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**Creator:** Cremonesini, L.

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## **Type two diabetes (T2D) in children and its association with obesity**

### **What is T2D**

T2D is emerging as a growing public health problem worldwide. T2D occurs when insulin secretion fails to meet the increased demand created by insulin resistance, thus leading to a state of relative insulin deficiency (1). T2D rarely occurs before puberty but most often during the second decade, with a median age of 13.5 years in girls with boys following one year later. From a physiological perspective, this coincides with a peak in insulin resistance. Of note young adults diagnosed with T2D tend to come from families where T2D is already prevalent (1).

### **T2D**

The incidence of T2D in children and young adults has increased worldwide, this shows a direct correlation with the increase in rates of obesity in the same population (2). In the United Kingdom around 31,500 children have diabetes, the majority will have Type 1 diabetes. T2D typically develops in adults over 40 however once a rare diagnosis in childhood is now seeing a rise in numbers, T2D was first reported in white adolescents in 2002, since this time there has been a year on year increase. The most recent National Paediatric Diabetes Audit (NPDA) highlights a total of 533 children presenting to paediatric diabetes Units in the United Kingdom with T2D (3).

Of note children of Asian origin are 8.9 times more likely to have type 2 diabetes than their white counterparts whilst children of Black origin were 5.8 times more likely (3).

Increases in childhood obesity mark a significant contribution to the rising diagnosis in T2D but not Type 1. Children and adolescents who are obese have a four times greater risk than their non-obese peers of developing type 2 diabetes (4).

### **Treatment aims and management**

- To normalise sugar levels
- To support and enable family lifestyle changes
- Effective management of co-morbidities

## **Normalise sugar levels**

The ideal aim of treatment is normalization of blood glucose values. To reduce the risks of long term complications, children with T2D should aim for a HbA1c target level of 48mmol/mol (5).

Early age onset of T2D in children may particularly increase the risk of microvascular complications such as retinopathy, nephropathy and neuropathy, this accelerated development of diabetes complications is yet unclear and certainly more research is required in this field to investigate the pathophysiology behind this (6).

Initial treatment regimens will largely depend on how symptomatic the child is at presentation/diagnosis, some clinical features that may suggest insulin therapy include significant dehydration, ketosis and acidosis (6).

In a child that is potentially asymptomatic changes to diet, physical exercise routine and oral drug therapy may suffice. Whichever treatment option is followed the aim is to achieve glycemic control. Early consultation and referral to paediatric/ adolescent endocrinologists or specialist paediatric diabetes units is key to appropriate care. (6).

## **Lifestyle changes**

Whilst this is of vital importance evidence tells us that less than 10% of young adults with T2D will achieve their glycaemic target with only lifestyle alterations.

It is crucial that at each contact the young person and their family receive education on how healthy eating can reduce hyperglycaemia, reduce cardiovascular risk and promote weight loss (5). Resources available to support and enable them in doing this will be variable dependent on where in the UK the child and family live, ideally, they should have access to a dietetic department, psychologist and specialist nurse. In some areas, local authorities may also provide access to physical activity advisors (5).

Exercise is a significant aspect of any diabetes management plan. With regular exercise resulting in improved blood glucose control, reduced cardiovascular risk factors, recordable weight loss, and improved well-being. Young adults with T2D should be encouraged to engage in moderate-to-vigorous exercise for at least 60 min daily; if individuals feel that this is not achievable it may be completed in several shorter segments (7).

As mentioned previously one risk factor for young adults with T2D is T2D already being a feature within their family, hence it is of the upmost importance that the whole family receive education to understand the principles of treatment and to recognise the importance of the required lifestyle changes (5).

**Action in primary care**

NICE Guidelines dictate that at each contact those children who are obese or overweight should be given important information and advice about benefits of physical activity, dietary advice and information regarding weight loss. Those caring for these patients should familiarize themselves with what is available locally, programs such as MEND/Fit family may be commissioned by the local authority.

**Comorbidities**

The most common co morbidity of T2D in young adults is obesity, studies done mainly in the United States indicate that more than 85% of children when diagnosed with T2D are overweight or obese this has also been found in smaller UK studies. Alongside this there are other serious health complications, see figure 1(8).

**Comorbidities associated with T2D Figure 1**

<b>Comorbidity</b>	<b>Prevalence</b>	<b>Management</b>	<b>Who can help</b>
<b>Hypertension</b>	36% of young adults within 1.3 years of diagnosis	<ul style="list-style-type: none"> <li>• Weight loss,</li> <li>• Increase activity,</li> <li>• reduce salt intake.</li> <li>• Consider ACE inhibitors</li> </ul>	<ul style="list-style-type: none"> <li>• Practice Nurse</li> <li>• School nurse</li> <li>• Specialist nurse</li> <li>• GP</li> <li>• Paediatrician</li> </ul>
<b>Retinopathy</b>	9.35 % at diagnosis  12.7% with proliferative retinopathy at age 35	<ul style="list-style-type: none"> <li>• Refer to ophthalmology services.</li> <li>• May require intervention</li> </ul>	<ul style="list-style-type: none"> <li>• GP</li> <li>• Peadiatrician</li> <li>• Specialist nurse</li> </ul>

