospital, patients are discharged without the necessary survival skills or a care plan.
for disease management (Clement et al., 2004). A goal-directed plan should be developed with a medical team for short and long-term blood glucose tests, instruction on diabetes survival skills, follow-up, and overall management (Clement et al. 2004; Consensus Development Conference, 2006).

Both the patient-administered blood glucose test results and the physician-directed lab test results (HbA1c) are important. While the patient-administered blood glucose levels provide a point-in-time level, the periodic HbA1c indicates the longer term self-management and treatment plan effectiveness. Each of these demonstrates the level of diabetes management (Harris, 2001). The measure of blood glucose used in this study is the last daily blood glucose measurement recorded in the patient’s hospital chart.

**Blood pressure readings.** Blood pressure measures the force placed on the walls of the vessels. Offering a real-time measure, blood pressure is an important marker in general health assessment as well as diabetes. Approximately 65% of patients with diabetes die from heart disease or stroke (Sedor, 2006). Research has demonstrated that controlling blood pressure will reduce the risk of cardiovascular complications and increase kidney function (Caramori, Pioretto, & Mauer, 2006). The significant and serious combination of diabetes and high blood pressure affects other disease processes of the kidney known as nephropathy and End Stage Renal Disease (ESRD) (Sedor, 2006). Diabetes contributed to more than 44% of all new cases of ESRD from 1999 to 2003 (Caramori et al., 2006). The traditional measure for blood pressure is stated in millimeters of mercury (mm/Hg). The National Diabetes Education Program’s (2007) ABC’s for controlling diabetes recommend controlling blood pressure to 130/80 mm/Hg.
Regretfully, a review of patient charts in a study by Caramori et al. (2006) revealed that blood pressure was not controlled to the suggested standard or was overlooked in hospitalized diabetic patients. This is unfortunate because it is known that blood pressure in the upper strata of the normal range may lead to kidney disease related to diabetes. The measure of blood pressure used in this study will be the last recorded measurement in the patient’s chart prior to discharge.

Diabetes Education

In 1977, the Diabetes Research and Education Act (Boucai & Zonszein, 2007) directed federal resources toward health education for persons with diabetes. Education materials and programs are developed at participating universities (National Diabetes Education Programs and Diabetes Research and Training Centers) and materials are disseminated through channels such as the National Diabetes Information Clearinghouse as well as private providers.

Many methods are used to stem the tide of recidivistic visits of patients with diabetes including patient education, lifestyle management, and intense pharmacological therapy. The literature demonstrates that diabetes education has a profound effect on self-care (Berg & Wadhwa, 2002). The ADA has developed national standards for diabetes self-management education. Within this document, the ADA states that “There is no ‘best’ education program or approach” (Funnell et al., 2008, p. 55), but suggests programs that encompass behavioral and psycho-social strategies have better outcomes. Education of the patient may be offered by the primary healthcare provider, through classes, or at the time of hospitalization by a variety of healthcare professionals.
**Diabetes education by physician.** Diabetes disease management education may be conducted by the primary care giver such as the attending physician or nurse. However, most physicians feel ill-equipped to educate their patients (Smith et al., 2000). A study from *Family Practice News* ("Physicians Report Gap," 2005) surveyed physicians in two metropolitan areas and found that only 21% of primary care physicians believed they were managing their patient’s diabetes *very well*, and only 10% felt they were effective in managing the disease. The study states that the physicians were not confident that they had enough resources to help their patients manage diabetes. The survey also reveals that only 28% of physicians frequently refer diabetes patients to a diabetes educator or program.

*Diabetes education classes.* Research studies have indicated that persons with diabetes that complete a comprehensive course in Diabetes Self-Management Education (DSME) self-manage their disease better than those who do not (Christensen et al. 2004; Gollin, DiMatteo, Leake, Dunan, & Gelberg, 2001; Sedor, 2006). This course imparts information on vital aspects of self-care including medication, blood glucose monitoring, nutrition, and exercise. It provides instruction on how life-style behaviors and relative biomarkers including blood glucose level and blood pressure affect the practice of self-management. Self-management education provides patients with important tools to manage their disease and leads to better outcomes (Bowker, Mitchell, Majumdar, Toth, & Johnson, 2004; Leichter et al., 2003).

*Diabetes education for hospitalized patients.* It is in both the patient’s and the hospital’s best interest to provide diabetes education to bolster patient understanding of the disease and the impact of lifestyle habits and medications (Berg & Wadhwa, 2002;
Hospital education should be delivered to the patient by a nurse educator or other healthcare professional qualified by rigorous training. The well-researched curriculum aims to provide the patient with tools, such as proper eating habits and proper use of medications, to establish and maintain optimum blood sugar or metabolic control (ADA, 2003). Research by Gilmer et al. (1997) reviewed an inpatient diabetes education program that demonstrated significant first year net savings and the second year reduction of Length of Stay (LOS) and recidivistic admissions. Data from a pilot study conducted by the researcher in a rural hospital in North Carolina suggests that patients who were instructed in diabetes education had a significant drop in LOS and less frequent readmissions.

Physician Specialty and Diabetes Outcomes

Caring for acutely ill patients with chronic disease is a complex task. There are often multiple diagnoses that confuse and confound care. Patients with diabetes may be admitted for sundry other primary conditions such as heart disease, nerve disease, and kidney disease, just to name a few (Sedor, 2006). Even though diabetes is considered a manageable chronic disease, if left unmanaged or mismanaged it can become acute rapidly, thrusting the patient into a life-threatening situation requiring hospitalization.

Levetan, Passaro, Jablonski and Ratner (1999) reviewed acutely ill diabetes patients cared for by family care physicians (non-specialists) and endocrinologists (diabetes specialists) with similar case mix and severity of diabetes. Their results demonstrated the average length of stay (LOS) for patients under the care of physician generalists was 4.9 days, while those under the care of an endocrinologist averaged a LOS of 3.3 days. Average hospital expenses differed for patients of endocrinologists and
generalists. Mean cost of a hospital stay for patients of endocrinologists averaged $5,463; the mean for patients of physician generalists was $10,109. Physician generalists’ patients incurred additional charges due in part to patients undergoing more procedures. While no differences in diabetes-related complications occurred during admission, patients treated by an endocrinologist experienced lower readmission rates. The results of this study by Levetan et al. demonstrated that diabetes patients hospitalized for acute illness that were cared for by a specialist, as opposed to a non-specialist, evidence potential differences in knowledge, treatment patterns, and outcomes.

