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Childhood Diabetes Type 1 and 2: General Pathophysiology, Treatment and Comparison of Diabetes Education, Treatment, and Treatment Goals between the United States and Europe and Hypothesized Outcomes

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Abstract
The goals of this paper are to bring awareness of the increasing diagnoses of diabetes in children, the resources available to help educate the diabetic child and his/her family, the importance of early treatment, diet, and compliance with treatment, and how the education readily available, treatment, and treatment goals differ between European nations and the United States. Multiple topics will be discussed within this paper, the pathophysiological differences between Type I Diabetes Mellitus (T1DM) and Type II Diabetes Mellitus (T2DM), the differences in the treatment methods for each, nutritional needs, challenges throughout childhood, and the differing outcomes for the two types of Diabetes. Also to be discussed are the differences in how pediatric patients and their families are educated, and the educational tools that are used and readily available in the United States vs. European Nations. Additionally, how the treatment plans and goals differ between the United States and European Nations. Finally, hypothesizes will be drawn on the potential future outcomes of the differing Diabetic treatments and educational methods that are practiced in the United States and Europe.

Cover Page Footnote
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Introduction

The goals of this paper are to bring awareness of the increasing diagnoses of diabetes in children, the resources available to help educate the diabetic child and his/her family, the importance of early treatment, diet, and compliance with treatment, and how the education readily available, treatment, and treatment goals differ between European nations and the United States. Multiple topics will be discussed within this paper, the pathophysiological differences between Type I Diabetes Mellitus (T1DM) and Type II Diabetes Mellitus (T2DM), the differences in the treatment methods for each, nutritional needs, challenges throughout childhood, and the differing outcomes for the two types of Diabetes. Also to be discussed are the differences in how pediatric patients and their families are educated, and the educational tools that are used and readily available in the United States vs. European Nations. Additionally, how the treatment plans and goals differ between the United States and European Nations. Finally, hypothesizes will be drawn on the potential future outcomes of the differing Diabetic treatments and educational methods that are practiced in the United States and Europe.

Incident Rates of T1DM and T2DM in U.S. and European Children

The prevalence of Diabetes in children living in the U.S. has been slowly and steadily increasing particularly in the last few decades. The most current rates of Diabetes in children consist of more than 18,000 youth or approximately 78.3% of new cases per year are diagnosed with T1DM in 2008 and 2009 in the U.S. and more than 5,000 youth or 21% of the new cases each year (2008 and 2009) were diagnosed with T2DM (Centers for Disease Control and Prevention). Using SEARCH for Diabetes Study, a six center observational study to determine population-based determination of physician-diagnosed diabetes in youth using four

geographically based centers and two health plan-based centers in the U.S. to calculate the prevalence rates of diabetes in youth based on age, gender, ethnicity, and type; it was determined that in 2001 the approximate prevalence of T1DM in children of all ages and ethnicity was estimated at 1.54 per 1000 youth and approximate prevalence of T2DM in children in 2001 was estimated at 0.22 per 1000 youth, with T1DM accounting for approximately 80% of diabetic children and adolescents while T2DM is only approximately 20% of the remaining diabetes cases. It is important to know that the incidence of T2DM varies greatly by ethnicity with Native Americans being effected at a rate of approximately 0.03 per 1000 youth in the 0-9 year age group and a staggering rate of 1.74 per 1000 youth in the 10-19 year age group, by contrast non-Hispanic whites have an incidence rate of 0.0 per 1000 youth at 0-9 year age group and 0.19 per 1000 youth in the 10-19 year age group, so a big variation of prevalence of T2DM depending on age and ethnicity is seen. By comparison the estimated number of children with T1DM in the 1970s ranged from 0.6 to 1.9 cases per 1000 youth including all youth under the age of 19, and those estimates were limited geographically and looked at data almost exclusively of non-Hispanic white youth and these numbers did not count for T2DM as it was rarely if ever diagnosed in youth during this time, only recently being reported in clinical studies in the last few decades (American Academy of Pediatrics) (Kaufman).

