

## Causes of Hyperglycemia in Subjects with Diabetes who presented to the JAHVA ED during the Months of July 2009 and January 2010

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### Abstract

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**Purpose:** Determine the reasons diabetic subjects have elevated blood glucose ( $\geq 200$  mg/dl) coincidental to Emergency Department visits and to suggest strategies for addressing these deficiencies.

**Method:** This is a single site retrospective chart review of diabetic subjects who visited the JAHVA ED, Tampa, Florida. Subjects were selected and charts reviewed using the automatic data mining tool within the Computerized Patient Record System. Inclusion criteria encompassed both males and females with Type 1 or 2 diabetes and a blood glucose  $\geq 200$  mg/dl upon arrival.

**Results:** 56 subjects met criteria for inclusion with a mean age of 62 years, A1C of 9.5% and BMI of 31. The duration of diabetes was 11.8 years; 95% (n =52) were males; 73% (n=41) were not adherent with diabetes medications; 57% (n=32) were not adherent with lifestyle changes; 23% (n=13) had not participated in diabetes educational programs. The presence of other comorbidities were not independent reasons to explain the high glucose levels.

**Conclusions:** The reasons why subjects with diabetes reported to the ED with glucose  $\geq 200$  mg/dl, in order of importance, were limited adherence and lack of participation in diabetes educational programs. Implementing strategies to address these deficiencies should lead to better diabetes control in Veterans.

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**Keywords:** Hyperglycemia, Diabetes, Emergency Department, Adherence

### 1. Introduction

There are ~29 million diabetics in the United States including 8 million adults who are undiagnosed (Centers for Disease Control and Prevention: National Diabetes Statistical Report, 2015, 2015). Diabetes is the sixth leading cause of death listed on U.S. Death Certificates, contributing to ~225,000 deaths annually (Gambert, 2006. Narayan, 2003). Diabetes affects >20% of the American population over the age of 60 years (McNaughton, 2011., Centers for Disease Control and Prevention: National Diabetes Statistical Report, 2015). Type 1 diabetes is caused by the autoimmune destruction of the pancreatic beta cells responsible for the production of insulin. Type 2 diabetes is characterized by multi-tissue insulin resistance leading to beta cell ineffectiveness (Ramirez, 2008).

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The American Diabetes Association suggests the following targets for non-pregnant adults with diabetes: A1C < 7.0%, preprandial capillary plasma glucose 80-130 mg/dl (5.0-7.2 mmol/l), peak postprandial capillary plasma glucose <180 (< 10.0 mmol/l) (Standards of Medical Care in Diabetes 2017, 2017) to prevent diabetic complications. Multiple factors can contribute to daily blood glucose levels that are not ideal. These include not being able to follow medication regimens, keep follow-up appointments, afford the cost of medications, and/or obtain appropriate diabetic education to understand the complications and prognosis for this disease.

Limited adherence has always been an issue for treating diabetic subjects. Studies demonstrate that those who fail to adhere to prescribed clinical regimens have poor outcomes (Leichter, 2005., Laing, 2005). The JAHVA Hospital in Tampa, Florida, is one of the busiest Veterans' Hospital facilities in the United States. Services are available to more than 116,000 Veterans living in a four-county area (U.S. Department of Veterans Affairs. James A. Haley Veterans' Hospital, <http://www.tampa.va.gov/about>, 2011). The prevalence of diabetes in the Veterans Health Administration (VHA) system increased from 16.7% in fiscal year 1998 (from October 1, 1997 to September 30, 1998) to 19.6% in fiscal year 2000 (from October 1, 1999 to September 30, 2000) (Maciejewski, 2004., Pogach, 1998., Haas, 2005., Miller, 2004).

Total costs attributed to diabetes in the United States are estimated to be as high as \$132 billion annually including direct and indirect medical costs, the latter of which include disability, lost work days, and premature mortality (Mary, 2004., Blaum, 2003., Ousman, 2002). Therefore, it is important to address and improve diabetes control. This study was designed to objectively review and determine the reasons VA diabetic subjects have hyperglycemia when they present to the JAHVA ED in Tampa, Florida. By finding the reasons for these elevated blood sugars, healthcare professionals can institute strategies to improve glycemic control.