Hospital Readmissions for Diabetic Patients

Persons who experience uncontrollable diabetes or have other related conditions often become acutely ill and enter into a cycle of hospital admission and readmissions. Hospital admission or readmission could simply be due to the natural disease pathology of diabetes or one of the other conditions related to diabetes such as cardiovascular or kidney disease (Ashton et al., 1995). Regretfully, far too often readmission is related to quality of care, both inpatient care and the patient’s self-management care (Maldonado et al., 2003; Smith et al., 2000). A recidivistic readmission is generally defined as a visit that could have been avoided if proper care had been rendered, either by the patient through self-care or by care team while in the hospital.

Ashton et al. (1995) considered the association between quality of inpatient care and early readmission. They reviewed three disease processes including diabetes. Using three categories to evaluate Process of Care, their results demonstrated that the course of care during the hospital stay was related to the probability of readmission within 14 days. Readmission rates offer an important and straightforward measurement of hospital care
(Ashton et al.; Maldonado et al., 2003; Smith et al., 2000). Although the Ashton et al. study found a significant relationship between care and readmission, this study and other similar studies are challenging to compare because of the lack of consistent parameters for readmission.

Landrum and Weinrich (2006) reviewed 1139 articles and excluded most for not clearly defining readmission or not providing two or more measurement criteria. They suggest using the following five criteria in order to clearly define readmission.

1. Identify hospital admissions and define terms as recommended.
2. Establish clinical diagnosis for readmission.
3. Establish purpose for readmission.
4. Set a \textit{discharge to readmission} timeframe.
5. Identify source(s) of information.

Use of these criteria will ensure that the cases for this study fit the readmission definition and structure a stronger study.

Economic Impact of Readmissions

Chronic uncontrolled diabetes can lead to other serious conditions (comorbidities) including heart disease, blindness, kidney failure, and nerve damage, and is also the number one reason for non-traumatic amputation in the United States (ADA, 2003; Bowker et al., 2004). The combinations of these conditions make diabetes one of the most expensive diseases to treat medically (Leichter, et al., 2003). The total annual economic cost of diabetes for the U.S. in 2007 was estimated to be $174 billion. Medical payments amounted to $116 billion and encompassed $27 billion for diabetes care, $58 billion for chronic diabetes-related complications, and $31 billion for other medical expenses. This represents an escalation of $42 billion since 2002, demonstrating a 32% increase or a proliferation of over $8 billion each year (ADA, 2008). These figures
clearly illustrate the devastating effect diabetes has on the healthcare industry as well as the patient.

Frequent emergency visits and readmissions due to poor self-care contribute to the over-utilization strain on the healthcare system (Bowker et al., 2004; Gilmer et al., 1997; Maldonado et al., 2003). Hospitals attempt to reduce over-utilization to help control costs. Therefore, it benefits the hospital to provide the best care in the most appropriate amount of time not only to maximize the health benefit to the individual, but also to prevent costly readmissions (Brandle et al., 2003; Gilmer et al.; Miller et al., 2006).

Leichter et al. (2003) state that, excluding recidivistic admissions, the average charge per day for a patient with diabetes was approximately $8,558. Providing diabetes education to patients who are frequently admitted into the hospital may save the hospital money and may also lead to better disease management of patients with diabetes. Hospital stays of more than four days are costly, leaving the hospital to absorb the tremendous impact of the extended Length of Stay (LOS) (Gilmer et al., 1997).

Chapter Summary

Diabetes is at epidemic proportions in the United States. While it knows no demographic barriers, some ethnic groups experience diabetes at a rate greater than two times that of non-Hispanic Whites. The risk is compounded in those demographic categories that are socio-economically disadvantaged. While diabetes is a chronic disease that affects millions of people, it can often be managed to delay or even prevent comorbidities. Left unmanaged, diabetes will dramatically affect the patient’s quality of life, leading to acute illness and unnecessary hospital admissions. These preventable
admissions account for millions of dollars in potentially preventable healthcare costs annually. Identifying factors that predict poor self-care which lead to recidivistic hospital care is beneficial to the patient and to the healthcare organization. Chapter three presents the methodology for this study; chapters four and five present the findings and conclusions.
METHOD

This quantitative study reviewed historical patient records of a hospital in northeastern North Carolina. This region of North Carolina has a population base in which the incidence of diabetes and cardiovascular disease is higher than the national average (Dickson et al., 2004). The purpose of this study was to identify possible predictors of avoidable hospital admissions of patients with diabetes that are related to improper management of the disease. Variables under consideration were patient demographics (age, gender, ethnicity), lifestyle components (marriage status, religious affiliation or not and smoking status), biomarkers (glucose level, blood pressure) and disease management aspects (physician specialty or not and participation in a diabetes education program) to predicting hospitalization readmissions for patients with diabetes.

The primary questions for the study were:

1. What aspects of patient characteristics, lifestyle, biomarkers and disease management predict readmissions for conditions caused by or related to diabetes management?

2. Are there combinations of patient characteristics, lifestyle, biomarkers, and disease management aspects that predict unnecessary readmissions caused by or related to diabetes management?
Population and Sample

This study is an analysis of existing patient records of a hospital in northeastern North Carolina. This region of North Carolina has a population base that has an incidence for diabetes and cardiovascular disease higher than the national average (Dickson et al., 2004). The ethnic makeup of the five surrounding counties consists primarily of non-Hispanic White and non-Hispanic Black, 73.9%, and 21.8 respectively.

The sample consisted of 389 patients hospitalized with a primary or secondary diagnosis of diabetes, dating from January 2004 to December 2006. Each case was reviewed to determine if sufficient documentation of various components of demographics, lifestyle, and specific aspects of healthcare could be retrieved. These components included age, gender, ethnicity, marital status, religious affiliation or not, smoking status, blood glucose level, blood pressure, physician specialty or not, and if the patient’s record indicated they had received diabetes education. Descriptive statistics for the sample are presented in the next chapter.

