MANAGEMENT · MONITORING
PAEDIATRIC AND ADOLESCENT
DIABETES

EUROPEAN ROADSHOW

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MADRID, SPAIN

An independent education programme for healthcare professionals managing children and adolescents living with type 1 diabetes

MEETING REPORT

CONTENTS

INTRODUCTION

The Monitoring and Management of Paediatric and Adolescent Diabetes (MMPAD) Roadshow is part of a European-wide set of independent educational activities, organised by Springer Healthcare IME, for healthcare professionals managing children and adolescents living with type 1 diabetes. This expert-led day-long meeting in Madrid offered attendees the opportunity to learn from the experts as well as share and discuss their own experiences in the diagnosis, management and possible prevention of the condition in Spain.

The programme covered acute and chronic complications, practical information about insulin treatment and the latest advances in technology used to treat young patients with type 1 diabetes.

We hope that you will find this meeting report useful, and that it will help further your understanding of the management and monitoring of paediatric and adolescent diabetes.

PROGRAMME

Morning sessions:

- Prediction and prevention of type 1 diabetes in children - Luis Castaño
- Diabetic ketoacidosis - Patricia Enes Romero
- Hypoglycaemia - Isabel Leiva
- Chronic complications - Roque Cardona-Hernández

Afternoon sessions:

- Practical insulin treatment - Roque Cardona-Hernández
- Advances in technology for diabetes treatment - Patricia Enes Romero

LEARNING OBJECTIVES

Following this meeting, delegates will be able to:

- Estimate the risk of, and understand how to predict and possibly prevent, type 1 diabetes in children and adolescents.
- Assess the risks of, and effectively manage, acute and chronic complications of type 1 diabetes.
- Discuss the best treatment options, including new insulins and advanced technologies, for maintaining optimal glucose control.

EXPERT FACULTY

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Dr. Isabel Leiva
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Dr. Roque Cardona-Hernández
Hospital Sant Joan de Déu, Barcelona, Spain.

PREDICTION AND PREVENTION OF TYPE 1 DIABETES IN CHILDREN

Presented by Dr Luis Castaño - Hospital Universitario Cruces, Barakaldo

Dr Luis Castaño started by explaining that, in 1916, Dr. E. P. Joslin correctly predicted that the way forward with finding a cure for diabetes is the early diagnosis and prevention of the disease in people with a genetic predisposition. Research continues in this field today.

Type 1 diabetes (T1D) is an autoimmune disease that occurs when people with high risk genes are exposed to certain environmental risk factors that trigger an immune response, leading to the destruction of pancreatic beta cells.[1]

> ***There are more than 30 genomic regions associated with T1D risk or protection and, since genes cannot be changed, knowledge of the environmental factors is paramount so as to act on them and prevent the immune response.***

The phases of diabetes are:

1. Risk of diabetes: people without diabetes with a genetic risk.
2. Pathophysiological diabetes: destruction of the beta cells begins and, little by little, hypoinsulinaemia occurs (which is undetectable in this phase). The presence of autoantibodies – anti-insulin (IAA), anti-glutamic acid decarboxylase (GAD), anti-tyrosine phosphatase (IA2) – in laboratory tests would suggest that an autoimmune process is underway.
3. Clinical diabetes: there is progressive destruction of the beta cells and hyperglycaemia occurs (first asymptomatic and later, symptomatic). This is the onset phase of T1D.

In terms of markers of T1D, we know that the main factors for genetic susceptibility to the disease are the HLA (human lymphocyte antigen) genes: *DR3* and *DR4*. We also know that autoantibodies against pancreatic beta cells are markers of T1D. When examined using one marker, 63% of diabetics were positive for IAA; when examined with two (IAA and anti-GAD), 89% were positive; and with four (GAD, IAA, IA2 and zinc transporter 8 [ZnT8]), immunity is detected in 95% of patients.

