Trials and tribulations of childhood type 2 diabetes mellitus

Tanusha Nathan, MMed (Fam Med)[1], Leelavathi Muthupalaniappen, MMed (Fam Med)[2], Ravena Raj Menon[3], Chong Wei Wen, PhD[4]

[1]Klinik Kesihatan Bandar Sungai Petani, Sungai Petani, Kedah, Malaysia, [2]Department of Family Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia, [3]Jeffrey Cheah School of Medicine & Health Sciences, Monash University Malaysia, Subang Jaya, Selangor, Malaysia, [4]Centre of Quality Management of Medicine, Faculty of Pharmacy, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

SUMMARY

Type 2 Diabetes Mellitus (T2DM) is a common condition among adults. However, increasing rates of childhood obesity has led to a rise in this condition among children worldwide. Children with T2DM develop comorbidities and complications similar to adults, resulting in increased morbidity. Managing T2DM among children requires good family support along with the involvement of a multidisciplinary team to ensure optimal glycaemic control and minimal complications. This case describes the diagnosis and management of a 12-year-old girl with T2DM using Family-Centred Care (FCC) approach, pharmacological treatment and supportive care from a multidisciplinary team consisting of a family physician, dietician, pharmacist and physiotherapist. Key elements of care in managing this lifelong condition in a child is by using a coordinated approach of lifestyle modification, family support and medication based on the latest evidence. A summary of the recent management guideline for T2DM in children is also provided.

INTRODUCTION

More than 41 thousand children and adolescents under the age of 20 years are estimated to have T2DM worldwide.[1] In Malaysia, the prevalence of T2DM among children and adolescents under the age of 20 years is about 17.5%.[2] It usually occurs in obese children at puberty, when they may be asymptomatic or present with metabolic symptoms.[3] T2DM among children is aggressive and associated with rapidly progressive pancreatic beta cell destruction and early development of complications.[4,5] Hence identification of this condition and its appropriate management is essential to ensure that these children reach adulthood with minimal complications. This case illustrates how an obese child was diagnosed with T2DM and the challenges faced by the medical team and her family in her management. Recent update on the management and follow-up care of T2DM among children and adolescents is also summarised.

CASE REPORT

A 12-year-old girl was noted to have a body mass index (BMI) of 44.3 by the school health team and was referred for further evaluation at the nearest health clinic. She had symptoms of polyphagia, polydipsia and polyuria for two months. Both her parents were healthy, and her mother did not have gestational diabetes during pregnancy. Her birth weight was 3.7 kg, she had normal developmental milestones and average academic performance. She had a sedentary lifestyle as she was not involved in any co-curricular activities or sports at school and spent about two hours a day on digital devices and television. She attained menarche at the age of ten and her menstrual cycle was regular. Her four younger siblings were all healthy and had normal BMIs.

Clinically, she did not have any dysmorphic features. Her weight was 107.7 kg, height was 156 cm and BMI was 44.3, which was more than the 95th centile for her age. Her blood pressure was 135/80 mm Hg. Physical examination showed the presence of acanthosis nigricans on her neck. Secondary sexual characteristics development was at Tanner stage V. No other abnormalities were noted. She was diagnosed to have obesity, and baseline blood investigations were done. Blood investigations showed a high fasting blood sugar of 15.1 mmol/L and HbA1c of 11.5%. She had dyslipidemia with a triglyceride (TG) level of 2.2 mmol/L, low density lipoprotein (LDL) of 3.2 mmol/L, high density lipoprotein (HDL) of 1.1 mmol/L and total cholesterol (TC) of 7.0 mmol/L. Liver, renal and thyroid function tests were all normal.

Both parents and the patient were were informed of the diagnosis of T2DM and that she needed medication. At first, they could not accept the diagnosis as they perceived that T2DM was a disease of older people and could not occur in children. Hence, the initial management was to educate them regarding diabetes. However, even after receiving relevant information, they refused medication mainly because of the misperception that their daughter would become dependent on the medication for life. Although they were given explanation that the drug does not cause dependence but that it will be required for a long time as it helps to normalise blood sugar level and prevent complications but, they were not keen for any medication. Exploring the patient's perception of her diagnosis revealed that she too felt that she did not have any disease as she felt well and refused medication. It took many encounters with the multidisciplinary team members and after much

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Corresponding Author: Leelavathi Muthupalaniappen
Email: drleelaraj@gmail.com

explanation regarding T2DM and counselling to help them understand the nature of this condition, both the patient and her parents were open for the first step of intervention. After understanding about the relationship between obesity and diabetes, they were keen to try lifestyle modification but still refused medication. After a few months of trial of lifestyle modification with diet, active lifestyle and exercise, her blood glucose level remained high. Parents were still not keen to start medication but agreed to meet a paediatrician for a second opinion and further assessment. She was referred to a paediatrician at the nearest tertiary hospital where she was assessed and was advised to start Metformin 500 mg twice daily. The patient and her parents agreed for metformin trial. After a few months of treatment with metformin while continuing lifestyle changes, her HbA1c level reduced to 9.5%. Since her glycaemic control was not optimal, she was advised for basal insulin, but her parents refused insulin and requested to be referred back to primary care.