Procedures

Using a customized query function of the patient database, the Information Specialist of the hospital retrieved 389 records of adult patients who were admitted with a diabetes-related diagnosis, as indicated by the International Classification of Disease code (ICD-9) of 250.00, between January 1, 2004 and December 31, 2006. Patient records that were incomplete were not included in this investigation. The first three numbers in the ICD-9 code (250) are specific to the disease, in this case diabetes. The numbers after the decimal point are known as qualifiers that help to identify conditions related to diabetes.
Classification of Patient Data by Variable

Age. The variable of age was coded into decade age groups.

Gender. The gender was classified as indicated in the patient’s chart.

Ethnicity. Because the sample population largely consisted of two ethnic groups, non-Hispanic Whites and non-Hispanic Blacks, ethnicity was classified as non-Caucasian and Caucasian.

Blood pressure. The last blood pressure measurement reported in the patient’s medical chart was considered to be indicative of the level of medical attention given to the maintenance of the patient’s blood pressure. These variables, systolic and diastolic blood pressure, were dichotomized values based on the literature.

Blood glucose. The blood glucose was measured by an Accucheck model 6320 glucometer, which uses a finger prick to obtain the blood sample and was stratified into levels based on the literature. The last documented blood glucose measure was used to indicate how well it was controlled during the stay.

Marital status. Patients were considered to be married if they indicated they were married or had a significant other.

Religious affiliation or lack thereof. If patients indicated an affiliation, regardless of faith or denomination, they were considered to have an affiliation. For our purposes, martial status and having a religious affiliation were considered an indication of support structure.

Smoking status. Patients who stated they smoked regularly during the previous 12 months were classified as smokers.
Physician specialty or not. Physicians that were trained and practicing as endocrinologists, nephrologists, cardiologists, and medical internists were considered specialists; physicians that practiced in areas other than those were considered non-specialists.

Diabetes education. A patient was considered to have diabetes education if it was indicated in the patient’s medical chart. This classification was not made with regard to depth and breadth of the education.

Readmission. An admission was considered recidivistic when the second admission was within 60 days from the initial admission of that year.

Coding of Data

The medical record of each patient was reviewed in each case. Of the predictors, nine variables were grouped as dichotomous variables and two as categorical. Dichotomous independent variables included were gender (0 = male, 1 = female), ethnicity, (0 = non-Caucasian, 1 = Caucasian), marital status (0 = yes, 1 = no), religious affiliation or not (0 = yes, 1 = no), blood pressure (systolic blood pressure, 1 = < 130 mmHg, 2 = > 131 mmHg; diastolic blood pressure, 1 = < 80 mmHg, 2 = > 81 mmHg), smoking status (0 = yes, 1 = no), physician specialty of diabetes specialist or not (0 = specialist, 1 = not specialist) and if the patient met with the diabetes educator (0 = had education, 1 = did not have education). Age and blood glucose were categorized variables. Age was delineated by decades (1 = 18-29, 2 = 30-39, 3 = 40-49, 4 = 50-59, 5 = 60-69, 6 = 70 and above years). Blood glucose was stratified by levels based on research conducted by Quevedo, Sullivan, Kington, and Rogers (2001), (1 = <70 mg/dl, 2 = 70-99 mg/dl, 3 = 100-119 mg/dl, 4 = 120-180 mg/dl, 5 = 181-240 mg/dl, 6 = >241
mg/dl). The dependent variable, hospital readmission for acute diabetes care, was also coded into a dichotomous variable of less than or more than 60 days (0 = < 60 days, 1 = >61 or not at all).

Data Analysis

Prediction models for the recidivistic admissions of patients with diabetes were generated by logistic regression (LR) and predictive discriminant analysis (PDA). A comparison of these models was conducted to determine which method produced the best predictors (PDA). To assess the likelihood of recidivistic diabetes admissions, a predictive equation was developed using data from 389 cases. An examination of medical records was assessed for 11 predictors common to this data set.

A number of variables were considered as possible predictors for recidivistic admissions of patients with diabetes. Logistic regression and predictive discriminant analysis models were used to assess the correlation of the variables (IVs) to the time to the next visit (DV) in days. These included dichotomous variables: gender, marital status, religious affiliation or not, blood pressure, smoking status, physician specialist, having met with the diabetes educator, and ethnicity. Categorical variables included age and blood glucose.

Chapter Summary

This study endeavored to discover the predictability of readmission in patients with diabetes using 11 variables to predict readmission occurrence within 60 days or less. The convenience sample was taken from historical patient medical records from a rural hospital in northeastern North Carolina. A query customized by the hospital's
information services department was used to compile data from medical records that fit the study criteria. All records were coded to protect patient anonymity.
RESULTS

The objective of this study was to determine whether 11 independent variables, as defined in the literature, help to predict a diabetes-related hospital readmission for patients with diabetes within 60 days from discharge. The predictor variables consisted of patient demographics (age, gender, ethnicity), lifestyle components (marriage status, religious affiliation or not, smoking status), biomarkers (glucose level, systolic blood pressure, diastolic blood pressure) and disease management aspects (physician specialty or not, participation in a diabetes education program).

The target population consisted of hospital patient cases admitted for a diagnosis related to diabetes (ICD 9 code 250.00) in a rural hospital in northeastern North Carolina. Information on all patients was obtained from the Health Information Department from the data collection site. A total of 389 cases from January, 2004, to December, 2006, fit the research criteria of 11 variables related to diabetes treatment. The chronological first admission discharge date was considered the initial index or individual benchmark in this study. Readmission was defined as a subsequent admission that occurred within 60 days of the benchmark date. A data collection program was developed by the Health Information Department to collect information on the identified variables.

Three statistical programs were used to (a) identify the best method of analysis, (b) determine if the model performed statistically better than chance explanations, and (c)
identify propitious predictors and subsets of predictors of readmissions. The following questions were proposed:

1. What aspects of patient characteristics, lifestyle, biomarkers, and disease management predict readmissions for conditions caused by or related to diabetes management?
2. Are there combinations of patient characteristics, lifestyle, biomarkers, and disease management aspects that predict readmissions caused by or related to diabetes management?

This chapter first presents a description of the sample, including detailed characteristics: (a) demographics of the sample, (b) patient lifestyle components, (c) patient biomarkers, and (d) disease management aspects. The statistical analyses of the data and the major findings are then detailed, followed by a summary of the chapter.

