Diabetes is a chronic condition which occurs either when the pancreas cannot produce insulin or the body is unable to properly use the insulin that the pancreas does produce (U.S. Department of Health and Human Services, National Institutes of Health [NIH], 2012b). Under normal circumstances, insulin is produced by the pancreas in order to regulate the body's metabolism. When food is digested, it is broken down into glucose. The glucose molecules enter the bloodstream, causing a rise in blood sugar levels. Soon thereafter, the pancreas secretes insulin via the pancreatic beta cells. Insulin is responsible for facilitating the transfer of glucose from the bloodstream to the inside of the body's cells. Once glucose enters the cells it can then be used immediately for energy or stored for later use. It is when the insulin pathway becomes disrupted that diabetes develops (NIH, 2011b).

In 2010 8.3% of the American public had diabetes. 18.8 million Americans had been medically diagnosed with diabetes and it is estimated that another 7 million had diabetes that was undiagnosed (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention [CDC], 2011a). Additionally, 79 million U.S. adults over the age of 20 have pre-diabetes characterized by elevated blood sugar levels (CDC, 2011a). There are three primary types of diabetes and several less common forms.

TYPES OF DIABETES

Type 1 diabetes, previously known as insulin-dependent diabetes mellitus or juvenile-onset diabetes, is the most severe form of the disorder. It is an autoimmune disease that develops when the body begins to destroy its insulin-producing pancreatic beta cells. Type 1 diabetes typically affects children and young adults. However, its onset can occur at any age (NIH, 2012b). The resulting shortage of insulin causes glucose to remain in the bloodstream instead of entering the cells to be converted into energy. In order to survive, the patient must receive daily injections of insulin (MayoClinic.com, 2010).

Type 2 diabetes, previously referred to as non-insulin dependent diabetes mellitus or adult-onset diabetes, is the most common form of diabetes. It accounts for 90 to 95 percent of the documented cases of diabetes. While the

exact etiology of type 2 diabetes is unknown, studies indicate that the disorder begins in the form of insulin resistance. The pancreas produces sufficient insulin but the body cannot properly use the insulin to transport glucose into the cells. The pancreas responds to the resultant high blood sugar level by producing more insulin. Over time, the pancreas loses the ability to produce the amount of insulin needed to transport glucose into cells. Ultimately, the pancreas becomes permanently damaged due to the continual elevation of insulin production (NIH, 2012b).

Gestational diabetes is diagnosed when any degree of glucose intolerance or high blood sugar is first discovered during pregnancy. This type of diabetes occurs in approximately 7-18 percent of all pregnancies and usually disappears during the postpartum period (NIH, 2012b, National Diabetes Education Program (NDEP), 2011).

Maturity Onset Diabetes of the Young (MODY) occurs in individuals less than 20 years old and is considered a form of type 2 diabetes. MODY is known to be the result of genetic mutation and can be passed from parent to child. Several different gene mutations have been identified but each mutation results in lack of insulin production by the pancreas. Approximately 1-5 percent of all cases of diabetes in the U.S. are MODY (NIH, 2007).

Pre-diabetes is the state where a patient's blood glucose level is higher than normal but not high enough to be considered diabetes. This condition may also be referred to as impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) depending on which test was used to measure the blood sugar level (NIH, 2011b).

DETECTION

Diabetes is detected by tests that measure the amount of glucose in the blood. There are four different tests that can be used and each usually must have the same result on different days to confirm the diagnosis. (1) The A1C test measures what percentage of hemoglobin (the protein in red blood cells that carries oxygen) is coated with sugar. The test reflects the average blood sugar level over several months and is the preferred method for diabetes screening according to the American Diabetes Association (2012). A1C level of 6.5% or higher is

indicative of diabetes. (2) The fasting plasma glucose (FPG) test, where the glucose is measured after at least eight hours of not eating, FPG values of 126 mg/dl or higher indicate diabetes. (3) The oral glucose tolerance test (OGTT) measures the blood sugar level two hours after ingesting a specified amount of glucose. Values of 200 mg/dl or higher are diabetic. (4) A casual (done anytime regardless of meal schedule) plasma glucose test reading of 200 mg/dl or higher, together with symptoms of hyperglycemia (high blood sugar) also indicate diabetes (American Diabetes Association [ADA], 2012).

SYMPTOMS

Many of the symptoms of diabetes are the same regardless of the type and may include any of the following: fatigue, frequent urination, blurred vision, tingling or numbness in hands and feet, very dry skin, slow-healing sores, increased incidence of infections, unexplained weight loss, and excessive hunger and thirst. In type 1 diabetes the symptoms usually develop over a short period of time with an identifiable beginning. Type 2 diabetes is usually slow to develop and the symptoms may be ignored or, in some cases, there may be no symptoms at all. Many women presenting with gestational diabetes also may have no symptoms (NIH, 2012b).

