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AEROMEDICAL ISSUES IN DIABETIC AVIATORS

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ABSTRACT

Diabetes mellitus is a common disease that poses a serious health and safety threat to civilian aviators. Complications secondary to diabetes can be severe and result in sudden incapacitation. The Federal Aviation Administration (FAA) has developed regulations for certifying aviators with diabetes, as well as guidelines for in-flight management of blood glucose levels. Advances in medical technology have led to treatments and countermeasures for diabetes that enable many individuals to engage in physically and mentally demanding activities. This paper presents a basic overview of the pathophysiology, diagnosis, and management of diabetes mellitus in civil aviators. In addition, current FAA regulations for medical certification and blood glucose management will be outlined.

BACKGROUND

In order to understand the hazard that diabetes poses to a pilot's health and flying safety, one must understand the nature of this condition. Diabetes is a metabolic condition that usually presents with symptoms of uncontrolled blood sugar, such as increased urination, persistent thirst, frequent urination at night, and weight loss (Braunstein, G.D., Friedman, T., Herman-Bonert, V., Peters, A.L., 1997). A random blood sugar level greater than 200 mg/dl usually confirms the diagnosis. Diabetes mellitus is a life-long disease that can lead to blindness, heart and blood vessel disease, strokes, kidney failure, amputations, nerve damage, and death.

Diabetes is generally the result of the body's inability to produce enough insulin, resistance to insulin, or both (Braunstein et al., 1997). Insulin is a polypeptide hormone secreted by the islets of Langerhans, located in the pancreas. Its primary function is to regulate the metabolism of carbohydrates and fats, especially the conversion of glucose to glycogen. This conversion is what lowers the blood glucose level. In addition, insulin allows nutrients to enter the muscle were it can be stored and later used for energy.

How does this process unfold during our daily consumption of food? Food is digested in the stomach and the intestines where carbohydrates are broken down in to sugar molecules, or glucose. At this point glucose is absorbed into the circulatory system, causing the blood glucose levels to rise. In response to elevated blood glucose levels, the pancreas releases insulin from beta cells.

There are 18.2 million people in the United States, or 6.3% of the population, who have diabetes (American Diabetes Association, 2003). While an estimated 13 million have been diagnosed, unfortunately, 5.2 million people (or nearly one-third) are unaware that they have the disease (ADA, 2003). Approximately 2,200 people are diagnosed with diabetes each day. Almost 800,000 people will be diagnosed each year. Diabetes is the seventh leading cause of death and sixth-leading cause of death by disease in the United States (ADA, 2003).

TYPE I DIABETES

Diabetes is generally classified into two basic categories: type I and type II. Type I diabetes, or insulin dependent diabetes, usually presents at a young age and is characterized by the inability of beta cells in the pancreas to produce adequate levels of insulin. Without the appropriate level of insulin in the bloodstream, glucose levels increase and cannot be converted into energy. After five to ten years, the beta cells of the pancreas are completely destroyed. The exact process leading to type I

diabetes mellitus is still not known.

There are several indicators related to type I diabetes: increased thirst and urination do to the increased glucose levels in the bloodstream; weight loss, despite an increased appetite; and nausea, vomiting, abdominal pain, and fatigue. Type I symptoms are usually severe and occur rapidly. Type I diabetes accounts for three percent of all new cases of diabetes each year. The disease primarily affects children, with one new case per every 7,000 children per year. Initial presentation is less common among adults older than twenty (Braunstein et al., 1997).

Insulin injections and blood glucose monitoring are the mainstay of therapy for type I diabetes. Failure to follow this course of treatment can result in complications and a premature death. In addition, those with type I should maintain good health practices, such as a controlled diet and physical exercise.