**Characteristics of the Sample**

The sample for this study consisted of hospital patient files ($N = 389$) representing patients hospitalized with a primary or secondary diagnosis of diabetes, dating from January, 2004, to December, 2006. Data were obtained using a customized query function of the patient database. The Information Specialist of the hospital retrieved 389 records of adult patients who were admitted with a diabetes-related diagnosis as indicated by the International Classification of Disease code (ICD-9) of 250.00.

**Demographics of the Sample**

The sample was a nearly equal distribution of 192 males (49.4%) and 197 females (50.6%). The number in each age group increased as the age category increased to ages 69-70, where it began to decline. Ethnicity was divided into two groups: non-Caucasian (African American 53.6% and Hispanic, 0.8% other 1.6%) and Caucasian (44.7%). Only
two groups were used for ethnicity because of the extremely small numbers of other ethnicities. Table 2 displays the demographics of the sample.

Table 2. Gender, Age, and Ethnicity of the Sample

<table>
<thead>
<tr>
<th>Variable and category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>192</td>
<td>49.4</td>
</tr>
<tr>
<td>Female</td>
<td>197</td>
<td>50.6</td>
</tr>
<tr>
<td></td>
<td>389</td>
<td>100.0</td>
</tr>
<tr>
<td>Age range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-29</td>
<td>15</td>
<td>3.9</td>
</tr>
<tr>
<td>30-39</td>
<td>34</td>
<td>8.7</td>
</tr>
<tr>
<td>40-49</td>
<td>59</td>
<td>15.2</td>
</tr>
<tr>
<td>50-59</td>
<td>65</td>
<td>16.7</td>
</tr>
<tr>
<td>60-69</td>
<td>83</td>
<td>21.3</td>
</tr>
<tr>
<td>70-79</td>
<td>71</td>
<td>18.3</td>
</tr>
<tr>
<td>&gt;80</td>
<td>62</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>389</td>
<td>100.0</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>214</td>
<td>55.2</td>
</tr>
<tr>
<td>Caucasian</td>
<td>174</td>
<td>44.7</td>
</tr>
<tr>
<td></td>
<td>398</td>
<td>100.0</td>
</tr>
<tr>
<td>African American</td>
<td>208</td>
<td>53.6</td>
</tr>
</tbody>
</table>
Table 2. (continued). Gender, Age, and Ethnicity of the Sample

<table>
<thead>
<tr>
<th>Variable and category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>174</td>
<td>44.7</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>389</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Patient Lifestyle Components

The patient lifestyle components included marital status, religious affiliation or not and smoking status. In this sample, 80.5% of the patients were married, 67.1% had a religious affiliation or not and 45.2% were smokers. Components of lifestyle characteristics are detailed in Table 3.

Table 3. Lifestyle Characteristics

<table>
<thead>
<tr>
<th>Variable and category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martial status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>313</td>
<td>80.5</td>
</tr>
<tr>
<td>Not married</td>
<td>76</td>
<td>19.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>389</td>
<td>100.0</td>
</tr>
<tr>
<td>Religious affiliation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religious</td>
<td>261</td>
<td>67.1</td>
</tr>
<tr>
<td>Not religious</td>
<td>128</td>
<td>32.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>389</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 3. (continued) Lifestyle Characteristics

<table>
<thead>
<tr>
<th>Variable and category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoker</td>
<td>176</td>
<td>45.3</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>213</td>
<td>54.7</td>
</tr>
</tbody>
</table>

389 100.0

Patient Biomarkers

Biomarkers are considered to be indicative of levels of successful care. The biomarkers considered in this study included blood glucose and systolic and diastolic blood pressure levels. Table 4 presents these data. Blood glucose was delineated into levels based on a review of the literature. The greatest percentage of patients (28%) had blood glucose levels in the 120-180 mg/dl range with a mean of 126 mg/dl, which is above the ideal mark of 120 mg/dl. The majority of patients (63.5%) had a systolic blood pressure in the normal range (<130 mm/Hg), while only 36.2% fell into the high category. Similarly, nearly 90% of the patient’s records listed diastolic blood pressure in the normal range (<80 mm/Hg).

Disease Management Aspects

This study considered physician specialty (specialist or not) and diabetes education (having participated or not) as indicators of disease management (see Table 5). Only 14.1% (55) of the patients had diabetes education, leaving the remaining 85.9% (334) with no record of education.
Diabetes is a complex disease and is often managed by physicians with specialized training. Most of the patients (274) were treated by non-specialists, while the remaining patients listed a physician specialist as their caregiver. Endocrinologists are considered to be the most appropriate specialty to treat patients with diabetes. Because of the complexity of the disease, however, other specialists including internal medicine

Table 4. Biomarker Counts and Percentages

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>Variable and Group</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose</td>
<td>&lt;69</td>
<td>7</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>70-99</td>
<td>30</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td>100-119</td>
<td>41</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>120-180</td>
<td>110</td>
<td>28.3</td>
</tr>
<tr>
<td></td>
<td>181-240</td>
<td>92</td>
<td>23.7</td>
</tr>
<tr>
<td></td>
<td>&gt;240</td>
<td>109</td>
<td>28.0</td>
</tr>
<tr>
<td></td>
<td>389</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>&lt;130 mmHg</td>
<td>247</td>
<td>63.5</td>
</tr>
<tr>
<td></td>
<td>&gt;131 mmHg</td>
<td>141</td>
<td>36.2</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>&lt; 80 mmHg</td>
<td>348</td>
<td>89.5</td>
</tr>
<tr>
<td></td>
<td>&gt;81 mmHg</td>
<td>40</td>
<td>10.3</td>
</tr>
</tbody>
</table>

Note: A blood glucose level of 80 - 120 mg/dl is considered to be desirable.
practitioners, nephrologists, and cardiologists, who typically undergo considerable training in diabetes treatment, were also categorized as specialists. Of the 389 in the sample, two patients were cared for by endocrinologists, 57 by an internal medicine physician, 26 by nephrologists, and 21 by cardiologists. The remaining 283 patients listed a non-specialist as the treating physician.