RISK FACTORS

It is estimated that by the year 2050, the prevalence of diabetes in the United States will increase 165 percent from today's levels (NIH, 2012b). Factors that increase the likelihood of developing diabetes include:

- **Ethnicity**. Type 1 diabetes occurs more often in whites than non-whites. Type 2 diabetes is more prevalent in non-whites. In 2010, African Americans aged 20 years or older were 77% more likely to have diabetes then non-Hispanic whites of similar age. Hispanic populations also appear to have a higher incidence of diabetes, almost double that of their non-Hispanic white peers. Mexican Americans are 1.9 times as likely to develop diabetes as non-Hispanic whites. In 2009, American Indians and Alaska Natives experience the highest risk of becoming diabetic; they are 2 times as likely as non-Hispanic whites.
- **Age**. Likelihood of developing diabetes increases with age (40 and older).
- **Obesity**. Almost 80 percent of type 2 diabetics are overweight.
- **Family History.** Having a first-degree family member (parent or sibling) with the disease.
- **Gestational Diabetes.** Having had gestational diabetes or giving birth to a child weighing over 9 pounds increases risk.
- **Hypertension.** Blood pressure of 140/90 mm Hg or higher.
- **Dyslipidemia.** Low high-density lipoprotein (HDL) cholesterol level (35 or lower) or a high triglyceride level (250 or higher).
- **Sedentary.** Exercise less than three times per week.
- **Pre-diabetes.** History of previous impaired glucose tolerance (IGT) or impaired fasting glucose (IFG)

- **Polycystic ovarian syndrome.** Results in insulin resistance.
- **Smoking.** "Chemicals in tobacco smoke complicate the regulation of blood sugar levels, exacerbating the health issues resulting from diabetes. Smokers with diabetes have a higher risk of heart and kidney disease, amputation, eye disease causing blindness, nerve damage and poor circulation" (Surgeon General, n.d). (CDC, 2011a; NIH, 2011b; NIH, 2012b).

The American Diabetes Association (2012) recommends that all adults who are overweight and have any of the risk factors listed above be tested for pre-diabetes and diabetes. If none of the risks are present, testing for diabetes should begin at age 45. For children, the ADA recommends testing every three years beginning at age 10 if the child is overweight and has two of the listed risk factors.

REDUCING THE RISK

Reducing the risk of diabetes has been the focus of many studies. The Diabetes Prevention Program (DPP), reported that "people aged 60 or older who made lifestyle changes lowered their chances of developing diabetes by 70 percent" (NIH, 2011b). Participants taking oral medication (Metformin) therapy also reduced their risk by 31 percent. The DPP showed that simple lifestyle changes were the best treatment for pre-diabetes and insulin resistance:

- **Diet.** A low-fat, low-calorie diet will significantly reduce cholesterol levels and blood pressure.
- **Exercise.** As little as 30 minutes a day of walking, or other moderate intensity activity, five days a week is sufficient to make a difference.
- **Weight Loss**. Losing 5-7 percent of body weight (as little as five or ten pounds) improves insulin function.

Many of the test subjects who followed the lifestyle recommendations were able to return their blood glucose level to the normal range. No drug has been approved by the Food and Drug Administration specifically for treatment of insulin resistance or pre-diabetes (NIH, 2011b).

TREATMENT

No cure for diabetes exists as of yet. Diabetes treatment therefore consists of various measures to control, or manage, the disease. Treatment of diabetes today focuses largely on adopting and maintaining a healthier lifestyle in addition to glucose monitoring, oral medications and/or insulin injections (NIH, 2012b).

Type 1 diabetics do not produce any insulin and must receive insulin injections. There are four basic types of insulin available that differ in how long it takes to begin working, at what point it is at its peak, and the duration of its effectiveness (ADA, n.d.a). Individual therapy depends on many factors including how the blood glucose level fluctuates throughout the day (MayoClinic.com, 2010).

Type 2 diabetes is managed through a combination of diet, exercise, and medication if needed. Blood glucose level, blood pressure and cholesterol levels should be

monitored regularly. A patient participates in the treatment by monitoring the **ABCs of diabetes:**

A is for A1C. This blood test shows a three month average blood glucose level and is recommended for all diabetics at least twice a year. Many individuals with type 2 diabetes need to monitor their blood glucose on a daily basis using one of a number of monitoring devices as recommended by the physician. Every percentage point drop in A1C blood test results can reduce the risk of microvascular complications (eye, kidney, and nerve diseases) by 40%. Target values are:

♦   A1C – below 5.7 percent
♦   Blood glucose level before meals – 70 to 130 mg/dL
♦   Blood glucose 1-2 hours after meals – < 180 mg/dL

B is for Blood Pressure.
♦   Target value is below 130/80 mm Hg.
♦   10 millimeter reduction in systolic (top number) pressure results in 12% reduction in complications.

