Management of Diabetes in the Adolescent and Young Adult During Transition

Joe M. Chehade, MD; David L. Wood, MD, MPH; L.A. Fox, MD; and Carlos Palacio, MD

Abstract: *The prevalence of obesity and Type 2 Diabetes Mellitus among children and youth has doubled during the past three decades. The challenges of the transition to adulthood are especially complex for adolescents and emerging adults with diabetes. In this article we review these challenges along with the concept of the Chronic Care Model (CCM). CCM provides an organizational approach to integrated care for people with chronic disease that is sufficiently robust to address both the health care system challenges during transition and the developmental needs of the emerging adult. Patient self management of chronic disease has increasingly been recognized as an essential component of the Chronic Care Model and of effective chronic disease treatment and control. The medical management of children and youth with diabetes, along with screening schedule recommendations, will be also reviewed.*

Type 1 vs. Type 2 Diabetes

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Pathogenic processes in the development of diabetes range from autoimmune destruction of the beta cells of the pancreas with consequent insulin deficiency to abnormalities that result in resistance to insulin action.[1]

To diagnose diabetes mellitus, any of three criteria may be used:

1. Symptoms of diabetes plus casual plasma glucose concentration ≥200 mg/dL (11.1 mmol/L). Classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss
2. Fasting (no caloric intake for at least 8 hours) plasma glucose of ≥126 mg/dL (7.0 mmol/L)
3. 2-hour plasma glucose ≥126 mg/dL (11.1 mmol/L) during an oral glucose tolerance test (OGTT), which should be performed by using a glucose load that contains 1.75 gm/kg of anhydrous glucose dissolved in water[2]

The vast majority of patients with diabetes fall into two broad categories. In type 1 diabetes (T1DM), the cause is an absolute deficiency of insulin secretion due to pancreatic islet cell destruction. Individuals at increased risk of developing this type of diabetes can often be identified by serological evidence of an autoimmune pathologic process occurring in the pancreatic islets and by genetic markers. This group of patients is typically symptomatic at diagnosis and is prone to ketoacidosis. Most T1DM is characterized by the presence of islet cell, GAD, IA-2, IA- 2 beta, or insulin autoantibodies that serve as markers of the autoimmune pathologic process that leads to beta-cell destruction. In some, evidence of autoimmunity is absent and these are classified as type 1 idiopathic diabetes mellitus.[1] Type 2 diabetes (T2DM) is much more prevalent and is caused by a combination of resistance to insulin action and an inadequate compensatory insulin secretory response. This group of patients can be asymptomatic, even for several years, during which deficiencies in carbohydrate metabolism may be evident in the forms of impaired fasting glucose or impaired glucose tolerance.[1,3]

Screening for T1DM in the general population has little supporting evidence due to a lack of proven preventive therapies.[4] Evaluation for T1DM is recommended only in patients who have signs and symptoms of diabetes. By contrast, screening for T2DM is recommended in children and adolescents who are overweight (BMI >85th percentile for age and sex or weight >120% of ideal for height) plus any two of the following risk factors.[5]:

- Family history of type 2 diabetes in first or second-degree relative
- Race/ethnicity, e.g., Native American, African American, Latino, Asian American, and Pacific Islander
- Signs of insulin resistance or conditions associated with insulin resistance, e.g., acanthosis nigricans, hypertension, dyslipidemia, or PCOS
- Maternal history of diabetes or gestational diabetes

Age of initiation for screening is at 10 years or at onset of puberty, if puberty occurs at a younger age. Screening frequency should be every 2 years with the preferred test being fasting plasma glucose.[5] This is because there is evidence that detecting T2DM improves estimates of cardiovascular risk and may provide opportunity for earlier, more aggressive hypertension- and lipid-control to reduce cardiovascular events.

Obesity/Diabetes Among Children and Youth

During the past three decades, the number of children and youth (<18 years of age) diagnosed as being overweight has doubled.[6] As in adults, obesity is a major risk factor for the development of T2DM in children and youth. Current epidemiological data suggest an increase in T2DM in children and youth parallel with the rise in obesity.[7-10] The 1999–2002 National Health and Nutrition Examination Survey data indicate that 22.6% of 2- to 5-year-olds and 31% of 6- to 19-year-olds in the United States are "at risk for being overweight" as defined by a body mass index (BMI) between the 85th and 95th percentiles for age.[11] The prevalence of "overweight," defined as a BMI of ≥95th percentile for age, was 10.3% in 2- to 5-year-olds and 16% in 6- to 19-year-olds. In contrast, between 1988 and 1994, an average of 11.3%