Table 5. Disease Management Aspects for Sample

<table>
<thead>
<tr>
<th>Variable and Criteria</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Had education</td>
<td>55</td>
<td>14.1</td>
</tr>
<tr>
<td>No education</td>
<td>334</td>
<td>85.9</td>
</tr>
<tr>
<td></td>
<td>389</td>
<td>100.0</td>
</tr>
<tr>
<td>Physician specialist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specialist</td>
<td>106</td>
<td>29.6</td>
</tr>
<tr>
<td>Non-specialist</td>
<td>283</td>
<td>70.4</td>
</tr>
<tr>
<td></td>
<td>389</td>
<td>100.0</td>
</tr>
<tr>
<td>Physician by specialty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocrinologist</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>57</td>
<td>14.7</td>
</tr>
<tr>
<td>Nephrologist</td>
<td>26</td>
<td>6.7</td>
</tr>
<tr>
<td>Cardiologist</td>
<td>21</td>
<td>5.4</td>
</tr>
<tr>
<td>Generalist or family care</td>
<td>283</td>
<td>72.8</td>
</tr>
<tr>
<td></td>
<td>389</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Results of Statistical Analysis

The purpose of this study was to explore which aspects of disease management and patient care factors and what combination of the factors may predict hospital readmissions. Three statistical programs were used to (a) determine the best method of analysis, (b) determine if the model performed better than chance expectations, and (c) identify predictors of readmissions.

Selection of Optimal Statistical Method

To determine the most accurate prediction methods and to test those methods’ performance in respect to chance, the computer program PDALR (Meshbane, 1996; Meshbane & Morris, 1996) was run to determine whether predictive discriminant analysis (PDA) or logistic regression (LR) was the better method to use for predicting recidivism. To consider the two, most frequently used, competing mathematical models for classification, predictive discriminant analysis and logistic regression, the “leave-one-out” classification accuracies of each were compared as has been proposed in the literature. The computer program PDALR was used to accomplish this and is available at http://www.coe.fau.edu/faculty/morris/7114-lab_8__dalr_comparison.htm. To correctly identify the accurately classifying subsets of variables, the leave-one-out accuracies of all possible subsets of variables were compared using the computer program CLASSVSP (Morris & Meshbane, 1995; Morris & Lieberman, 2007; Lieberman & Morris, 2003, 2004). This computer program is available at http://www.coe.fau.edu/faculty/morris/7114-lab6-d-consideration.htm. In order to test the hit-rate of models against chance expectation, the method proposed by Huberty (1975) was used; ZCLASS, the computer
program that incorporates that method, is available at http://www.coe.fau.edu/faculty/morris/STA7114%20Files/Lab%206b/lab_6b__test_of_significance_oface.htm.

Table 6 shows the counts and percentages for patients readmitted to the hospital. Forty-two patients were accurately classified as readmitted within 60 days and 347 patients were accurately classified as not being readmitted within 60 days.

Table 6. Counts and Percentages for Readmission to Hospital

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 60 days</td>
<td>42</td>
<td>10.8</td>
</tr>
<tr>
<td>≥ 60 days</td>
<td>347</td>
<td>89.2</td>
</tr>
<tr>
<td>Total</td>
<td>389</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 7 demonstrates the model classification rates for PDA and LR. LR has a much higher total classification accuracy than PDA (89.2% vs. 57.3%), but at the cost of misclassifying everyone in readmitted group. As subjects who were readmitted were more important to avoid missing than those who were not readmitted, the results indicated that the LR model was not a good choice for this study. McNemar’s Z (4.80) (Morris & Huberty, 1987), from PDALR, indicated that the PDA model correctly...
classified more early readmits than the LR model \((p < .05)\). In terms of practical significance, the PDA model classified 58.8\% more readmits than the LR model. Predictive discriminant analysis proved to be the preferred statistical approach for this study.

*Predictive Discriminant Subset Analysis*

The answer to the first question, “What aspects of patient characteristics, lifestyle, biomarkers and disease management predict readmissions for conditions caused by or related to diabetes?” was found by reviewing the output of CLASSVSP to find the predictive discriminant analysis model that yielded the most accurate classifications for the patients who were readmitted in less than 60 days.

There were many subsets that demonstrated predictability. The best overall subset accurately classified 27 cases with six predictors. These predictors were: (a) systolic blood pressure, (b) smoking status, (c) blood glucose range, (d) ethnicity, (e) diabetes education, and (f) diastolic blood pressure. These combined variables performed as well or better than other models in predicting readmissions within 60 days from the date of discharge with the fewest variables.

To answer the second question, “Are there combinations of patient characteristics, lifestyle, biomarkers, and disease management aspects that predict readmissions caused by or related to diabetes management?” the statistical program CLASSVSP was used to determine the best 280 subsets of predictors and then to identify which of these subsets performed significantly better than chance expectations. Of the 280 best subsets, all but one performed significantly better than chance expectations in classifying early readmissions. In the interest of parsimony, several 2-predictor subsets were identified that
performed nearly as well as the overall best model, but with fewer predictors. Four 2-predictor variable subsets that accurately classified 25 early readmissions were (a) smoking status and physician specialty or not, (b) religious affiliation or not and smoking status, (c) gender and smoking status, (d) smoking status and ethnicity.

*Predictive Discriminant Analysis Compared to Chance Expectations*

Once the best model had been identified, the ZCLASS program was used to determine whether the model performed significantly better than chance expectations. The results showed that the model correctly classified 59.52% of recidivistic cases. In comparison to the proportional chance criterion, the classification accuracy for recidivistic group result was both statistically significant (McNemar’s $Z = 10.18, p < .05$) and of practical significance.

To further investigate the results already discussed, independent samples $t$-tests were performed to compare correctly classified readmitted patients to incorrectly classified readmitted patients on the predictors identified by CLASSVSP as useful in predicting readmission. Statistically significant results were assessed for practical significance using $\eta^2$ with a critical effect size of .10.

Descriptive statistics and $t$-test results are provided in Table 8. As displayed in Table 8, all correctly classified readmitted patients with diabetes were smokers, while 76% of the incorrectly classified readmitted diabetics were nonsmokers. This effect was both statistically significant and of practical significance ($t[40] = 20.3, p < .05, \eta^2 = .85$). There was no significant difference between correctly and incorrectly classified readmitted patients with diabetes on the predictors of physician specialty or not, religious affiliation or not, gender, or ethnicity.
Chapter Summary

The first question addressed by this study was “What aspects of patient characteristics, lifestyle, biomarkers and disease management predict readmissions for conditions caused by or related to diabetes management?” The best overall subset accurately classified 27 cases with six predictors from the following variable categories: (a) systolic blood pressure, (b) smoking status (c) blood glucose range, (d) ethnicity, (e) diabetes education, and (f) diastolic blood pressure. These combined variables performed as well or better than other models in predicting readmissions within 60 days from the date of discharge with the fewest variables.