C is for cholesterol. Target values include:
♦   LDL (bad cholesterol) under 100 mg/dL
♦   Triglycerides under 150 mg/dL
♦   HDL (good cholesterol) above 40 (men) or 50 (women) mg/dL
♦   20-50% reduction in cardiovascular complications when cholesterol is adequately controlled
(CDC, 2011a; NIH, 2011a; NDEP, 2012)

According to the American Diabetes Association, "There has been steady improvement in the proportion of diabetes patients achieving recommended levels of A1C, blood pressure, and LDL cholesterol in the last 10 years... Nevertheless in some studies only 57.1% of adults with diagnosed diabetes achieved an A1C of <7%, only 45.5% had a blood pressure <130/80 mmHg, and only 46.5% had a total cholesterol <200 mg/dl, with only 12.2% of people with diabetes achieved all three treatment goals" (ADA, 2012).

COMPLICATIONS OF DIABETES

Heart disease and stroke. High blood glucose levels will eventually damage the blood vessels leaving the individual at high risk for heart disease and stroke:
♦   2-4 times higher rate of heart disease/stroke than those without diabetes
♦   Leading cause of death in diabetics – In 2007 diabetes mortality rate for Texas was 26 deaths per 100,000 persons
♦   22% of people with diabetes in Texas also had cardiovascular disease in 2007 (versus 5% of non-diabetics)
♦   10% of people with diabetes in Texas also had a stroke in 2007 (versus 2% of non-diabetics)
(CDC, 2011a; Texas Diabetes Council [TDC], 2011; TDC, 2008)

Neuropathies. Nerve damage resulting from diabetes may involve any organ system such as the digestive track and heart as well as the extremities:

♦   60-70% of diabetics have some form of nerve damage
♦   Risks increase with duration of diabetes
♦   Major contributing factor in lower-limb amputations
♦   30% of diabetics aged 40 and older have impaired sensation in the feet
♦   60% of all nontraumatic amputations occur in diabetics – In 2006, approximately 65,700 per year
(CDC, 2011a; NIH, 2012a)

Retinopathy. Damage to the blood vessels in the retina due to diabetes is the leading cause of blindness among adults:
♦   Leading cause of new cases of blindness among adults aged 20-74 years
♦   28.5% of people with diabetics have some stage of diabetic retinopathy and of those 4.4% had advanced diabetic retinopathy
♦   Four progressive stages
♦   16.8% of people with diabetes in Texas also had retinopathy in 2006
(CDC, 2011a; NEI, 2012; CDC, n.d.)

Kidney disease. Diabetes is the leading cause of kidney failure requiring either dialysis or transplantation:
♦   44% of new cases due to diabetes. In 2010, more than 10% of people ages 20 and older in the US had Chronic Kidney Disease.
♦   Damage occurs between 15 to 25 years of duration of diabetes
♦   Diabetes and Hypertension are major factors in the cause and effect of kidney disease. In 2008, 547,982 Americans were treated for End-stage Renal Disease and of those treated 133,537 were due to hypertension and 205,724 were due to diabetes
(CDC, 2011a; NIH, 2010; NIH, 2012c)

Complications of pregnancy. Poorly controlled diabetes before conception and during the first trimester of pregnancy causes major birth defects in 5-10% of all pregnancies and spontaneous abortions in 15-20% of pregnancies among women with type 1 diabetes. (CDC, 2011a)

PREVALENCE IN TEXAS

It is estimated that the number of people in the U.S. diagnosed with diabetes is growing by approximately one million per year. The most recent data shows that 8.3% of the national population has diabetes. Diabetes currently affects almost 10% of the population in Texas and it is expected that the total number of diabetes cases will increase by 77% over the next 30 years from 1.3 million in 2005 to almost 2.3 million in 2040 (CDC, 2009). The chart below shows the current prevalence in adults by age and ethnicity:

2010 Diabetes Prevalence in Texas

Age Group	White, non-Hispanic	Black, non-Hispanic	Hispanic	All Races
18 - 44	2.2%	8.0%	4.2%	3.5%
45 - 64	10.1%	20.8%	21.5%	14.0%
65+	19.2%	38.0%	32.2%	23.0%

(TDC, 2012)

Additionally, during 2002–2005, 15,600 (19.7 per 100,000) youth in the U.S. were newly diagnosed with type 1 diabetes annually, and 3,600 (18.6 per 100,000) youth were newly diagnosed with type 2 diabetes annually amongst youth aged under 10 years. Research has shown that nutritional intake in adolescents with diabetes is poor and does not follow current recommendations. Recommendations for total dietary fat intake are met by only 10% of youth with diabetes and recommendations for saturated fat intake by only 7% (CDC, 2011b; TDC, 2011).