In Europe, the incidences of both T1DM and T2DM are increasing in significant numbers. The current studies using data from EURODIAB, a European population based diabetes data base and registry that tracks all information regarding diabetes across 17 European nations, as well as DIAMOND, a diabetes database and registry that tracks T1DM worldwide, the study groups show an average of a 3.9% yearly increase in diagnosis of T1DM across 17 European Nations when examining 15 years of records (1989-2003) and noting newly diagnosed

cases of T1DM in children under the age of 15 with the greatest percentage increase in diagnosed cases in those 5 years old or younger. The European study predicts that if the current trends of increase in new T1DM cases continues in addition to predicted population increases, then it is believed that the incidences in T1DM in the 5 and under age group will double sometime between 2005 and 2020. In addition, the overall increase in T1DM in all children 15 years of age and under is predicted to increase by 70% (Patterson, Dahlquist and Gyürüs). Europe, like the U.S., has also noted an increase in T2DM diagnoses in children the last few decades and has taken note of the rate of increase however, though Patterson, et. al. has made note of the increase of T2DM throughout European nations, he stresses that the increase in T2DM should not overshadow the rapid increase in T1DM diagnoses. He does acknowledge that in a few European countries T2DM may be a predominant diabetes diagnosis in pediatric patients however, T1DM is and will probably continue to be the predominant type of diabetes throughout most European countries (Patterson, Dahlquist and Gyürüs).

Etiology and Pathophysiology of Type 1 and Type 2 Diabetes in Children

The pathophysiology of T1DM and T2DM differ in many ways, most notably which T1DM is considered by current research and studies to be an autoimmune disorder, while T2DM is basically thought of as an "acquired" metabolic disorder as a result of poor diet, obesity, lack of physical exercise and characterized by insulin resistance, insufficiency of the β cells in the pancreas, and an inability to properly metabolize glucose and lipids that can result in hyperglycemia. The most common type of diabetes found in children is T1DM. In T1DM, current studies and research indicates that there is an autoimmune response that causes a T-Cell mediated attack on the β cells in the islet of the pancreas resulting in the destruction of the β cells

responsible for the production of insulin leading to either no insulin production from the pancreas or insufficient insulin production leaving the body unable to regulate blood sugar levels (BSL). Most children who are diagnosed with T1DM have a prolonged asymptomatic period where no illness appears to be present until such a point where the β cell destruction has reached a point where the body can no longer regulate BSLs. At this point the children with T1DM will present with polyuria (excessive urination), polyphagia (excessive hunger), and weight loss. If the condition is not recognized early enough with the afore mentioned symptoms then ketoacidosis, defined as the presence of ketone bodies in the urine and/or blood as the result of the abnormal metabolism of fatty acids and denaturing of amino acids resulting in a dangerously low blood pH, can occur. This is a true life or death emergent condition and if not treated promptly then death will soon follow. Approximately 30% of children newly diagnosed with T1DM will present in Diabetic Ketoacidosis and require hospitalization to bring glucose levels under control the other 70% will not require hospitalization provided adequate outpatient facilities that are able to provide education and self-management care are accessible to the family (Janet Silverstein MD) (International Society for Pediatric and Adolecent Diabetes).

Conformation of a T1DM diagnosis is the same as it is for T2DM, a fasting plasma glucose level of ≥126 ml/dL which should be confirmed by a repeat test showing similar results, a $A1_c \geq 6.5\%$ using a method certified by the National Glycohemoglobin Standardization Program and is standardized to the Diabetes Control and Complications assay, random plasma glucose of ≥ 200 ml/dL with symptoms of hyperglycemia, or plasma glucose level of ≥ 200 ml/dL at 2hr on a Glucose Tolerance Test. Additionally, an islet autoantibody test may be performed to detect autoantibodies in the plasma that may be responsible for the destruction of the β cells in the pancreas. However, it must be noted that there are T1DM individuals who are

negative for the islet autoantibodies, in which a plasma C-peptide test may provide some guidance in diagnosis although the interpretation of the test are controversial at this time (American Diabetes Association) (Porth) (Skies) (Janet Silverstein MD) (International Society for Pediatric and Adolecent Diabetes).