Address Correspondence to: Joe M. Chehade, MD, University of Florida, 653-1 West 8th Street L-14, Jacksonville, FL 32209. Email: Joe.chehade@jax.ufl.edu.

of 6- to 11-year-olds and 10.5% of 12- to 19-year-olds were overweight.[12] T2DM had previously been thought to account for less than 5% of all childhood diabetes; however, recent case series suggest as many as 29% of all diagnoses of diabetes in youth are T2DM.[13] Epidemiologic data from NHANES 1999–2002 support these findings that 29% of the 0.5% of all adolescents' diagnosed diabetes probably had type 2.[14]

Challenges for Youth with Diabetes

Diabetes can have a profound effect on the quality of life for both those with the disease and their families.[15] The challenges of the transition to adulthood are especially complex for adolescents and emerging adults with diabetes. The disease imposes extensive behavioral demands on the patient, including consumption of a special diet, regular physical exercise, and for those on insulin, blood glucose monitoring, precisely scheduled daily insulin injections, recording of blood glucose test results, and management of hypoglycemia and hyperglycemia. In early adulthood, frequent changes in roles, lifestyles, living situations, educational routines, jobs, friendships and romantic relationships are common and can undermine the routines and the resolve needed to maintain metabolic control or follow specific diets or exercise programs.[16]

Furthermore, the developmental tasks of early adulthood may be at odds with maintaining intensive management of diabetes. For example, the tasks of establishing autonomy and prevailing egocentrism may be associated with the emerging adult not wanting to follow medical advice or the advice of his family.[17] Heightened concern for peer acceptance or the establishment of intimate relationships is characteristic of this period of development. Emerging adults may be reluctant to admit to their significant other that they have diabetes.[18] Moreover, the major cognitive developmental milestone during the stage of emerging adulthood is the ability to think abstractly. Those who have not accomplished this developmental milestone may struggle with taking responsibility to maintain good control or understand the consequences of poor control. While abstract thinking may allow the emerging adult to appreciate the need for better adherence to prevent future complications, it may also result in them feeling overwhelmed and depressed about their future. Lastly, increased rates of drinking, illicit drug use, or other high risk behaviors may disrupt the emerging adult's lifestyle and negatively impact diabetes self management.[18] An increase in these types of behaviors may also impact their personal adherence with health care appointments, laboratory studies, etc.[18]

Many adolescents with diabetes enter the transition to adulthood with a record of poor dietary and treatment compliance and poor attitudes toward the disease and its management.[19] Studies specifically of transition are few but show that young adults with diabetes are at very high risk for worsening control after leaving pediatric care. Wysocki, *et al*, surveyed 81 early adults ages 18-23 with Type 1 DM who had left a pediatric endocrinology specialty clinic, to determine their current access to adult primary and specialty medical services and their level of metabolic control.[19] They found that only 12% had transitioned to an adult endocrinologist and only 24% had good control. Bryden and colleagues followed 76 adolescents with T1DM and found that 54% had deterioration in their metabolic control during transition.[20] Similarly, a study in the UK found that 40% of young persons of transition age (ages 16-25), registered with a regional clinic for adults with T1DM, were not attending the clinic.[21]

In summary, the period of transition to adulthood appears to be one of vulnerability, especially for youth with diabetes. Adolescents prior to this transition may have their health and health care needs met by supportive families and a number of federal, state and school based programs that specifically target children and youth with diabetes. As these support systems are stripped away and the developmental challenges and life changes take on greater importance for the emerging adult, they are at significant risk for receiving inadequate health care services, experiencing deterioration in their diabetes management, and potentially setting them on a poor health trajectory of premature morbidity and mortality.

The Chronic Care Model

The Chronic Care Model provides an organizational approach of integrated care for people with chronic disease that is sufficiently robust to address both the health care system challenges during transition and the developmental needs of the emerging adult.[22] Wagner identified the following elements as the most critical to effective chronic disease management:

- Well-developed processes and incentives for making changes in the care delivery system
- Assure behaviorally sophisticated self-management support that gives priority to increasing patients' confidence and skills so that they can be the ultimate managers of their illness
- Reorganize team function and practice systems (e.g., appointments and follow-up) to meet the needs of chronically ill patients
- Develop and implement evidence-based guidelines and support those guidelines through provider education, reminders, and increase interaction between generalists and specialists
- Enhance information systems to facilitate the development of disease registries, tracking systems, and reminders and to give feedback on performance[22]