The second question, “Are there combinations of patient characteristics, lifestyle, biomarkers, and disease management aspects that predict readmissions caused by or
related to diabetes management?” was answered using a similar procedure as was used to answer the first question. The CLASSVSP software was used to identify subsets of predictors with the most influence of predicting readmission, and the ZCLASS program was used to compare the performance of these subsets to chance expectations. CLASSVSP statistical software provided the 280 best subsets overall, and the 25 best subsets of each size. In the interest of parsimony, four 2-predictor subsets identified pairs of predictors that accurately classified 25 early readmissions. The subsets were (a) smoking status and physician specialty or not, (b) smoking status and religious affiliation or lack thereof, (c) smoking status and gender, and (d) smoking status and ethnicity. These subsets are not listed as reported in the analysis and are not in any specific order. Since there are many models that include different predictors that manifest very similar predictive accuracy, it is possible to substitute missing predictors with another as long as one of the predictors in the subset was the predictor smoking status.

To gain a further understanding of the results of the 2-predictor subsets identified by CLASSVSP, independent samples t-tests were performed to compare correctly classified readmitted patients to incorrectly classified readmitted patients. This analysis demonstrated that all correctly classified readmitted patients with diabetes were smokers, while most of the incorrectly classified readmitted diabetics were nonsmokers. The analysis also revealed that there was no significant difference between correctly and incorrectly classified readmitted patients with diabetes on the predictors of physician specialty or not, religious affiliation or a lack thereof, gender, or ethnicity. Chapter five will include conclusions, discussions, recommendations and suggestions for further research.
CONCLUSIONS, DISCUSSION, IMPLICATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

This study assessed the power of 11 variables to predict recidivistic admissions to the hospital for patients with diabetes. While overall accuracy was less than desirable, the analysis did indicate that a single subset of six variables and four subsets of 2-predictors were statistically and practically significant. The variables predicting a diabetes-related hospital readmission for patients within 60 days from discharge were categorized into four main groups: (a) patient characteristics (age, gender, ethnicity); (b) lifestyle characteristics (marriage status, religious affiliation or not, smoking status); (c) biomarkers (glucose level, systolic blood pressure, diastolic blood pressure); and (d) disease management aspects (physician specialty or not, participation in a diabetes education program). A convenience sample of 389 historical medical records of patients who were admitted to a rural hospital in northeastern North Carolina with a diagnosis of, or relating to, diabetes was studied. After comparing predictive discriminant analysis and logistic regression, PDA performed better and was chosen to analyze a convenience sample of patients admitted to the hospital for a diabetes-related diagnosis from January, 2004, to December, 2006.

This area of the United States experiences a higher than normal prevalence of diabetes; it is also one of the poorest socioeconomic areas of the country. Low socioeconomic status has been historically associated with lower levels of literacy that
translate into decreased health literacy and high incidence of chronic diseases such as diabetes. Further, economically challenged segments of the population often have restricted access to healthcare, which the literature states directly affects health outcomes of patients with diabetes.

The two research questions addressed in this study included:

1. What aspects of patient characteristics, lifestyle, biomarkers and disease management predict readmissions for conditions caused by or related to diabetes management?
2. Are there combinations of patient characteristics, lifestyle, biomarkers, and disease management aspects that predict readmissions caused by or related to diabetes management?

Conclusions and Discussion

While each predictor model for hospital readmission of diabetes patients demonstrated both statistical and practical significance, the overall hit rates were not impressive.

Most Accurate Model

Based on the findings of this study, it can be concluded that, for this sample, a six-variable model manifested the most accurate prediction of readmissions to the hospital for conditions caused by or related to diabetes within a 60-day time period for patients with diabetes.

The variables were selected by the total number of correct classifications in the CLASSVSP statistical analysis that performed better than chance. These variables are (a) systolic blood pressure, (b) smoking status, (c) blood glucose range, (d) ethnicity, (e) diabetes education, and (f) diastolic blood pressure.
Two-Predictor Models

In an effort to simplify the prediction process, the subsets of fewer predictors were examined by CLASSVSP statistical analysis. The results of the analysis returned four subsets that correctly classified 25 cases for readmission. Each of the four subsets has two predictors that were statistically significant for predicting readmissions. The subsets are: (a) smoking status and physician specialist or not, (b) smoking status and religious affiliation or not, (c) smoking status and gender, and (d) smoking status and ethnicity.

Each of the predictors is a dichotomous variable. To determine the direction of the effect, the proportion of cases readmitted was examined for each level of each variable. This examination yielded a specific aspect of each predictor that was linked to readmission within 60 days. The predictors and direction of effect for each subset are in Table 9.

The regularity of smoking as a predictor in all of the most accurate models indicates its importance. Predictors that are present in multiple models are more potent than predictors that show up in only one model. If a patient is missing a predictor (other than the smoking predictor) from one of the two-predictor models, any of the other three models could be used, with no loss in predictive accuracy.

Discussion

Smoking status. The results of the current study support the premise that patients with diabetes who smoke are at higher risk for readmission within 60 days. Smoking was
a recurring variable in all five of the 2-predictor subsets. Smoking is commonly known to be deleterious to general health and is proven to cause and exacerbate disease. In separate research by Eliasson (2003), and Rimm et al. (1993), it was found that persons who smoke often have other life-style risk factors for cancer and cardiovascular disease that include sedentary life-style, overweight or obesity, as well as have high blood pressure, and high cholesterol.

Smoking confounds the management process of diabetes. Patients that smoke often describe their health as fair or poor and often experience depression (Eliasson, 2003). Solberg et al. (2004) reported that smokers did not check blood glucose levels as frequently, were more sedentary, and did not visit their physician as often as their nonsmoking counterparts. These patients also reported receiving and desiring less support from family and friends specific to diabetic self-management activities and were less likely to consider smoking cessation than what has been observed in other population groups.
While it is widely known that smoking adversely affects heart rate and blood pressure, it is less apparent that smoking affects metabolic processes related to insulin function. Cigarette smoking decreases fasting insulin levels and increases insulin resistance. These physical responses add an ambiguous dynamic to an already complicated management regime (Eliasson, 2003).