Diabetes is the sixth leading cause of death in the nation as well as in Texas. In 2007, there were 5,105 deaths attributed directly to diabetes but it is estimated that the mortality rate in Texas is 27.8 per 100,000 (TDC, 2011). In 2010, Bexar County reported 354 deaths caused by diabetes (23 per 100,000) (Schlenker, 2011). Diabetes is believed to be significantly under-reported as the cause of death where death occurs as a result of a complication of the disease such as heart disease or kidney failure. The reported mortality rate for Bexar County in 2004 - 2007 was significantly higher than the state rate (TDC, 2011).

ECONOMIC COST

The American Diabetes Association has conducted in-depth studies of the economic costs of diabetes in the U.S. beginning in 2003 (ADA, 2008). Findings for 2007 include:
- $174 billion – total national cost of diabetes
- Direct medical costs -- $116 billion
  - $27 billion direct diabetes treatment
  - $58 billion treatment of diabetes-related chronic complications
  - $31 billion excess general medical costs
- Indirect costs – $58 billion
  - Work-related absenteeism – 15 million work days
  - Reduced work performance – 120 million work days
  - 107 million work days lost due to unemployment disability
  - 6 million reduced productivity days for those not employed
  - $26.9 billion lost productivity due to premature death (284,000 deaths in 2007)

In essence, one out of every five dollars spent on healthcare is used to care for someone with diabetes (ADA, 2008).

A recent cost analysis for Texas reported that the total cost attributed to diabetes in Texas was estimated to be $12.5 billion in 2006 (ADA, n.d.b). The national cost of

diabetes in the U.S. in 2007 exceeded $174 billion. The total costs of diabetes for people in the Congressional Districts of the four KCF counties of interest are listed below.

2006 Estimated Cost (in millions) of Diabetes in Texas

Congressional Districts	Medical cost	Indirect cost	Total
20 (Bexar County)	342.3	154.4	**496.7**
21 (Banderas, Bexar, Comal, and Kendall counties)	264.5	135.3	**399.8**
23 (Bexar County)	324	156.9	**480.9**
28 (Bexar County)	322.3	148.3	**470.6**
Combined total	**1,253.1**	**594.9**	**1,848**

(ADA, n.d.b)

Diabetes poses a source of economic strain for both individuals and the state. Individuals with diabetes spent approximately 2.3 times more on medical care than those without diabetes but there exists a significant disparity in access to health care (CDC, 2011a). People with diabetes were more likely to defer or avoid treatment due to cost than those without diabetes. Of those diagnosed with diabetes, there were a disproportionate number of Hispanic/Latinos that reported not having access to medical care:

Percentage of Diabetics in Texas (2007)				
	Hispanic/ Latino	Non-Hispanic Black	Non-Hispanic white	All Diabetics in Texas
Did not have healthcare coverage	38%	18%	11%	22%
Could not see doctor due to cost	39%	28%	17%	n/a

(TDC, 2008)

State and federal diabetes expenditures in Texas also included almost $2.7 million for Medicaid and Children's Health Insurance Program (CHIP) claims related to diabetes in children and approximately $5.7 million for the activities of the Department of State Health Services Diabetes Program in 2007, which provided education and outreach community-based programs for children and adults with or at risk for diabetes (TDC, 2008).

RESEARCH

Numerous organizations help fund studies to increase understanding of diabetes, including, but not limited to, the National Diabetes Education Program (NDEP), the American Diabetes Association (ADA), the National Institute of Health (NIH), the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), the National Eye Institute, the Center for Disease Control and Prevention (CDC), the Texas Diabetes Council, and the Texas Department of State Health Services.

The city of San Antonio is home to several research organizations including, but not limited to, the University of Texas Health Science Center at San Antonio, the Texas Diabetes Institute, the South Texas Health Research

Center, and the Texas Biomedical Research Institute. These organizations have participated in and share access to a number of long-term studies focused on diabetes and heart disease including:

♦ *Veterans Administration Genetic Epidemiology Study (VAGES).* 1,800 family members from 300 families with a Mexican American individual with type 2 diabetes and one or more affected siblings, one affected parent, and one other sibling for genotyping.

♦ *San Antonio Family Diabetes Study (SAFDS).* 1,000 family members from 39 Mexican American extended families phenotyped for diabetes traits.

♦ *San Antonio Family Heart Study.* 1,400 individuals from 42 families over four generations undergo clinic exam every five years including tests for diabetes.

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