A number of studies have demonstrated that the Chronic Care Model (compared to regular primary care) can improve processes of care and health outcomes for persons with T1DM and T2DM.[23,24] A Cochrane review of the effectiveness of the Chronic Care Model for diabetes found that it enhanced health system-controlled processes of care (regular monitoring of HbA1c, blood pressure, etc.) and improved patient metabolic control of diabetes (lower HbA1c). [25] The review also found that the addition of patient-oriented, self-management support interventions can lead to improved patient health

outcomes. Wagner tested the Chronic Care Model in adults with diabetes and found that patients in the CCM group received significantly more preventative procedures (influenza vaccination, etc.), and reported better quality of life, less disability days and fewer emergency room visits.[25,26]

Promoting Self-Management/Type 1 Diabetes

Patient self management of chronic disease has increasingly been recognized as an essential component of the Chronic Care Model and of effective chronic disease treatment and control.[23,24,27,28] The psychosocial nature of behavioral self management has led to a variety of theory-based approaches to encourage, facilitate and reinforce adherence behaviors that are conducive to diabetes control, including Cognitive Behavioral interventions[29], Behavioral Family Systems therapy[30,31], Motivational Interviewing[32,33], and Empowerment and Goal Setting.[34]

As with self management and psychosocial factors, the person's stage of change has been demonstrated to impact diabetes outcomes such as HbA1c.[35] The stage of change has also been demonstrated to impact participation in prevention interventions[36], influence the impact of educational programs[37], and mediate readiness to adopt diabetes related healthful behaviors.[38]

It has become clear over several decades of psychological research on management of diabetes in adolescents, that it is most appropriate to consider the family as the unit of care.[39,40] Efficacy of diabetes management during adolescence has been shown to depend heavily on family communication and problem solving[41], effectiveness of parent-adolescent teamwork[42] and the degree to which adolescents assume diabetes management responsibilities in a manner that is appropriately balanced with their maturity and psychological capacity for autonomous self-care.[43] Further, adolescents with favorable psychological and behavioral adjustment to diabetes tend to achieve better glycemic control and lower risk of psychiatric and medical complications during early adulthood.[20] But, there have been no psychological or behavioral intervention studies targeting the emerging adult with T1DM and, given the emerging adults' increasing geographic and psychological autonomy from parents, and the special health systems changes that occur during this period, interventions limited to a focus on the family as the unit of intervention are perhaps less pertinent for this clinical population.

Self-management support for youth during late adolescence and early adulthood must be a youth-centered approach, encouraging the youth to exercise more independence in their diabetes self-management. Motivational interviewing (MI) is a set of techniques used to promote disease self-management that are readily adaptable to a brief intervention model, and adaptable to different developmental levels, life situations, and cultural beliefs. These can be delivered in the context of a primary care setting. The MI approach also takes into consideration the cultural background of the adolescent and allows for them to design goals that are appropriate, given their culture and heritage. Channon and colleagues in Wales[44] demonstrated that this approach for teens with diabetes, was effective at improving glycemic control, treatment adherence and psychological adjustment. All of this must be orchestrated while the youth and family are going though the specific challenges inherent in this stage of life, as described earlier.

Management of Youth with Diabetes

Diet and Weight Loss – Weight loss and/or prevention of weight gain are the foundation in preventing T2DM among children with risk factors for the disease.[45,46] Meal planning is also critical in T1DM, although weight loss may not be necessary. American children in most cases consume too many highly processed, high-fat, or sweetened foods and too little fruits and vegetables.[47] Physicians should encourage a healthier diet, eliminate calories from sweetened beverages[48] along with promoting increased physical activity and reduced sedentary lifestyle. Regardless of the lack of successful obesity-prevention and treatment programs, aggressive lifestyle modification is commonly recommended for all children who are at risk for becoming or are overweight.

Medical Treatment of Diabetes – While diet and exercise are important for the treatment of both T1DM and T2DM, medical management will be different for each type. With the rising incidence of T2DM among adolescent and young adults, a review of the available oral agents will be discussed briefly. As in adults, T2DM in children and adolescents results from both insulin resistance and relative pancreatic β-cell secretory failure, with some subjects presenting with symptomatic hyperglycemia. About one third of subjects actually present in ketoacidosis.