In T2DM, which used to only be diagnosed in adults usually over the age of 40, the diagnoses in children, particularly adolescents are increasing rapidly over the last two decades (Giannini). T2DM is typically considered to be an acquired disease or secondary disease caused by a metabolism disorder resulting from a poor diet that is high in carbohydrates and sugars, lack of adequate exercise, obesity, or in rare cases temporary T2DM may be brought on by pharmacological treatments for other disorders such as high doses or prolonged use of steroids for inflammatory or autoimmune conditions is one example, the symptomology and pathophysiological aspects of T2DM will clear up once the treatment is discontinued, or in the case of a syndrome or disorder causing the T2DM, the T2DM will clear up once the syndrome or disorder is properly treated or cured. Of the above mentioned factors in developing T2DM, obesity poses the highest risk. However, new studies are showing that perhaps even more of a factor than obesity itself, is how the lipids are distributed through the body. Those with higher levels of visceral fat and/or intramyocellular lipid content are at an even higher risk of T2DM than their peers with a similar BMI and lower levels of visceral fat and/or intramyocellular lipid content, as this group showed higher plasma glucose levels at 2 hr. on the Glucose test, and showed a higher insulin resistance (Giannini) (Constantino). The diagnostic criteria for T2DM is the same as T1DM. T2DM generally has a higher age at onset and the symptomology is similar to T1DM and includes polyuria, polydipsia (excessive thirst), weight loss, polyphagia, fatigue,

blurred vision, slow healing sores or frequent infections (International Society for Pediatric and Adolecent Diabetes).

The pathophysiology of T2DM is complex, it basically involves first the individual becoming resistant to the insulin that is being produced by the β cells in the pancreas and/or β cell failure. The difference between insulin resistance and β cell failure is that with insulin resistance the cells throughout the body no longer respond appropriately to the normal hormonal action of insulin to pull glucose from the blood into the cells for utilization and storage whereas, β cell failure is due to the pancreatic β cells not producing adequate amounts of insulin to lower the BSL either due to exhaustion or cellular damage not due to autoimmune destruction. The pancreatic islet β cells now work on producing even more insulin for the same levels of glucose present in the blood in effort to compensate for the resistance. Eventually the pancreatic β cells are unable to compensate for the insulin resistance and hyperglycemia develops resulting in T2DM. With obesity as well as more specifically increased levels of visceral fat and/or intramyocellular lipid levels, it is the increased adipose tissues and lipids that contributes to the insulin resistance although it is not for certain why or well understood. It is to be noted that an increase of fat within the liver significantly increases the likelihood of developing T2DM, and as obesity rises among the youth this is becoming more and more of an issue that was typically reserved for adults. The studies that have been done show that while obesity, genetics, physical activity, and diet all play a significant role in the development of T2DM, the highest incidences of the disorder is found in individuals whose body does not partition and store lipids in an ideal manner (Giannini). It is important to note how vital it is to differentiate whether the child has T1DM or T2DM when diagnosing diabetes in any child, as the treatment, educational approaches, pathology, etiology, and outcomes will differ depending on the diagnosis. As a

result, a child that is overweight and/or exhibits symptoms of both T1DM and T2DM it is thought that an islet autoantibody test would be useful in differentiating diagnosis of T1DM and T2DM. A plasma C-peptide level may be indicated if the child has negative autoantibody levels however, the readings of the measurements is a controversial issue in the medical community (Janet Silverstein MD) (International Society for Pediatric and Adolecent Diabetes) (Kaufman).