## **2. Materials and Method**

### **2.1. Design**

This study is a single site retrospective chart review of subjects who visited the JAHVA ED, Tampa, Florida, during the months of July 2009 and January 2010. These two months were selected to assess for findings that can be explained by a difference in the season - July, a summer month, and January, a winter month - during which respiratory tract infections are more prevalent. The subjects were selected and charts reviewed using the automatic data mining tool within the JAHVA Computerized Patient Record System (CPRS).

This study was approved by the JAHVA R&D Committee and by the USF IRB (Pro00007011). It was noted early in the study that nonadherence was the most common cause of hyperglycemia. This study was placed on hold in an effort to obtain funding, increase sample size, and extend time of study. Funds were not obtained, leading to delay, which is the reason data is seven years old; however, the authors feel this information is still relevant to current practice.

### **2.2. Selection**

Inclusion criteria were subjects with a random blood glucose  $\geq$  200mg/dl upon arrival to the JAHVA ED during the months of July 2009 and January 2010. Type 1 and type 2 diabetic subjects that were established with a VA Primary Care Clinic before the two months of the study were included. Excluded subjects included those with blood glucose <200 mg/d and subjects with glucose  $\geq$  200mg/dl but with an admission diagnosis of stroke or myocardial infarction (MI) which can cause stress hyperglycemia. A total of 60 subjects met initial criteria but following screening four were excluded: One had a cerebrovascular accident (CVA), one had an MI, and two were not established with a Primary Care Physician or other healthcare professional. A total of 56 subjects met the inclusion and exclusion criteria and their charts were reviewed. Both female and male patients were included.

### **2.3. Data Collection**

We collected data using the automatic data mining tool within CPRS at the JAHVA. We obtained age, sex, weight, BMI, distance from living address to JAHVA, and service connection status. We retrieved hemoglobin A1C (the JAHVA laboratory uses high-pressure liquid chromatography) and patients' glucose levels from laboratory results upon arrival to the Emergency Department. We also looked at duration of diabetes, recent use of glucocorticoids, hospitalizations, surgeries, medical procedures, infections, medications used, and recent imaging studies with intravenous contrast.

Adherence was assessed by reviewing providers' medical progress notes with specific reference to adherence, Pharmacists' progress notes, Dietitians' progress notes, medical problem lists for each patient, Veterans' medication refill histories, expired medications, and scheduled medical appointment cancellations and no-shows. Diabetes education was assessed by looking at each Veteran's participation in basic diabetes class, group class, individual diabetes class and/or any other diabetes educational activity.

#### 2.4. Clinical Endpoints

The primary endpoint is to assess possible reasons why diabetic subjects have elevated blood glucose levels upon arrival at the JAHVA ED. Secondary endpoint is to determine whether adherence is one of the main reasons affecting ED visits.

The goal, based on our findings, is to implement strategies to help subjects keep better glucose control at home and thus decrease healthcare costs, including frequency and number of hospitalizations and length of stay as well as the financial burden of worsening comorbidities, by decreasing acute hyperglycemia and preventing diabetic ketoacidosis or nonketotic hyperosmolar coma, decrease ED visits due to hyperglycemia, and improve hospitalization outcomes by maintaining a better blood glucose level.

#### 2.5. Statistical Analysis

Descriptive statistics were used to calculate the mean, interquartile range, and standard deviation for the continuous variables and frequency and percent for categorical variables. Data were analyzed using SAS 9.2 (SAS Institute, Cary, NC).

### 3. Results

Fifty-six total subjects were included in the study.

Table 1. In Table 1 mean values for the variables measured include HgbA1C, age, BMI, weight, distance to JAHVA, glucose values upon arrival at the ED and duration of diabetes.

<b>Table 1 Subject characteristics and mean values</b>	
<b>Variable</b>	<b>Mean</b>
<b>A1C</b>	9.5%
<b>Age (years)</b>	62
<b>BMI</b>	31
<b>Weight (lbs)</b>	212
<b>Distance to JAHVA (miles)</b>	75
<b>Glucose at ED (mg/dl)</b>	374
<b>Diabetes Duration (years)</b>	11.8

Table 2.

Some of the variables in our study that can affect blood glucose and diabetes management are tabulated in Table 2. Non-adherence (73%) was the most prevalent factor followed by limited adherence with diabetic lifestyle changes (57%) and third, the lack of diabetic education (23%). Some common associated comorbidities such as chronic kidney disease, coronary artery disease, congestive heart failure, and CVA collectively were present in 21% of records reviewed. Infections, including acute respiratory infections, were not reported and therefore not a significant variable for either July or January. 11% were Service Connected for diabetes and only 5% were on glucocorticoids.