Presently, the initial medical treatment of children with T2DM depends on the severity of the clinical presentation. The success of lifestyle modification may be limited, but so are its risks.[50] Therefore, lifestyle changes are always indicated in patients with T2DM. Patients presenting with mild hyperglycemia (126–200 mg/dL) and A1C <8.5% or an incidental diagnosis of T2DM can be treated initially with therapeutic lifestyle changes in combination with metformin, the only drug approved by the Food and Drug Administration for pediatric patients with T2DM.[50] Metformin, a biguanide, decreases hepatic glucose production and to a lesser extent increases insulin-mediated glucose uptake in peripheral tissues, primarily muscle tissue.[49] Because metformin does not stimulate insulin secretion, hypoglycemia is uncommon with monotherapy, making it an attractive agent for use in children and adolescents.

Metformin gained approval for its use in pediatrics based on a randomized, double-blind, placebo-controlled trial that evaluated the efficacy and safety of the medication, at doses up to 1,000 mg twice daily in 82 children aged 10–16 years. The participants were treated up to 16 weeks. Metformin significantly improved glycemic control and HbA1c values with no cases of lactic acidosis and minimal side effects.[51] In persons with T2DM and more severe hyperglycemia (>200 mg/dL), A1C >8.5%, and/or ketosis, insulin should be the

initial treatment of choice to achieve metabolic control. Metformin is prescribed to nonketotic patients at a low dose (500 mg twice a day or 850 mg once a day, given with meals) and increased as tolerated (in increments of 500 or 850 mg every 2 weeks, up to a total of 2000 mg per day).[50] Metformin is associated with disturbances in the gastrointestinal tract and, on rare occasions, with lactic acidosis. A modest amount of weight loss is a desirable side effect. Metformin is contra-indicated in a youth with T2DM and ketosis, due to the risk of precipitating lactic acidosis. It should be started, however, once the youth recovers from ketosis after treatment with rehydration and insulin. In the pediatric population, insulin should be added whenever glucose control cannot be achieved after 3 to 6 months of metformin therapy. [50]

There are no other oral hypoglycemic agents that have been approved for use in the pediatric population; however glimeperide, a sulfonylurea, and rosiglitazone, an insulin sensitizer, were both evaluated in juvenile-onset T2DM. Sulfonylureas (glimeperide, glyburide, and glipizide [second-generation agents]) and meglitinides (repaglinide and nateglinide) are insulin secretagogues that exert their effect by enhancing insulin secretion from β-cells.[49] Sulfonylureas are associated with hypoglycemia and weight gain which can be particularly troublesome for children and adolescents. In a single-blind, 26-week study comparing metformin to glimepiride in 263 obese youth with T2DM, the HbA1c reduction was not significant between the two groups. However, there was a difference in weight gain.[52] The thiazolidinediones or "TZD" (rosiglitazone and pioglitazone) enhance insulin sensitivity in liver, muscles and adipose tissue through a selective activation of peroxisome proliferator-activated receptor δ (PPARδ), a nuclear receptor that plays an important role in adipogenesis. TZDs are usually well tolerated and when used in monotherapy, there is no associated risk of hypoglycemia. Peripheral edema is occasionally seen, mainly as a result of the plasma volume expansion. Therefore, these agents are not recommended in patients with New York Heart Association (NYHA) Class III or IV congestive heart failure. A minor decrease in hematocrit and hemoglobin is another observation and this correlates with the dilutional effect of fluid retention.

The Rosiglitazone study included 195 obese T2DM children (age range 8–17 years), in a 24-week double-blind, randomized, metformin-controlled, parallel group design. Median reductions in HbA1c from baseline (rosiglitazone group: –0.25%, p = 0.027; metformin group: –0.55%, p = 0.0001) and from screening (rosiglitazone group: –0.5%, p = 0.011; metformin group: –0.5%, p = 0.0037) to week 24 were statistically significant in both groups. Differences between the two treatment groups were not statistically significant. The rosiglitazone group gained 3 kg at 24 weeks, with the occurrence of peripheral edema in one child.[53]

Insulin Therapy and Monitoring – Insulin is considered to be the most effective in lowering blood glucose in T2DM and the only therapy for T1DM. Over the last two decades, insulin analogs, insulin pens, insulin pumps and home blood glucose monitoring have made diabetes management much easier and less problematic. Yet, insulin is still used by many clinicians as a "therapy of last resort" for T2DM. Endogenous insulin production involves two components: basal insulin secretion to suppress hepatic glucose production overnight and during fasting, as well as postprandial bursts to cover glucose intake at mealtimes. An ideal insulin regimen is the one that mimics the normal physiology by using a basal bolus regimen. Such a regimen usually requires patients to use four injections daily.