Treatment for children with T1DM and T2DM

Treatment for both T1DM and T2DM is multifactorial but differ in some aspects, because of the differences in the pathophysiology and etiology of the two diseases, it is important to be able to differentiate between whether the child has T1DM or T2DM in order to achieve the best possible long-term outcomes in treatment, quality of life, and overall health. It is important to note that when treating both T1DM and T2DM in children and adolescents it must be recognized that there will be additional psychological stresses on the diabetic child as well as the parents that are not seen with non-diabetic children. These stresses revolve around fitting in with peers, frustration of not being able to eat whenever or whatever the child wants, fear of being excluded, and even the fear of hospitalizations. The stresses that arise with parents involve getting the child to comply with treatment, the huge responsibility of managing diabetes, medications, diet, and multiple doctor appointments. Additionally, the parents constantly live with the fear of their child having to be hospitalized, suffering organ or system damage due to diabetes, and even the fear of knowing their child may die prematurely due to complications of the disease. The stresses and psychological challenges facing children with diabetes often leads to increased rates of depression and conflicts with parents and if these

issues are not carefully addressed they can lead to lower treatment compliance which has its own set of short term and long term consequences (Naranjo) (Janet Silverstein MD).

With T1DM the diagnosed child is dependent on insulin injections or pump for infusion of insulin to control BSL in the absence of adequate pancreatic β cells to produce the necessary insulin. In addition, a diet that restricts refined carbohydrate intake and sugars is vital alongside a monitored but physically active lifestyle. A healthy well rounded diet consisting of appropriate amounts of protein, adequate vegetables and fruits, and accurate counting of carbohydrates is necessary to keeping the BSL well controlled and need for frequent insulin adjustments to a minimum. Working with a dietician who is experienced with diabetes and children as a member of the child's Diabetes treatment team will help in managing the child's BSLs through diet as much as possible, therefore helping to achieve the goal of optimal glycemic control as well as minimal insulin doses via Medical Nutrition Therapy. In addition, this individual can provide support and ideas for the child's parents as taste, preferences, and medical conditions change (Evert). The most concerning complication that can arise when treating T1DM in children is not only the ketoacidosis, but even just as concerning is hypoglycemic attacks which if they are left unchecked or are frequent, they can result in neuropsychological impairment and difficulty in learning with younger children whose brains are still developing rapidly (Janet Silverstein MD). The current recommendation for BSL testing is at least four times a day and even more often for younger children as determined by the child's physician, activity level, and dietary intake and is vital to maintaining good glycemic control (American Diabetes Association) (Janet Silverstein MD) (Skies).

Education for the family, parents, and the child is vitally important in managing T1DM and T2DM although the needed educational approaches differ depending on the type of diabetes. An important part of the education process again is dietary needs, changes, and how to meet dietary needs of children without them feeling left out or different among their peers. It is recommended in treating both T1DM and T2DM that a registered dietitian with experience in working with children of all ages, as well as with diabetics be part of each child's diabetic care team to educate and support both the parents and the children in finding a realistic dietary choices and solutions for the child and family as a whole (Evert) (Maffeis). Besides educating the parents and family on diet, exercise, how to perform finger sticks to check BSL, administration of insulin as well as calculating doses, and what symptoms to look for regarding hypoglycemic episodes or uncontrolled hyperglycemia in T1DM, it is just as important to educate the child at his or her developmental level (Evert). There are a variety of methods and educational goals for children of various developmental stages which will be discussed in a later section of this paper.

With T2DM the treatment involves much the same as T1DM, diet, exercise and monitoring and control of BSL, as well as education (American Diabetes Association). The control of BSLs in T2DM is mainly through diet, exercise, weight loss. Since the pancreas is still producing adequate insulin levels in a Type II diabetic and the main issue is the body's resistance to the insulin and β cell insufficiency, insulin therapy is not recommended except in severe cases of hyperglycemia and only as a temporary solution to reduction in BSL. However, health practitioners are beginning to prescribe Metformin or other hypoglycemic pharmaceuticals to help reduce BSLs in children. Metformin is the most common