*Monitoring blood glucose.* National diabetes experts in the field of endocrinology have concluded that a strict glycemic objective of 80-110 mg/dl was necessary to decrease mortality, infection, and kidney failure as well as decrease length of the hospital stay (Consensus Development Conference, 2006; Sedor, 2006). It is generally agreed that controlling blood glucose while hospitalized can set the patient on a solid footing upon discharge and potentially save considerable human and economic costs (Ashton et al., 1995; Miller et al., 2006). In the current study, blood glucose range surfaced as a predictor among the six best subsets but was not included in the 2-predictor subsets. The mean value to the blood glucose range of 2.2 placed the discharge level in the range of 120 – 180 mg/dl. This range is 9% above the recommended level of 110 mg/dl, thus supporting and underscoring the importance of strict blood glucose management.

*Gender and ethnicity.* For the current sample, gender and ethnicity influenced hospital readmissions of diabetes patients. Non-Caucasian women experienced a slightly higher frequency of readmissions than other segments of the sample. The data in the literature clearly suggest that minorities experience higher rates of diabetes-related complications than non-minorities. There are many factors common to minorities that may affect readmission data such as financial barriers, inadequate or limited access to healthcare, and cultural beliefs (Berg & Wadhwa, 2002), as well as cultural traditions,
language barriers, and socio-demographic characteristics (Montague et al., 2005). The findings of this study are consistent with the literature.

*Diabetes education.* The current study supports the importance of diabetes education in the six best subsets; however it did not rise to the level of significance in the 2-predictor subsets. This may be explained by several reasons: the rather small number of cases (55) that had been reported to have had diabetes education in this sample, the possibility that education did not have any effect on the patient’s ability to manage the disease, and/or the disease had progressed to the point where disease was nearly unmanageable by the patient, such as in end stage renal disease. It should be noted that the current study did not capture the type of education given, but only an indication that education was given.

*Blood pressure.* Blood pressure is a real-time measurement that is an important aspect in general health assessment as well as diabetes. The National Diabetes Education Program (2007) recommends controlling systolic blood pressure less than 130 millimeters of mercury (mmHg) and diastolic blood pressure under 80 mmHg. Approximately 65% of patients with diabetes die from heart disease or stroke (Sedor, 2006), and other research suggests that controlling blood pressure will reduce the risk of cardiovascular complications and stave off end stage renal disease, a common co-morbidity in uncontrolled diabetes patients (Caramori et al., 2006; Gifford et al., 2000; Sedor, 2006).

The results from the current study related to blood pressure are unsupported by the literature. The mean values for systolic and diastolic, 126 and 72 mmHg respectively, were below the desired range of 130/80 mmHg. Interestingly, systolic and diastolic blood
pressure surfaced as significant predictors in the best overall subsets; but when considering the 2-predictor subsets, neither appeared as predictors. It is important to note that the group means are based on the entire group of early readmits (42), and not just the 27 cases correctly classified by the best model.

Limitations

This was a retrospective study with clinical patient data from a rural hospital in Northeast North Carolina. While the current study has significant implications for predicting readmissions in patients with diabetes, some limitations exist within the model.

The sampling study timeframe and definition of index discharge limit generalizability. The population was from a rural hospital that basically had only two ethnic groups. Intuitively, one would suggest that this population demographic is rare in most areas of the U.S. and therefore limits the generalizability of the findings.

The timeframe of the study may also diminish generalizability. The interval of timeframe readmission varies greatly in the literature. Landrum and Weinrich (2006) reviewed 1136 articles addressing readmission criteria. Their research found studies that used timeframes of 1-14 days, 8-30 days and 60 days. Still other researchers used intervals of 90 days (Smith et al., 2000). Landrum and Weinrich (2006) assert that it is important to use definitive criteria, as listed in the literature review and used in the current study. While the delineation of the 60-day timeframe is supported by the literature, other intervals may have provided greater insight. Further, patients may have had a previous admission before the index date, and may have had a readmission either before or after the data collection period or may have died before the end of the study.
Some important patient information was not available in medical charts. Therefore, aspects of the patient’s lifestyle components, biomarkers and disease management were not fully captured in this study. The missing information is important in clearly understanding the patient’s disease process.

Lifestyle characteristics such as depth of religious affiliation or a lack thereof, marriage satisfaction, emotional status (depression), socioeconomic status, and lifestyle habits (exercise), were not known in this study. Knowing the biomarker components of body mass index, HbA1c and cholesterol levels, and kidney function may have provided greater insight into the severity of the disease for the individual patients. The disease management aspects that were not reviewed in this study include degree of medication adherence (self-reported monitoring habits); length of time since initial diagnosis; number and degree of comorbidities; type and frequency of education; and patient’s perception of locus of control to manage the disease.

Furthermore, quality of outpatient care after discharge may play a role in hospital readmission and is impossible to measure from the data collection methods. For example, knowing if the patient was going home after discharge or to a nursing home and if the patient or caregiver was to receive additional education would play an important role in predicting readmission. Patients would have different outcomes based on what environment they were discharged to and if they were able to care for themselves; both factors were unmeasured in the present study.

Living with diabetes is distressful and challenging and cannot be understood solely from reviewing medical charts. Both subjective and objective patient information are needed to fully capture the occurrence of readmission of patients with diabetes.
Subjective data can be added by interviews or surveys to enrich the depth of patient information.

Implications

Although one’s patient characteristics such as age, gender, and ethnicity cannot be controlled, disease management and lifestyle changes can influence the biomarkers associated with readmission. Patient education can affect disease management and lifestyle changes. Patient education was one of the variables predicting readmission, but was not a significant factor when defining the 2-predictor subsets. The study did not define the quantity, quality, and source of the patient education so conclusions are limited at this point. More information on the frequency, dosage, and methods of patient education may have yielded insights into what kind and how much (or by whom) patient education actually has the potential of changing patient behavior. There are implications for both the training and education of patients, and also the training and education of practitioners (physicians, allied health professionals, and health educators) who might deliver the training. There needs to be more information about the effectiveness of different patient education modalities and the efficacy of online resources (although these are probably less accessible to low income populations).