For those with great reluctance to multiple insulin injections, a premixed formulations of long-acting and short-acting insulin administered twice daily is an alternative, though used much less commonly. In the latter regimen, the fixed ratio of long and short acting insulin may be too difficult to titrate and is usually not consistent with normal three meals per day schedules. The long acting analogs are associated with lower incidence of nocturnal hypoglycemia. The rapid acting analogs are associated with less sustained action between meals and, therefore, a lower incidence of hypoglycemia. Although multiple algorithms are available to help guide clinicians to start insulin therapy, tailoring the regimen to the patient blood glucose profiles is indisputably a rational strategy.[54] The insulin regimen should afterward be customized on the basis of the individual's response to therapy.[54]

The optimal frequency of self blood glucose monitoring should be determined on an individual basis. The American Diabetes Association (ADA) recommends self-monitoring of blood glucose ≥3 times daily for patients with T1DM. While no specific frequency of testing has been recommended for those with T2DM, fasting and 1-2 hours postprandial checks once to twice daily if A1C >7 or less frequently if fasting within target and A1C <7 seems to be an appropriate and practical reference.

Using continuous glucose monitoring devices (CGM) in clinical practice has allowed clinicians to make several observations about the practical use of these devices. Most patients believe that the device works well and provides glucose information that helps them to alter diet/lifestyle and make better insulin treatment decisions. Patients who use sensors must be properly educated about the interpretation of interstitial glucose readings. Devices that are currently approved by the FDA appear to be safe and accurate although there are limitations in some patients with significant differences between the glucometer and the sensor readings. Future short and long term accuracy and clinical studies are essential to further evaluate sensors use in patients with T1DM and T2DM.

A Team Approach

Ideally, the care of adolescents with diabetes is shared among an endocrinologist, a primary care provider, diabetes nurse educator, nutritionist, physical-activity leader, and behavioral specialist or social worker. Such specialty teams are successful in optimizing therapy and promoting behavioral change. More importantly, careful involvement by family members is essential for children to reach therapeutic goals.

Screening Schedule Recommendations

Ophthalmology: Ask about changes in acuity, central visual loss, and eye pain at each visit. Perform formal eye exam in all patients at least annually and each visit if visual abnormalities are present. Obtain an ophthalmology consult for a dilated eye exam in patients with a 5-year history of type 1 diabetes and annually thereafter to reduce the risk of visual loss from diabetic retinopathy.[4,5]

Cardiac: Ask about diet, smoking, and cardiac events in family members. Need blood pressure determination and careful exam of heart and peripheral pulses at each visit. Fasting lipids should be done annually. Adjust antihypertensive and lipid-lowering medications to achieve target levels. Baseline electrocardiogram and other cardiovascular testing may be done as needed. Obtain cardiac stress testing in patients with typical/atypical cardiac symptoms and an abnormal resting ECG. Consider screening cardiac stress test in those with a history of peripheral or carotid occlusive diseases and in those with a sedentary lifestyle, age >35 years, who plan to begin a vigorous exercise program.[4,5]

Renal: Urinalysis, serum electrolytes, BUN, creatinine, and studies for microalbuminuria (if dipstick negative for protein) should be done at least annually. Assure adherence with ACE inhibitors for nephropathy. Refer patients with active urine sediment or nephrotic-range proteinuria to a nephrologist for advice about adjusting pharmacologic therapy and options about replacement therapy (dialysis and renal transplantations) when required.[4]

Neurologic: Ask about burning, numbness or tingling of extremities at least annually and each visit if neuropathy present. Neurologic exam and monofilament testing of the feet should be done at least annually or as needed. Patients with neuropathy should have a visual inspection of their skin at every health care contact. Institute or adjust medications for neuropathic symptoms.[4]

Immunizations: Since the guidelines are extensive, readers are advised to review recommendations for specific age groups which are electronically updated and maintained current by the CDC.[55-58]

Summary: Pediatric to Adult Care

The unique needs of emerging adults with diabetes pose a challenge to both pediatric and adult care systems, as these individuals fall outside the focus of the neatly divided pediatric and adult tracks.[59] The ADA guidelines make no mention of the special needs of young adults with diabetes or of the need to consider behavioral and developmental issues in their evaluation and treatment. The issue of transitioning adolescents and emerging adults to an adult care program is a concern for clinicians and researchers from a variety of medical subspecialties. Families who have already experienced this period of transition have expressed concerns about poor communication between families and providers. Adolescents themselves reported that they did not receive sufficient information about transition issues[59], and they worry about leaving their familiar health care team for an unfamiliar medical provider.