<b>Table 2 Factors affecting blood glucose on ED arrival</b>	
<b>Medication non-adherence</b>	41 (73%)
<b>Non-adherence with lifestyle changes</b>	32 (57%)
<b>Lack of diabetes education</b>	13 (23%)
<b>Presence of other comorbidities</b>	12 (21%)
<b>Service connected</b>	6 (11%)
<b>Current steroid use</b>	3 (5%)

Table 3. Table 3 shows the mean values of the variables measured among diabetic subjects in July vs January. There were no statistical significant differences between the two groups.

Variable	July's group (n=38)	January's group (n=18)	p-value
<b>A1C (%)</b>	9.35 (1.79)	9.89 (2.29)	0.35
<b>Age (years)</b>	60.71 (10.2)	63.67 (11.9)	0.35
<b>BMI</b>	30.62 (7.12)	31.64 (5.61)	0.60
<b>Weight (lbs)</b>	209.3 (50.74)	217.8 (41.27)	0.55
<b>Distance to JAHVA (miles)</b>	91.3 (276.9)	40.8 (60.5)	0.28
<b>Glucose in ED (mg/dl)</b>	337.9 (186.7)	365.7 (152)	0.81
<b>Duration of DM (years)</b>	11.67 (9.5)	12.08 (13.12)	0.89
<b>Males</b>	35 (92.11%)	18 (100%)	0.54
<b>Service connected</b>	3 (7.89%)	3 (16.67%)	0.37

#### 4. Discussion

There are no significant differences in age, BMI, distance to the VA facility, glucose value in the Emergency Department, duration of diabetes, gender, service connection, adherence, glucocorticoid use, diabetic education, or lifestyle changes in these two seasonal groups. Infections in general but with emphasis on respiratory tract infections were not a factor either month. Distance to the VA facility as well as some common associated comorbidities such as chronic kidney disease, coronary artery disease, congestive heart failure, and cerebrovascular disease were not factors explaining glucose  $\geq 200$  mg/dl in our diabetic subjects. In our study we looked at Service Connected as well as Non-Service Connected status to assess whether or not coverage of clinic visits, diabetes medications and Service Connected status for diabetes was not an important factor explaining glucose  $\geq 200$  mg/dl in our diabetic subjects.

Non-adherence to diabetes medications, lack of healthy lifestyle changes, and lack of participation in diabetes education programs are the most prevalent findings associated with a glucose  $\geq 200$  mg/dl in both groups. These findings concur with other studies (Ramirez, 2008, Laing, 2005).

Developing and implementing strategies that improve adherence should lead to better diabetes control and decrease ED visits in subjects with glucose  $\geq 200$  mg/dl (Delamater, 2006).

Referring diabetic patients to Diabetes Basic Group Class and/or one-to-one educational visits with a Diabetes Teaching Nurse, a Dietician, or a Certified Diabetes Education team member and encouraging their participation in these educational activities may help negate these results. For diabetic patients with limited adherence to medical recommendations more frequent follow-up visits with a medical team member and frequent phone calls by a case manager should improve adherence (Delamater, 2006). Referral to a Psychologist for mental health evaluation and motivational interviews to address barriers affecting adherence could also be considered for those diabetic patients for whom limited adherence persists (Kleinsinger, 2010).

The Endocrinology team at the JAHVA is currently working on implementing these strategies and is considering conducting a study in the future to evaluate their impact. Healthy lifestyle changes and adherence to medical recommendations should assist Veterans in maintaining better glucose control at home and result in decreased health costs by decreasing ED visits and hospitalizations, thus improving hospitalization outcomes. This study has some important limitations: First, the number of included subjects is low (less than 50 in each seasonal group); second, the population was predominantly male; and third, the data is seven years old. The authors believe that this information is still relevant as adherence continues to be one of the most common reasons for poor diabetic control in our Veterans.

#### 5. Conclusion

The reasons subjects with diabetes reported to the JAHVA ED with glucose levels  $\geq 200$  mg/dl, in order of importance, are limited adherence with diabetes medications, lack of healthy lifestyle changes, and lack participation in diabetes educational programs. Implementing strategies that address these deficiencies should lead to better diabetes control.

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