pharmacological treatment of choice for T2DM that is normally prescribed for adults and only recently began clinical trials for pediatric and adolescent patients in 2014. Physicians are beginning to prescribe Metformin to children and adolescents whose diabetes is poorly controlled using diet and exercise alone in hopes of gaining better glycemic control, as the Metformin can reduce $A1_c$ levels by an average of 1.5% and the Fasting Glucose Levels by an average of 25% (Diabetes Mall). The main goal in the treatment of T2DM is to treat the risk factors for the disease, namely obesity (Giannini) (American Diabetes Association). In order to treat obesity diet must be managed carefully with not just a reduced caloric intake, but a change in the foods that are consumed. The diet should become a lifestyle change and not just a diet and needs to include mostly fruits, vegetables, and small healthy proteins such as nuts, fish or lean meats while limiting carbohydrate intake and increasing fiber in the diet. In addition, to help with the child's compliance with the dietary changes the child should be involved in choosing and preparing the foods as appropriate for his/her age and development level (Evert) (Maffeis).

Just as the diet is a very important component in addressing obesity and T2DM, exercise is also important in order to burn calories consumed, increase metabolism, and to improve uptake of glucose independent of insulin from the blood via the GLUT-4 transporters in the muscles, increases oxidative capacity, lipid oxidation and turnover, and improves glycogen synthesis which overall improves glucose metabolism. Another important aspect of increased physical activity in the treatment of both obesity and T2DM is that the physical activity reduces insulin resistance over time (Giannini). It is a reasonable goal to believe that T2DM if caught early, and well managed through weight loss, changed lifestyle including a healthy more natural

diet that limits carbohydrates and packed with fruits and vegetables, regular physical exercise, and limits other risk factors such as abnormal lipid levels and hypertension, that T2DM could actually go into remission or be cured.

Comparison of Overall Long-Term Outcomes Between T1DM and T2DM Cohorts

Recent studies on the long-term effects of T2DM in comparison to T1DM in children and adolescence, with the study focusing on mid to late adolescence, regarding future health and mortality impacts have shown that those with T2DM tend to have more health complications in the long term and a higher mortality rate. It was found that those diagnosed with T2DM had significantly less favorable cardiac risk factors including lower HDL levels, higher serum triglyceride levels, higher BMI, and higher BP than their T1DM cohorts. These cardiovascular risk factors for the T2DM group was found both early in the disease, within 2-5 years of diagnosis, as well as later on in the disease progression (Constantino). Children and adolescence with T2DM tend to present with abnormal albuminuria, protein in the urine, their T1DM cohorts as well as macrovascular disease with a rate of 14.4 % for the T2DM compared to 5.7% for T1DM for the same cohort group. An additional sobering find is a higher incidence of ischemic heart disease for T2DM children and adolescents at a 12.6% for T2DM children and adolescents compared to a 2.5% for matched cohorts with T1DM and duration of diabetes were similar. Studies have found that the fatality rate for those with early onset T2DM, defined as T2DM diagnosis in childhood or adolescence, was double compared to the fatality rate of those diagnosed with T1DM of similar age and duration of disease. Most fatalities occurred in the prime of life and were a result of cardiovascular death. The results found in these studies give evidence to the significantly more aggressive nature of T2DM compared to T1DM (Constantino). The studies that have been performed in comparing the long term effects of

T2DM in comparison to T1DM and the lifelong implications and outcomes expected are indeed truly sobering, showing a very real possibility of a much lower life expectancy for those diagnosed with T2DM and for the population as a whole as the rate of T2DM diagnosis continues to increase, unless some major changes are made in lifestyle and education beginning at a young age.