Patients perceived huge differences between pediatric and adult programs, with pediatric models being family centered, more informal, and socially oriented. Adult programs were perceived as more formal, with an emphasis on the risks of long-term complications. Teens seem to prefer programs that are more developmentally sensitive to their unique needs.[55] The current literature suggests that the evidence base used to guide the clinical care of the young adult with diabetes is limited, although clinical guidelines do exist regarding transition issues for this population. In their recent review, Weissberg-Benchell et al [59] propose a set of recommendations to help both pediatric and adult providers care for the transition needs of this susceptible population. They are:

- Facilitate family and social supports for daily diabetes care tasks
- Assess for disordered eating, alcohol and/or drug history
- Assess for history of mental health services
- Develop "transition" clinic days, where pediatric and adult providers meet patients and their families at the same time
- Develop ongoing educational programs for providers regarding transition issues
- Hire a "transition coordinator" to help facilitate this

In addition, develop telephone and e-mail contact with young adults to facilitate transition plans. Develop a web site or newsletter that provides information regarding access to services and funding. Collaborate with patients and their families to develop an individualized written transition plan two years prior to the expected transition date. This should include an assessment of the patient's knowledge and skills, information regarding adult care providers and how to access those services, and information regarding access to funding/insurance coverage after age 18 years.[59]

References

1. Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care*; 2003:S5-20.
2. Genuth S, Alberti KG, Bennett P, et al. Follow-up report on the diagnosis of diabetes mellitus. *Diabetes Care* 2003;26(11):3160-7.
3. Harris MI, Klein R, Welborn TA, Knuiman MW. Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis. *Diabetes Care* 1992;15(7):815-9.
4. Diabetes Mellitus, Type 1. The American College of Physicians, 2008. (Accessed September 2008 at http://pier.acponline.org/physicians/diseases/d257/pdf/d257.pdf.)
5. Standards of Medical Care in Diabetes 2008. *Diabetes Care*, Vol 31, Supplement 1, January 2008.
6. Rocchini AP. Childhood obesity and a diabetes epidemic. *N Engl J Med.* 2002;346:854–855
7. Type 2 diabetes in children and adolescents. American Diabetes Association. *Pediatrics* 2000;105:671-80.
8. Fagot-Campagna A, Pettitt DJ, Engelgau MM *et al*. Type 2 diabetes among North American children and adolescents: an epidemiologic review and a public health perspective. *J Pediatr* 2000;136:664-72.
9. Rosenbloom AL, Joe JR, Young RS, Winter WE. Emerging epidemic of type 2 diabetes in youth. *Diabetes Care* 1999;22:345-54.

10. Libman I, Arslanian SA. Type II diabetes mellitus: no longer just adults. *Pediatr Ann* 1999;28:589-93.

11. Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. *JAMA.* 2004;291:2847–2850.

12. Troiano RP, Flegal KM. Overweight prevalence among youth in the United States: why so many different numbers? *Int J Obes Relat Metab Disord.* 1999;23(suppl 2):S22–S27.

13. Acton KJ, Rios Burrows N, Moore K, Querec L, Geiss LS, Engelgau MM. Trends in Diabetes Prevalence Among American Indian and Alaska Native Children, Adolescents, and Young Adults. *Am J Public Health* 2002;92:1485-90.

14. Duncan GE. Prevalence of diabetes and impaired fasting glucose levels among US adolescents: National Health and Nutrition Examination Survey, 1999-2002. *Arch Pediatr Adolesc Med* 2006; 160:523-8.

15. Edgar KA, Skinner TC. Illness representations and coping as predictors of emotional well-being in adolescents with type 1 diabetes. *J Pediatr Psychol*. 2003 Oct-Nov;28(7):485-93.

16. Anderson BJ, Wolpert HA. A developmental perspective on the challenges of diabetes education and care during the young adult period. *Patient Educ Couns.* 2004 Jun;53(3):347-52.

17. Masten AS, Coatsworth JD, Neemann J, Gest SD, Tellegen A, Garmezy N. The structure and coherence of competence from childhood through adolescence. *Child Dev.* 1995 Dec;66(6):1635-59.

18. Madsen SD, Roisman GI, Collins WA. The intersection of adolescent development and intensive intervention: age-related psychosocial correlates of treatment regimens in the diabetes control and complication trial. *J Pediatr Psychol.* 2002 Jul-Aug;27(5):451-9.