At primary care, her medication and follow up care plan was continued using the Family Centred Care (FCC) approach by a multidisciplinary team consisting of a family physician, dietician, pharmacist and physiotherapist. FCC is a partnership approach between the family and the health care provider for a collaborative health care related decision making to provide optimal health and wellbeing of children. The multidisciplinary team members meet the patient with her mother, who was her main caregiver, once a month. Initially the dietician assessed the diet history, previous measures used to prevent weight gain and their obstacles. Her current food intake was noted to be high in portion and in calories. She liked to snack on junk food such as potato chips and sweet cakes which were bought either from the stores by her parents or self-purchased by the patient from the school canteen. They were also assessed on their understanding of the concept of calorie content of food, their motivation and readiness to prevent weight gain and to lose weight. On the subsequent monthly visits, they were given simple methods to count calories for common food items. They were also given advice, which was tailored to the patients' needs. For example, to be able to reduce junk food consumption, parents were advised to stop buying snacks and replace it with fresh fruits of her choice like apples, grapes or carrot bites. Her mother was encouraged to pack simple homemade healthy food for school and given simple advice on how to prepare meals so that the whole family consumed healthy food. The family was suggested to eat the same healthy food together during mealtimes so that the patient did not feel alone in facing her disease and knew that the family supports her.

During the same monthly sessions, the pharmacist and the family physician would check on her glycaemic control. Since her blood sugar level remained high, counselling sessions were given, and parents were requested to consider insulin. Initially the patient and her parents refused insulin but when there was no further improvement of the serial HbA1c levels after eight months, they agreed to try insulin. She was started with subcutaneous Insulatard 10U injections at night before bedtime and gradually titrated up based on the Self-Monitoring of Blood Glucose (SMBG) levels. The patient and her mother were taught how to use the insulin injection (Novopen) and to monitor blood glucose levels using a glucometer. Glucometer was lent to them by the pharmacy and only the needle and test strips were purchased by the family. Initially, her mother administered the insulin injections. A few months later, the patient became more confident and wanted a more active role in her treatment and started taking the insulin injections herself.

The patient and her mother also met the physiotherapist on these visits where they were taught to do simple sets of exercises which could be done at home twice a week. The family was encouraged to do physical activities together for example walking or cycling a few times a week. Patient liked cycling, so she started cycling in a field near her house two or three times a week. Mother and daughter also were motivated to attend the group aerobic exercise sessions organised by the physiotherapy team on every Thursday evening, at the open space in front of the clinic.

Although the multidisciplinary team managed to achieve some of the targets of treatment through a holistic approach, they faced multiple challenges. Initial challenge for the team was to convince the parents and the patient that metformin was required and later insulin. Achieving glycaemic targets was also difficult as blood sugar levels were constantly fluctuating due to multiple issues especially related to compliance to dietary restrictions and medications. Other challenges faced by the team was the frequent non-attendance which was because the appointments overlapped with school activities and the patient was not keen to miss school. Non-adherence to dietary advice and medication was also an issue. This was addressed by using the reward method where the patient was allowed small food rewards when a milestone in weight management was achieved to encourage and motivate her to continue adherence to a healthy diet. Motivational interview sessions also brought about some changes in the patient's attitude. From the parent's perspective, one of the main challenges they faced was that they found it difficult to cope with the multiple appointments at the clinic and the amount of dedication required to manage their child's health. Sometimes the patient's mother had other commitments and could not accompany her daughter for the scheduled appointments. In these situations, her appointment was rescheduled to a different date which was convenient for parents and the team members.