Comparison of Treatment Goals and Patient Education for the U.S. and Europe

Treatment goals and education of patients and their family members do differ between the U.S. and Europe. In the U.S. the use of insulin is only advised for T1DM and not in T2DM unless reduction of BSL is or cannot be achieved with diet and exercise. Europe does advocate the use of insulin regardless of which type of Diabetes is diagnosed in order to bring BSL within a tight optimal window and then manage the levels within that window using diet and exercise (International Society for Pediatric and Adolecent Diabetes). In addition, Metformin is increasingly prescribed in both countries to pediatric patients since 2000 and the rate of new Metformin prescriptions in children in general has tripled in the UK, with the highest increase of new prescriptions being to girls between the ages of 12-18. This may be because besides Diabetes, Metformin is also being prescribed for Polycystic Ovarian Syndrome or PCOS as well as for diabetes and obesity treatment. Metformin is still prescribed for younger children against manufacture's recommendation for cases of uncontrolled diabetes though, the prescribing of Metformin in children younger than 11 has remained at a minimum showing only a handful of children in the UK being prescribed the drug (Hsia, Dawoud and Sutcliffe) (Metformin) (Diabetes Mall). The US the incidence of Metformin prescriptions for pediatric

patients is not specifically recorded, it is estimated that approximately 70% of the children and adolescents with T2DM in the U.S. are on Metformin, a higher rate than the United Kingdom, and approximately 30% are taking more than one hypoglycemic pharmacological treatment (Kaufman).

European nations tend to stress diet, exercise, and education to help control diabetes and generally have a healthier diet and less sedentary lifestyle than their counterparts in the U.S., as demonstrated by many European nations rejecting many of the processed foods, food additives, and Genetically Modified Foods that are commonly consumed in the U.S. and their lifestyle that promotes daily physical activity. Additionally, Europe has developed and implemented the SWEET project designed to improve and raise the standards of care for children and youth diagnosed with diabetes. This program began by surveying families with children who have been diagnosed with diabetes as well as health care professionals treating pediatric diabetics regarding all aspects of care and treatment of the disease as well as compliance in treatment and education. The SWEET project also created centers throughout Europe with the goal to house entire diabetic treatment teams consisting of pediatric endocrinologist, diabetic educators, diabetic specialty nurses, dieticians, and psychologist all experienced in pediatric diabetic care to help centralize access to the professionals needed to help manage the care and treatment of the diabetic child and provide age appropriate education and services for both the parents and the children. While many centers were successful at being fully staffed with recommended professionals to treat the patients in the area, not all were adequately staffed with all of the needed professionals for example, many did not provide a psychologist on staff to help with the emotional needs of the diabetic child

and/or family members. Besides being able to have all the needed health care professionals in one building to ease the treatment and care for the patient and family, just as importantly diabetic centers created by the SWEET project offered various educational methods and materials for all age groups and worked with the diabetic child in educating him or her based on their developmental level (Martin and Lange).

Europe also employs a wide variety of creative educational methods to educate children about treatment, dietary choices, injections, and a wide variety of topics regarding managing diabetes, regardless of the type. Various entrepreneurs, inventors, and companies within the European nations have come up with a variety of ways to help educate children in fun formats about diabetes, nutrition, and other health issues. These methods which have been found through internet search include stuffed animals that can help not only comfort a young child but just as importantly show them in a child friendly way how to check BSLs and give insulin injections as well as how to distinguish the various injection sites and how to rotate testing and injection sites to prevent scar tissue buildup. The stuffed animal also allows the child to practice and role play his or her treatment regimen to help gain mastery of his or her disease and needed treatment in a developmentally appropriate manner (Cramer). Another European, German to be more specific, entrepreneur has developed a board game for children and adolescents with diabetes which is designed to teach children not just about the disease, but also about relationship between what they eat, medications, treatment and the disease in an entertaining format by initiating role play and a question and answer format (Hunsberger). Yet another inventor in Germany has designed an electronic, multi-player game that can be programed to educate about various health issues as well as entertain the children playing. The