19. Wysocki T, Hough BS, Ward KM, Green LB. Diabetes mellitus in the transition to adulthood: adjustment, self-care, and health status. *J Dev Behav Pediatr.* 1992 Jun;13(3):194-201.

20. Bryden KS, Peveler RC, Stein A, Neil A, Mayou RA, Dunger DB. Clinical and psychological course of diabetes from adolescence to young adulthood: a longitudinal cohort study. *Diabetes Care*. 2001 Sep;24(9):1536-40.

21. Kipps S, Bahu T, Ong K, Ackland FM, Brown RS, Fox CT, Griffin NK, Knight AH, Mann NP, Neil HA, Simpson H, Edge JA, Dunger DB.Current methods of transfer of young people with Type 1 diabetes to adult services. *Diabet Med.* 2002 Aug;19(8):649-54.

22. Wagner EH. Chronic disease management: what will it take to improve care for chronic illness? *Eff Clin Pract*. 1998 Aug-Sep;1(1):2-4.

23. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. *JAMA*. 2002 Oct 16;288(15):1909-14.

24. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. *JAMA.* 2002 Oct 9;288(14):1775-9.

25. Renders CM, Valk GD, Griffin SJ, Wagner EH, Eijk Van JT, Assendelft WJ. Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. *Diabetes Care*. 2001 Oct;24(10):1821-33.

26. Renders CM, Valk GD, Griffin S, Wagner EH, Eijk JT, Assendelft WJ. Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings. *Cochrane Database Syst Rev. 2*001(1):CD001481.

27. Lorig KR, Holman H. Self-management education: history, definition, outcomes, and mechanisms. *Ann Behav Med*. 2003 Aug;26(1):1-7.

28. Sturt J, Hearnshaw H, Farmer A, Dale J, Eldridge S. The Diabetes Manual trial protocol - a cluster randomized controlled trial of a self-management intervention for type 2 diabetes [ISRCTN06315411]. BMC *Fam Pract.* 2006 Jul 17;7:45.

29. Hains AA, Davies WH, Parton E, Silverman AH. Brief report: a cognitive behavioral intervention for distressed adolescents with type I diabetes. *J Pediatr Psychol*. 2001 Jan-Feb;26(1):61-6.

30. Wysocki T, Harris MA, Buckloh LM, Mertlich D, Lochrie AS, Mauras N, White NH. Randomized trial of behavioral family systems therapy for diabetes: maintenance of effects on diabetes outcomes in adolescents. *Diabetes Care*. 2007 Mar;30(3):555-60.

31. Wysocki T, Harris MA, Buckloh LM, Mertlich D, Lochrie AS, Taylor A, Sadler M, Mauras N, White NH. Effects of behavioral family systems therapy for diabetes on adolescents' family relationships, treatment adherence, and metabolic control. *J Pediatr Psychol*. 2006 Oct;31(9):928-38. Epub 2006 Jan 9.

32. Channon SJ, Huws-Thomas MV, Rollnick S, Hood K, Cannings-John RL, Rogers C, Gregory JW. A multicenter randomized controlled trial of motivational interviewing in teenagers with diabetes. *Diabetes Care*. 2007 Jun;30(6):1390-5.

33. Channon S, Smith VJ, Gregory JW. A pilot study of motivational interviewing in adolescents with diabetes. *Arch Dis Child*. 2003 Aug;88(8):680-3. **:**

34. Langford AT, Sawyer DR, Gioimo S, Brownson CA, O'Toole ML. Patient-centered goal setting as a tool to improve diabetes self-management. *Diabetes Educ*. 2007 Jun;33 Suppl 6:139S-144S.

35. Peterson KA, Hughes M. Readiness to change and clinical success in a diabetes educational program. *J Am Board Fam Pract*. 2002 Jul-Aug;15(4):266-71 **:**

36. Helitzer DL, Peterson AB, Sanders M, Thompson J. Relationship of stages of change to attendance in a diabetes prevention program. *Am J Health Promot.* 2007 Jul-Aug;21(6):517-20.

37. Parchman ML, Arambula-Solomon TG, Noël PH, Larme AC, Pugh JA. Stage of change advancement for diabetes self-management behaviors and glucose control. *Diabetes Educ*. 2003 Jan-Feb;29(1):128-34.

38. Vallis M, Ruggiero L, Greene G, Jones H, Zinman B, Rossi S, Edwards L, Rossi JS, Prochaska JO. Stages of change for healthy eating in diabetes: relation to demographic, eating-related, health care utilization, and psychosocial factors. *Diabetes Care*. 2003 May;26(5):1468-74.