	23.7% blind by mean age of 32 years		
<b>Depression</b>	Up to 14.7% of population with T2D diagnosis. More likely in females	<ul style="list-style-type: none"> <li>• Refer to CAMHS or psychologist within the diabetes team</li> </ul>	<ul style="list-style-type: none"> <li>• School Nurse</li> <li>• Practice Nurse</li> <li>• Specialist nurse</li> <li>• GP</li> <li>• Paediatrician</li> </ul>
<b>Nephropathy</b>	May be present at diagnosis 14-22%	<ul style="list-style-type: none"> <li>• If persistent begin ACE inhibitors</li> <li>• Treat hypertension</li> <li>• Normalise microalbuminuria</li> </ul>	<ul style="list-style-type: none"> <li>• GP</li> <li>• Paediatrician</li> </ul>

Adapted from Springer et al (2013)

### **Type 2 diabetes and the link with Nonalcoholic fatty liver disease (NAFLD)**

NAFLD is a frequent finding in adult patients with T2D due to the complex pathogenic mechanisms of insulin resistance. Currently it is not alluded to in young adult screening with patients who have a diagnosis of T2D in the UK. Whilst it is written about infrequently in the UK research from North America has identified that hepatic steatosis is present in 25–50% of adolescents with T2D and more advanced forms of NAFLD, such as non-alcoholic steatohepatitis (NASH), are increasingly common (9).

In the USA NAFLD is now the most frequent cause of chronic liver disorder among obese young adults (9). In a recent study of 675 children all with a diagnosis of NAFLD almost 30% of them also had T2D, these children went on to have an increased risk of having nonalcoholic steatohepatitis and hence a much greater risk of complex liver failure (10).

### **Metformin as treatment**

Metformin is for most the first line treatment and acts through adenosine mono-phosphate (AMP) kinase in liver, muscle, and fat tissue, with a predominant action on the liver (11).

The primary effects of metformin are to reduce the level of glucose produced and released by the liver by increasing insulin sensitivity thus resulting in lower blood sugar measurements for the patient. Metformin also helps by reducing the level of glucose absorbed from the foods that are ingested (12).

Some patients may experience, nausea and diarrhoea but this can be reduced by use of slow release preparations and ensuring that it is taken with food (12).

If adult patients cannot use metformin and diet/exercise alone is not controlling their blood glucose levels there is now an alternative. Though not discussed in use with children there are three new drugs now recommended by NICE , canagliflozin (Invkano),dapagliflozin (Forxiga) and empagliflozin (Jardiance). NICE herald this as positive guidance for those patients looking for alternative treatment in managing T2D and gaining glycaemic control. (NICE)

### **Burden of cost on the NHS**

The burden of diabetes is one that impacts our scarce NHS resources considerably. Complication's associated with diabetes increase the NHS expenditure three-fold and increase the demand on available services significantly (13).

### **The Nurses role**

All nurses have an important role and clear responsibilities when treating people with diabetes whether they be adults or children. Nurses from a wide range of backgrounds including nurses working in primary care, public health and school nurses are likely to encounter people who have diabetes or who are at risk of developing the disease or perhaps having tests to diagnose diabetes. Practice nurses play a critical role in screening, maintaining and supporting people with diabetes (14).

NICE Guidelines 2015 advocate that education is a crucial element in the management of T2D in children, this involves offering children and their families continuing education from diagnosis which encapsulates the following topics:

- Aims of Metformin therapy

- Complications of Type 2 diabetes
- Effects of diet, body weight and physical activity on glucose levels
- HbA1c monitoring and individual targets (5)

### **Making Every Contact Count (MECC)**

With the need for radical change in disease prevention and public health education, strategies such as Making Every Contact Count (MECC) are fundamental to success. Set up by Public Health England (PHE) MECC practice can be applied to a wide range of health and social care professionals with the objective of supporting behavior change and helping individuals and communities to reduce their risks of disease. (15). Fig.2 illustrates how this might look in the practice context, whilst Fig 3 illustrates its broader function, although this is not a diabetes specific model it may be useful in visualizing how such behavior change can be encouraged in primary care and by whom. Of course, most of the patients we are considering here with T2D will receive tailor made care within a specialist diabetes clinic settings, however they may also access primary care, school nurse settings and out of hours' services. Hence it is all our business to ensure that every contact does matter.

Fig.2 (15)

All those working in primary care settings have a great many opportunities to improve the wellbeing of children and their families.

Simply MECC involves four key components :

1. systematically promoting the benefits of healthy living across an organisation
2. asking individuals about their lifestyle and changes they may wish to make, when there is an appropriate opportunity to do so
3. responding appropriately to the lifestyle issue/s once raised
4. taking the appropriate action to either give information, signpost or refer individuals to the support they need.



**Figure.2**

Behaviour change interventions diagram by Health Education England – Wessex Team (15).

### Key Messages

- **Primary prevention is key**
- **Education regarding healthy eating and regular physical activity should be relayed frequently by all HCP's**
- **Healthy eating to ensure glucose control will help control complications in the future**



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*Nisa M. Maruthur, MD, MHS; Eva Tseng, MD, MPH; Susan Hutfless, PhD; Lisa M. Wilson, ScM; Catalina Suarez-Cuervo, MD; Zackary Berger, MD,*

*PhD; Yue Chu, MSPH; Emmanuel Iyoha, MBChB, MPH; Jodi B. Segal, MD, MPH; Shari Bolen, MD, MPH*

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