idea behind this method of education is the fact that in the U.S. approximately 70% of homes with children have some type of electronic gaming system and the average child spends approximately one and a half hours a day playing on interactive electronic games. Additionally, these games could be programed to be played on a computer or other network gamming system allowing for the child to play with other children, who may have the same condition, remotely and therefore providing an additional support network and friendships. It has been demonstrated that diabetic children have a hard time discussing their disease with their peers but when a game related to diabetes was being played the child was able to better express and share his or her knowledge, thoughts and feelings regarding the disease and therefore helping to create social support via interplayer communication (Brown). It is well known that the repetitiveness of game play among children is helpful in habit formation in young children and the process of playing games provides a fun method of education and interaction with peers and adults. While these inventions were thought of and developed in European countries, it would not take much to market them globally, especially with the ease of international commerce in this day and age as well as the ease for many in the U.S., European nations, as well as other nations throughout the world where internet is not severely restricted, to order merchandise from websites and manufactures through the internet.

Within the U.S., diabetes education overall seems a bit less creative than its European counterparts. Upon a search on the internet, it was found that the majority of education materials for children was in the form of books, hundreds of different books about various topics regarding diabetes and written at a multitude of reading and comprehension levels (T-1 Today Inc.). While I am sure there are many of the same books and even different ones in

Europe, when searching online for “creative methods for educating children with diabetes in the U.S.,” the book list and the American Diabetes Association web page came up as the top methods in the U.S. for educating diabetic children. The program set up by the American Diabetes Association to help educate children with T2DM is called STAR. STAR stands for Stop, Think, Act, and Reflect. The goal is for children with T2DM to: Stop before making a decision to evaluate it regarding its impact on their diabetes, for example should they watch TV or go for a walk, is the snack they are considering a good or OK option considering their current BSL; Think is to get the child to think about his or her options and choices before taking action and how each one effects their BSL and care plan; Act, act on the better choice for his or her health and BSL; Reflect, think about the progress made with each healthy choice and if a poor choice is made think about how to make a better one next time. In addition to STAR the American Diabetes Association has a web page for teens which helps to answer questions regarding numerous teen topics such as alcohol use, sex, tobacco use, and other teen concerns such as dating (American Diabetes Association).

Whether in the U.S. or Europe, it is very important to be able to educate children of all ages and their families regarding healthy lifestyle choices, and how to best care for their health as well as to be able to honestly and freely communicate with the health care providers. This is so much more important when dealing with a chronic, lifelong health condition such as diabetes. A study lead by Carol Raff, demonstrates how using interactive multimedia can help engage children of various ages but particularly elementary school age of 7-11 years of age, in their education about the health condition they have, participation in treatment, as well as improving communication between the child and the healthcare professional. As a result, with

the use of multimedia to help engage the child and educate him or her, it is possible to have better health outcomes in the long run. It is important that for the interactive multimedia to be effective in promoting better outcomes, communication with healthcare professionals, and participation in treatment that the interactive media be clinically relevant to the child's health conditions in this instance it either deals with T1DM or T2DM depending on the diagnosis of the child (Raaff).

Comparison of Hypothesized Long Term Outcomes for the U.S. and Europe

Overall outcomes for the U.S. regarding the long term outlook for today's children who have T1DM and T2DM is poorer than that of European children. This is more so when looking at outcomes for children with T2DM. With the U.S. still having issues with access to health care for all individuals and insurance companies not paying for as many services while charging higher premiums, copays, and requiring families to meet higher deductibles, accessing the needed services for education, medication, and medical support to manage T1DM and T2DM among children will still pose an issue for children in the U.S. resulting in poorer outcomes for those who are unable to access the education and care needed. This issue will primarily effect low to middle income families. In the European nations the access to health care is not dependent on the family's income, and therefore everyone receives the same care regardless of their socioeconomic status especially in the care of children. This discrepancy in the ability to access needed health care and health education in the way of dieticians and diabetic nurse educators as well as pediatric endocrinologist will create a difference in long term outcomes

with nations able to provide adequate care for majority regardless of income having a better long term outcome in the management and reduction of childhood diabetes.