Theories of adult education that might apply include how to transfer agency or responsibility for learning to the patient (self-directed learning) and how to transfer the learning in such a way that it changes patients’ behaviors (transfer of training). It may be that information is shared, but without consideration for whether the patient is actually absorbing the information; reflecting teaching, but not resulting in learning. Application
of adult education theory, research findings, and practice principles in training health professionals and patients might produce different results.

Suggestions for Future Research and Practice

Recommendations for Future Research

There are other questions that might be asked of the current data to extend this current study or extend the method at this same hospital with a redesigned study that allows asking qualitative questions of the patients. Newly designed studies could correct for some of the limitations noted previously such as a sample that is more demographically representative and additional patient data. An experimental design with two groups receiving different types of patient education or professional preparation (for health professionals) might yield information on more effective strategies of preparing health care professionals or changing patient behaviors.

Determining the reasons for readmissions from solely examining medical charts is difficult. Diabetes is a challenging life-long chronic disease that is difficult to fully understand by simply reviewing a snapshot. Subjective and objective patient information are both needed to fully understand the phenomenon of readmission. Due to the nature of the clinical medical record review method used in this study, some important information was not available or collected. In this study, the model misclassified 17 recidivistic cases as non recidivists using the variables in this study. Interviews with these patients may uncover other variables that should be included in the model. For instance, patient characteristics of weight and mental status, socioeconomic status, and patient’s education level were not established and may be of important in predicting readmission. Lifestyle characteristics including self-management adherence, level of social support, or locus of
control were not adequately captured. Other important aspects of patient care such as length of time since diagnosis, admissions prior to index date, and discharge planning were not included. Biomarkers of body mass index, HbA1c and cholesterol level, and kidney function were not available or collected. The influential role education plays is well documented; however, this study was unable to acquire the method or frequency of diabetes education for the patients in this study.

The American Diabetes Association and the American Association of Diabetes Educators have gone to great lengths to develop a comprehensive curriculum and teaching strategies to educate persons with diabetes throughout the various stages of the disease process. This course is extensive and addresses the spectrum of needs a newly diagnosed or poorly controlled patient has. While it is considered to be effective, inconsistent implementation of these proven programs and methods remain (Gary, Genkinger, Guallar, Peyrot, & Brancati, 2003; Nettles, 2005).

Often, informal patient education is actually merely sharing information on procedures, recommended practices, and risks of not following through without thought to important principles of adult education. Sharing this information satisfies some legal responsibilities but is not necessarily effective in changing patient behavior. Some health practitioners are intuitively more effective at eliciting change in patient behaviors than others. Those that are more effective may be more intrusive in their assessment of the emotional barriers to good self-care such as depression or learned helplessness (Seligman, 1974). Redefining patient education to mean something far greater than sharing clinical information may alter the results for patient readmissions.
It takes a transformational approach (Freire, 1970; Mezirow, 1978, 1991) to assist patients to take responsibility for their condition and the management of their condition rather than to passively and helplessly submit to repeated admissions to the hospital. This requires a somewhat confrontive approach to uncover the hidden payoffs of poor health management. Use of some kind of transformational reflection could result in patients seeing themselves as more in control of their situation than previously thought. Some patients, perhaps those with higher literacy levels, higher education and socio-economic status, and access to electronic information sources are likely to be more self-directed in their education about their health condition. Incorporating what is known about self-directed learning (Houle, 1961; Tough, 1971; Knowles, 1975; Guglielmino, 1978) into the education of both health professionals and patients is likely to improve health outcomes for a larger portion of patients. Also, applying what is known about transfer of learning (Broad, 2005) or education that results in behavior changes, is likely to change the results in readmissions.

**Recommendations for Future Practice**

This study yields adult/health education practice recommendations at four levels: the level of the health professional, the level of the patient, the level of the caregiver (family and friends) and the level of the larger community. One practice recommendation is to be far more aggressive in training health care professionals in the theories, methods, and strategies of adult education that would result in behavior change. One strategy is to recognize that many adults in low SES areas have low literacy levels, and ensure that the educational material given to the patient or caregivers is at an appropriate reading level. Another strategy is to provide disease management education in various forms of media.
including DVD and audio recordings that may be used alone or to complement printed material and accommodate various learning styles. Another practice recommendation is to increase the effectiveness, frequency, and dosage of adult education to patients through both research and practice. Understanding if the application of education is influenced by age (i.e. younger vs. older patients) or level of self-directed-learning would be important to developing learning approaches. Strategies for engaging caregivers, family, and friends in the patient education must be explored. A better understanding of attitudes of the caregivers, family, and friends towards the care of the patient might explain tendencies for readmission and could be obtained through interviews. Another practice recommendation is to promote public engagement through community education strategies (such as broad advertising campaigns) regarding diabetes education so that those who might be able to support patients (families and friends) are better informed. Attention to these four levels of diabetes education (health professional, patient, caregiver, and community) could change the results for behavior changes in patients as measured by hospital readmissions.

What is known from this study points to the importance of effective patient education to change lifestyles and disease management and ultimately to improve the biomarkers in order to reduce hospital recidivism. Extensive implementation of best practice techniques and new education techniques must be devised and tested to improve results. When health education actually results in changed patient behaviors, hospital admissions should go down. Further research and development in this area are required.
April 16, 2008

Dr. Nancy Aaron Jones, Chair
Elissa Gaucher, Director, Research Compliance
FAU Institutional Review Board Human Subjects Review Committee
Division of Research
777 Glades Road
Boca Raton, FL 33431

Dear Dr. Jones:

Please accept this letter as formal permission for Darwin Asper to use the patient information data set from January 1, 2004 to December 31, 2006, from Albemarle Hospital for the purpose of researching the contribution of patient demographics lifestyle components, biomarkers and disease management aspects to predicting hospitalization readmissions for patients with diabetes.

I am assured that Mr. Asper has taken the necessary steps to conform to the Health Insurance Portability and Accountability Act, and will continue to maintain confidentiality and anonymity of all persons involved throughout and after the research process.

Should you need further information, please feel free to contact me directly by phone at 252-384-4367 or email: jking-robinson@ablemarlehealth.org.

Sincerely,

[Signature]
Janis King Robinson, Vice President
Human Resources & Organizational Development
REFERENCES