DISCUSSION

The rising number of children and adolescents with T2DM over the years has been attributed to the increase in obesity, sedentary lifestyle and intrauterine exposure to hyperglycemia. The onset of T2DM among children usually occurs at puberty and tends to be more common among females, those with a family history of diabetes and the low socioeconomic group.[4] T2DM among children is of concern as it progresses quickly due to more severe insulin resistance and rapid deterioration of pancreatic beta cells. T2DM complications such as retinopathy, nephropathy and neuropathy also tend to occur earlier, and progress more rapidly compared to type 1 diabetes (T1D).[4] Hence it is important to detect T2DM early, as diagnosis may be missed or delayed as children may not be perceived as being at risk. The first step is to make the diagnosis of T2DM among children. Most guidelines suggest that for children, a fasting

blood glucose of ≥ 7.0 mmol/L or a random blood glucose of ≥ 11.1 mmol/L with symptoms such as polyuria, polydipsia and unintentional weight loss, in the absence of islet autoantibodies, can be used to diagnose T2DM. Other parameters such as HbA1C level ≥ 6.5% or a 2-hour post-oral glucose tolerance test (OGTT) of ≥11.1 mmol/L (1.75 g of glucose per kg body weight) may also be used. T2DM in adolescents may be misdiagnosed as T1D, especially if the child is not obese or when ketoacidosis is detected at presentation, suggesting caution in interpreting these results.[3,4] Once T2DM is suspected, pancreatic autoantibodies should be done to exclude autoimmune T1D. Differentiating these two conditions is important as the management approach, treatment and outcome is different for each condition.[5] As for our patient, the diagnosis of T2DM was straight forward as she had symptoms of polyphagia, polydipsia, polyuria and hyperglycemia with fasting blood sugar of 15.1 mmol/L and HbA1c of 11.5%. To facilitate early detection, the American Diabetes Association (ADA) recommends that overweight (BMI > 85th percentile) or obese (BMI > 95th percentile) Asian children and adolescents at the age of 10 years and above or at puberty presenting with one or more of the following risk factors should be screened for T2DM:[3,5]

- 1st or 2nd degree family history of diabetes
- Maternal diabetes or gestational diabetes during the pregnancy with the child
- Signs of insulin resistance (e.g., acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome or small for gestational age birth weight)
- If the child is currently on atypical antipsychotic agents which can cause weight gain

Our patient fulfilled the criteria for screening as she was above 10 years of age, obese with BMI more than 95th centile for her age and had acanthosis nigricans on her neck. ADA also recommends that if the initial screening of high-risk children is normal, it should be repeated every three years. High risk patients with increasing BMI and a strong family history of T2DM should be screened annually.[5]

Management of adolescents with T2DM requires a comprehensive multidisciplinary approach including the family, paediatric endocrinologist, family medicine specialist, dietician, diabetic nurse educator and psychologist. The management triad includes lifestyle modification, pharmacological intervention and management of comorbidities.[5] This can be done by using the FCC approach as demonstrated in the management of our patient. The rationale for involving the family is based on the fact that children will not be able to manage their disease independently and they will need their family as they can provide the best support and care for them. This approach also facilitates bonding between the child and their family to foster a positive outcome. This approach involves sharing of information and involving the family in the care of the child by providing knowledge and skills to empower them to incorporate these skills in managing their child at home. Involving the family in the child's care is also important for decision-making processes regarding medication, implementing lifestyle changes and to ensure that the child received adequate support for this chronic condition.[6] For our patient, the FCC was established based on the partnership between the family, the patient and a multidisciplinary team of health care providers consisting of a family physician, dietician, pharmacist and physiotherapist. The objectives of this approach were to manage her holistically to achieve good glycaemic control, prevent further weight gain and to prevent diabetic related complications. This was achieved through multiple meetings with the patient and her mother who was the main caregiver.

An important aspect of T2DM management in obese children is to strike a balance between achieving and maintaining ideal body weight without compromising on linear growth and development as these children are still growing.[3] In general, obese children with T2DM are encouraged to reduce about 7 to 10% of the excess body weight.[5] Diet and weight related intervention should involve the family as they greatly influence children's food intake. Healthy eating habits include limiting portion size, eating low sugar and calories. For our patient, she managed to lose 8 kgs over 18 months by gradual change in dietary intake and increasing physical activity. She also managed to reduce screen time which gave her more time to have good quality sleep. Achieving regular and good quality sleep of about 8 to 11 hours a day, regular physical activities and reducing screen time entertainment of less than two hours a day plays an important role in lifestyle modification.[3,5]

Although there was a strong indication for starting pharmacological management for our patient at presentation as she had high blood sugar levels, parents had refused medical management. Hence the team had to tailor plans to the needs of the patient using a shared care approach with lifestyle modification as a first step in management. Current guidelines recommend that oral metformin, which is the drug of choice for children with T2DM, should be initiated at the point of diagnosis with concomitant lifestyle modifications. Metformin 500 mg daily can be initiated and titrated over 3 to 4 weeks to a maximum of 1 g twice daily.[3,4,5] Short-term basal insulin (intermediate or long acting) may be required if:

- Random blood sugar is ≥ 13.9 mmol/ L
- HbA1C level is >8.5%
- Glycaemic control is poor with 3 to 4 months of metformin monotherapy

Basal insulin dosage of 0.25 to up to 0.5 U/kg/day dose can be given and increased every two to three days guided by self-monitoring of blood glucose (SMBG). If target HbA1C of < 7% is not achieved with metformin and maximum basal insulin of 1.5 U/kg/day, then fast-acting prandial insulin may be added. Once target blood sugars are achieved, insulin may be reduced by 10 to 30% every few days over 2 to 6 weeks and stopped but maintenance therapy with lifestyle modification and metformin must be continued. The aim is to achieve fasting blood glucose levels between 4 to 6 mmol/L, post-meal between 4 to 8 mmol/L and three monthly HbA1C between < 6.5 to < 7% without inducing hypoglycemia. [3,5] However this is an uphill task to achieve and may take a long time with much commitment from the patient, the family and the multidisciplinary team members. This is compounded by the fact that puberty itself can affect blood

glucose control due to hormonal changes. For example, the increase in cortisol and catecholamines raises blood glucose levels. Rapid weight gain during puberty of both lean body mass and adipose tissue increases insulin demand and deteriorates blood glucose level further.[7] For our patient, intermediate acting insulin was started at 10 units and gradually increased by two units every two weeks and monitored closely. The patient and her mother attended diabetes self-management education (DSME) sessions conducted by the diabetic nurse educator at primary care for tips on selfcare. Each time the insulin dose was adjusted, the patient was seen on two weekly basis by the diabetic nurse educator to evaluate the glycaemic control and assess for hypoglycemia.

New diabetic medication, such as the Glucagon-Like Peptide-1 (GLP-1) receptor agonists (e.g., liraglutide) is now approved for children between 12 to 17 years with a body weight of ≥ 60 kg.[3] However, the use of this drug is best done in collaboration with the paediatric endocrinologist at a tertiary facility for close monitoring and dose adjustment.

Other aspects of the management of children with T2DM include screening and managing comorbidities in such as hypertension and dyslipidemia. [3,4,5] Our patient had mildly elevated blood pressure and lipid levels hence, we proceeded with non-pharmacological management to lose weight, in anticipation that these parameters would normalise with this intervention. Initial blood pressure management should be advocated by salt restriction and weight loss, failing which, an angiotensin-converting enzyme inhibitor (ACEI) or an angiotensin receptor blocker (ARB) may be used. The targeted blood pressure is <90th percentile or blood pressure < 130/80 mm Hg.[3,5] Statins should be considered when the LDL levels are persistently > 3.4 mmol/L after 6 months of lifestyle modification, while fibrates may be considered if triglyceride levels are > 4.6 mmol/L. The aim of treatment is to optimise LDL level to <2.6 mmol/L, HDL to >0.9 mmol/L and triglycerides to <1.7 mmol/L. Our patient's lipid and blood pressure gradually improved with weight loss, hence, did not require any medications.

Management of T2DM in this child was a long and challenging journey with multiple obstacles and issues with adherence. But, with perseverance and patience of the medical team, the patient and her mother, small achievements were made gradually. Although the patient was not able to achieve her ideal body weight and to normalise glycaemic control rapidly, some changes were observed over time. One of the main challenges in managing diabetes in this child was the resistance from parents towards medication, poor adherence to treatment and inconsistent adherence to dietary and lifestyle modification intervention. Although the patient has made some progress towards achieving the treatment targets for now, there will be other challenges in the near future especially during transition to adulthood when the patient becomes independent and takes full responsibility for her diabetes self-care. Hence the multidisciplinary team must be vigilant to anticipate challenges and be prepared as comorbidities and risk of complications are higher as the child grows.

CONCLUSION

Early identification and management of children with T2DM is important, as it is a lifelong condition with severe complications and consequences. Managing this condition among children is a long and challenging journey which requires much perseverance and patience from healthcare personnel, family and the patient themselves. Furthermore, the onset of T2DM at puberty, which is a crucial stage of physical and emotional upheaval, acts as an additional burden for these children. Early management using the family centred care involving a multidisciplinary team is essential as these children need regular follow-up, good family and health care support. Comprehensive lifestyle modification and medication can help these children to achieve a healthier life with minimal complications as they grow into adults.

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DECLARATION

The authors declare no actual or potential conflict of interest in relation to this article.

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