The U.S also has a poorer diet overall, with more processed foods available and it is often difficult to find foods that do not contain added sugars, food additives, and refined carbohydrates compared to European counterparts whose diet consist of more whole foods. The European Food Safety regulations severely limit the additives that are allowed in the foods processed and sold in European Union (United States Department of Agriculture). The differences in diets between the U.S. and Europe will lead to significantly poorer outcomes for U.S. children diagnosed with T2DM especially however, it will also effect those with T1DM as well if the diet is not significantly changed over the course of the child's lifetime and the typical processed foods and foods containing refined carbohydrates and added sugars are not sharply reduced or eliminated from the diet. Additionally, with Europe's better diet overall and restrictions on additives in food it would be easy to hypothesize that Europe will continue to have much lower rate of T2DM in children and adolescents than the U.S.

As far as treatment models between the U.S. and Europe, the European nations have a much better model in place thanks to the SWEET project, better than anything the U.S. has in place. This is demonstrated by diabetics in Europe having a "diabetic care team" consisting of a group of professionals, at one of the numerous diabetic care centers through many parts of Europe where all needed medical professionals and care for the diabetic patient is in one building including but not limited to endocrinologist, dieticians, diabetic nurse educators, and some even have psychologist on staff as is recommended in order to address all aspects of diabetic care in one building (International Society for Pediatric and Adolecent Diabetes). In the

U.S., most families have to schedule multiple appointments at sometimes multiple offices for complete diabetic treatment with multiple health professionals. This also puts Europe ahead of the U.S. in being able to achieve better long term outcomes for children with both T1DM and T2DM. The same could also be held true regarding education of both diabetic children and their parents with the creative educational tools, methods and emphasis within healthcare setting. To be fair, it should be noted that the same educational methods and tools used and developed in Europe could also easily implemented and used in the U.S., therefore leveling the field so to speak in the area of education.

Conclusions

Both T1DM and T2DM are complex metabolic diseases that have significant lifelong implications for children who are diagnosed with the conditions. Treatment and education for each are similar, yet each has its unique specific treatment plans that needs to be created for each individual child through a multifocal approach of medicine, education, diet, and active lifestyle.

The European nations look to be on the right track in spite of the increasing rates of T1DM and T2DM within their nations. The rates of increase of T1DM and T2DM in the European nations is not as high as the U.S. overall though they are increasing significantly. Europe, with its universal healthcare system that spans more than 17 nations, has been able to track data easily and has taken the initiative to set up diabetic centers that can provide all treatment, monitoring, support, and education in one place. This provides ease of obtaining needed treatment, support, and monitoring regardless of income and in addition the family

would not have to travel to multiple different offices to receive all the services needed. Additionally, it appears through internet searching that most of the creative methods for educating children and families dealing with diabetes come from European nations such as Germany. The diet among Europeans generally has been more whole foods that are in season and fewer processed foods. However, with the globalization of fast food and more American fast food restaurants being built abroad, maintaining the healthier eating habits and diet may prove to be a bit of a challenge.

The U.S. has a huge challenge ahead to bring the prevalence of diabetes under control, especially T2DM. With the U.S. having such a high incidence of childhood obesity compared to European nations, a more sedentary lifestyle, a diet which contains so many more processed foods and refined sugars and carbohydrates, and more issues with accessing health care, I believe it will take some big changes within the U.S. at the family level, in ability to access to needed healthcare and education regardless of family's income, and better regulation of insurance policies regarding paying for needed services, and changes at the FDA level to bring about the needed changes in regards to additives allowed in our foods in order to lower the incidences of T1DM and more specifically T2DM among children in the U.S. At the family level parents must encourage and demonstrate healthy eating habits and diet as well as an active lifestyle for their children, as it is well known that children learn more form what they see than what they are told. Families in the U.S. need to be able to access education, healthy foods, and necessary health care regardless of the family income in order to have a healthier U.S., this is also true to have any hope in reducing the rates of T1DM and especially T2DM within the U.S.

and hopefully reverse the current course and prevent premature death due to T2DM, a largely preventable and treatable disease.

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