TYPE II DIABETES

Type II diabetes is known as noninsulin-dependent diabetes mellitus and adult-onset diabetes. It is thought to be the result of insulin resistance at the fat and muscle cell level. As a result of this resistance, insulin cannot be properly utilized to let glucose into cells to produce energy. This results in abnormal levels of glucose in the bloodstream and urine. Type II diabetes has several indicators: excessive thirst, frequent urination, fatigue, blurred vision, and slow healing of injuries. Lastly, individuals with type II diabetes suffer from an increased weight loss despite an amplification of appetite (Braunstein et al., 1997).

Family history is a risk factor in type II diabetes, which indicates that genetics play a large role in an individual's predisposition. Environmental factors, such as a sedentary lifestyle and poor diet, can elevate a person's risk for type II diabetes. Ethnicity, hypertension, and age are also risk factors. Approximately sixteen million people have type II diabetes and almost half of are unaware of their condition. Type II diabetes often goes undetected for many years because symptoms develop gradually without overt physical signs.

Several treatments are available to treat type II diabetes. Initial treatment generally consists of lifestyle modifications, such as weight control by strict diet and exercise. Most people diagnosed with type II diabetes are obese and have relatively inactive lifestyle habits. Type II diabetes can also be treated with oral medications. Several types of oral hypoglycemics are available to treat type II diabetes. One type increases insulin production; another decreases insulin resistance, while the last slows absorption of carbohydrates.

An important complication of diabetes is hypoglycemia. It occurs when there is a low blood glucose level. Both type I and type II diabetics can suffer from hypoglycemia. The brain is dependent on a supply of glucose to function. When blood levels begin to fall the brain starts a series of physiological responses, which include cognitive impairment and decreased blood flow in the brain (Braunstein et al., 1997).

Hypoglycemia can be separated into three categories: mild, moderate, and severe. Mild symptoms consist of nausea, apprehension, excessive sweating, increased heat rate, and trembling. Moderate hypoglycemia is characterized by mood changes, confusion, blurred vision, dizziness, and headache. Additional symptoms include weakness, poor coordination, fatigue, and impaired walking and talking. Severe hypoglycemia symptoms are the most devastating. Seizures, loss of consciousness, and coma can occur. Prolonged periods of severe hypoglycemia can lead to irreversible brain damage, heart problems, and even death (Braunstein et al., 1997).

FAA REGULATIONS

The Federal Aviation Administration (FAA) has several rules and regulations regarding airmen with diabetes. The FAA created a policy in 1996 that allows insulin-treated applicants to receive a third-class medical certificate (Stephens,2000). Individuals granted this special issuance are restricted to flying within the United States. The medical certificate is only good for one year and requires close physician supervision. First and second-class license are not considered for certification although special issuance may be considered on a case-by-case basis. Applicants are only considered if they have a stable condition for six months on their current treatment. The applicant must not have any recurrent episodes of hypoglycemia in the past five years. The individual must also not have any episodes resulting in loss of

consciousness, seizure, or impaired cognitive function requiring medical intervention. Sudden incapacitation from hypoglycemia (hypoglycemia unawareness) within the preceding year is also disqualifying (The Federal Aviation Administration, 2003). Airmen must provide medical records recording any incidents or mishaps that were related to their condition. A complete medical examination should also be conducted. It is preferred that such an examination is conducted by a diabetes specialist. The examination includes measurements of glycated hemoglobin, which provides a reference of diabetes management. Insulin dosage, diet, documented training on glucometer usage, and recognition and treatment of symptoms. Presence or absence of cerebrovascular, cardiovascular, peripheral vascular disease, or neuropathy should be documented. An eye specialist should confirm the absence of clinically significant eye disease. Lastly, airmen over the age of forty must submit a report with ECG tracings of a maximal graded exercise stress test (FAA, 2003). Airmen require evaluations every three months by their treating physician and have an annual physical requirement.