39. Wysocki T, Harris MA, Greco P, Harvey LM, McDonell K, Danda CL, Bubb J, White NH. Social validity of support group and behavior therapy interventions for families of adolescents with insulin-dependent diabetes mellitus. *J Pediatr Psychol.* 1997 Oct;22(5):635-49.

40. Wysocki T, Buckloh LM, Lochrie AS, Antal H. The psychologic context of pediatric diabetes. *Pediatr Clin North Am*. 2005 Dec;52(6):1755-78.

41. Miller-Johnson S, Emery RE, Marvin RS, Clarke W, Lovinger R, Martin M. Parent-child relationships and the management of insulin-dependent diabetes mellitus. *J Consult Clin Psychol.*1994 Jun;62(3):603-10.

42. Anderson BJ, Brackett J, Ho J, Laffel LM.An office-based intervention to maintain parent-adolescent teamwork in diabetes management. Impact on parent involvement, family conflict, and subsequent glycemic control. *Diabetes Care*. 1999 May;22(5):713-21.

43. Wysocki T, Taylor A, Hough BS, Linscheid TR, Yeates KO,

Naglieri JA. Deviation from developmentally appropriate self-care autonomy. Association with diabetes outcomes. *Diabetes Care*. 1996 Feb;19(2):119-25.

44. Channon SJ, Huws-Thomas MV, Rollnick S, Hood K, Cannings-John RL, Rogers C, Gregory JW. A multicenter randomized controlled trial of motivational interviewing in teenagers with diabetes. *Diabetes Care*. 2007 Jun;30(6):1390-5.
45. Barlow SE, Dietz WH. Obesity evaluation and treatment: expert committee recommendations. *Pediatrics.* 1998;102(3).
46. Krebs NF, Jacobson MS. Prevention of pediatric overweight and obesity. *Pediatrics.* 2003;112:424–430. 49.
47. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics.* 1998;101(3 pt 2):539–549.
48. Fisher EA, Van Horn L, McGill HC Jr. Nutrition and children. A statement for healthcare professionals from the Nutrition Committee, American Heart Association. *Circulation*. 1997;95:2332–2333.
49. Chehade JM, Mooradian AD. A Rational Approach to Drug Therapy of Type 2 Diabetes Mellitus. *Drugs.* 2000; 60(1):95-113.
50. Hannon TS, Rao G and Arslanian SA. Childhood Obesity and Type 2 Diabetes Mellitus. *Pediatrics* 2005;116;473-480.
51. Jones K, Arslanian S, Peterokova VA, Park JS, Tomlinson MJ: Effect of metformin in pediatric patients with type 2 diabetes: a randomized controlled trial. *Diabetes Care* 2002; 25: 89–94.
52. Gottschalk M, Danne T, Cara J, Vlajinic A, Issa M: Glimepiride vs. metformin a monotherapy in pediatric subjects with T2DM: a single-blind comparison study (abstract). *Pediatr Diabetes* 2005; 6:SP18.
53. Dabiri G, Jones K, Krebs J, Sun Y, Mudd P, Weston W, Cobitz A, Freed M, Porter LE: Benefits of rosiglitazone in children with T2DM (abstract). *Diabetes* 2005;A457**.**
54. Mooradian AD, Bernbaum M, Albert SG. Narrative review: a rational approach to starting insulin therapy. *Ann Intern Med.* 2006 Jul 18;145(2):125-34.
55. Recommended Immunization Schedule for Persons Aged 0–6 Years. CDC, 2007. (Accessed August 1, 2008, at http://www.cdc.gov/vaccines/recs/schedules/downloads/child/2007/child-schedule-color-print.pdf.)
56. Recommended Immunization Schedule for Persons Aged 7–18 Years. CDC, 2007. (Accessed August 1, 2008, at http://www.cdc.gov/vaccines/recs/schedules/downloads/child/2007/child-schedule-color-print.pdf.)
57. Recommended adult immunization schedule: United States, October 2007-September 2008. *Ann Intern Med* 2007;147(10):725-9.
58. Recommended Adult Immunization Schedule—United States, October 2007–September 2008. *MMWR*, 2008. (Accessed August 1, 2008, at http://www.cdc.gov/mmwr/pdf/wk/mm5641-Immunization.pdf.)
59. Weissberg-Benchell J, Wolpert H, Anderson BJ. Transitioning from pediatric to adult care: a new approach to the post-adolescent young person with type 1 diabetes. *Diabetes Care*. 2007 Oct;30(10):2441-6.