Diabetic airmen that are certified to fly are required by the FAA to carry a recording glucose meter and 10 gram portions of a rapidly absorbable glucose appropriate for the duration of a planned flight. Pilots are required to measure blood glucose levels several times, with the first interval thirty minutes prior to takeoff. The preflight blood glucose should not be lower than 10 mg/dl. If blood glucose falls below this level, the airman must ingest no less then a 10 gram glucose snack and retest thirty minutes later. The process must be repeated if the blood glucose level remains below 100 mg/dl. If it exceeds 300mg/dl, the flight must be cancelled. The airman must maintain a safe level of 100 to 300 mg/dl to takeoff. In addition to preflight requirements, an airman must monitor blood glucose level one hour into flight and each consecutive hour. This process ensures that the glucose level is between the recommended levels. If the person falls below 100 mg/dl, the pilot must ingest a 20 gram glucose snack and retest one hour later. If levels are above 300mg/dl, the individuals must land at the closest suitable airport until levels can be controlled. If an airman cannot check his or her glucose level due to adverse conditions, the airman must ingest 10 gram glucose snack and recheck one hour later. If airmen cannot make a second reading one hour later he/she must ingest 20 gram glucose snack and land at the closest suitable airport until a proper blood glucose level can be obtained. Lastly, airmen must check levels one half hour prior to landing (FAA, 2003).

FAA regulations concerning diabetes treated with oral medications are very similar to insulin-dependent airmen (FAA, 2003). Type II diabetic airmen treated with oral medications are only required to have an annual physical. An airman should report changes in medication dosage or side effects. Individuals on oral hypoglycemics are also restricted to a class-three medical certification.

Pilots, who can control their diabetes with diet and exercise, are eligible for all classes of medical certification (FAA, 2003). Certification is dependent on documented evidence of no associated disqualifying conditions, such as cardiovascular, neurological, renal, or eye disease. Special exams are not required unless it is indicated by the airman's clinical history or examination.

AEROMEDICAL SAFETY ISSUES

Type I and type II diabetic airmen must overcome several obstacles in order to fly. The FAA requirement to monitor blood glucose while inflight provides a potentially dangerous inflight distraction. A pilot must constantly veer their attention away from flying in order to monitor their blood glucose level. This situation greatly reduces situational awareness and can lead to an increase in pilot error during critical phases of flight. One example commonly given is flying under adverse weather conditions. If an airman is unable to monitor glucose levels for two hours, the FAA requires the pilot to land at the closest suitable airport. Diabetic pilots trying to meet this demand in an already dangerous flying environment can lead to high stress levels potentially leading to an insulin reaction. Insulin reactions are caused by an imbalance between medication and diet leading to a drop in the blood glucose level. A pilot's ability to control an aircraft may be impaired because of the resulting hypoglycemia.

Complacency is another threat to flying safety among diabetic airmen. Pilots who have flown with this condition for several years may fail to comply with blood

glucose monitoring requirements. This could lead to abnormally high or low blood glucose levels impairing the pilot's ability to fly safely.

Pilot education is the most important preventive measure. All airmen should be educated to recognize the symptoms and risk factors of diabetes. This is especially important because it is estimated that eight million people in the United States have undiagnosed diabetes. Proper education can reduce the incidence of hypoglycemic episodes in unrecognized diabetics and provide airmen with the appropriate resources to help mitigate the effects of this condition.

Several technological advances in diagnosing and treating diabetes have increased the safety of flying with this condition. Compact blood glucose meters, the size of a stopwatch, allow individuals to acquire accurate blood glucose levels in less than thirty seconds. Proactive regulations by the FAA for monitoring blood glucose levels before and during flights have helped decrease the amount of mishaps due to hyper- and hypoglycemic reactions. Medications have also made several advances over the last few years. Four waiverable oral medications are available to airmen after proper medical evaluation. This variety allows an individual with type II diabetes a better chance of finding a medication that works for them.

With the advances in medication and testing equipment that are currently available, future mishaps due to insulin reactions inflight can be avoided. Four hundred airmen are currently flying with type I diabetes (FAA, 2003). With the large number of newly diagnosed diabetics each year, the number of airmen flying with diabetes will steadily increase and the FAA will continue to modify its regulations in order to optimize flying safety.✈

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