> ***Genetic markers and autoantibodies help to identify the patient's stage of diabetes.***

Studies on prevention of T1D:

- **Tertiary prevention** (after clinical onset of the diabetes). This is where the first prevention studies started. The immunosuppressant cyclosporine was used, halting the diabetes in 70% of children who had begun to present show symptoms, but only temporarily.[2] *Upon finding that tertiary prevention was too late, it became apparent that secondary prevention studies were needed.*
- **Secondary prevention** (after immune activation but before clinical onset of diabetes). Secondary prevention studies with insulin (injected or oral)[3] in pre-diabetes and the European Nicotinamide Diabetes Intervention Trial (ENDIT)[4] with nicotinamide both failed. *It was concluded that secondary prevention was also too late, and so it was deemed necessary to conduct primary prevention studies.*

- **Primary prevention** (before immune activation). The TRIGR study[5] showed that, compared to formula milk, breastfeeding did not protect children with high risk HLA genes from T1D. The AIDA study[6] with interleukin antagonists showed no response, nor did the study with GAD65 antigen therapy.[7] A study conducted using the monoclonal antibody rituximab (anti-CD20)[8] found that, if administered during the first month after the onset of T1D, it improved the C-peptide response after 12 months in the sub-groups of children aged under 18 years. Cytotoxic T lymphocyte antigen 4-immunoglobulin (CTLA-4-Ig) treatment[9] was observed to improve C-peptide and glycosylated haemoglobin (HbA1c) in the long term.

An extract from Dr. Luis Castaño's presentation is available here

Some findings in the prevention studies show that, even though insulin dependence was not cured, research is on the right track to improve C-peptide response, which helps to reduce hypoglycaemic episodes and complications in T1D.

In view of these findings, would you recommend primary prevention for the entire population?

We do not currently have effective primary prevention strategies to be able to propose that. Nevertheless, it is important for first-degree relatives of people with diabetes to know if they share their genetic risk (for example, by analysing their HLA), so that they can be properly monitored and avoid new-onset diabetic ketoacidosis (DKA) as far as possible. This strategy should be combined with educating the public about signs and symptoms of diabetes to ensure early diagnosis, before the patient develops ketoacidosis. ***It is unacceptable that, today, a diabetic can die of ketoacidosis at disease onset.***

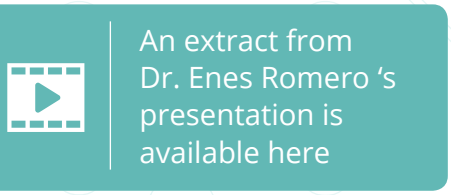
DIABETIC KETOACIDOSIS

Presented by Dr Patricia Enes Romero - Clínica Dialibre

Dr Patricia Enes Romero opened her presentation on DKA by describing the case of a child who had not been diagnosed with T1D and who had died recently as a result of DKA.

> ***Deaths due to DKA occur more often than they should and in many cases could be prevented with prompt diagnosis of diabetes and better management of symptoms when detected.***

DKA is the leading cause of morbidity and mortality in T1D, and is associated with poorer outcomes in the long-term, and not only at the time that it occurs.[10]



High incidence of DKA at onset of diabetes in Spain[11]			
Frequency (39.5%)		Severity	
0-4.9 years	33.8%	Mild	47.8%
5-10.9 years	40.8%	Moderate	34.4%
11-14.9 years	25.2%	Severe	17.8% (< 2 years)

> ***When comparing countries, it is notable that in countries with a higher incidence of diabetes, patients presenting with DKA are less common.[12]***

The definition of DKA has 3 parts:[13]

- Hyperglycaemia: Blood glucose (BG) > 200 mg/dL
- Ketosis: Ketosis BOHB (beta-hydroxybutyrate) > 3 mmol/L
- Acidosis: pH <7.3 or HCO3 < 15 mEq/L

> ***The severity of DKA is related to the degree of acidosis: the lower the bicarbonate level, the greater its severity.***

The pathophysiology of DKA can be summarised in the following steps:[14]

Insulin deficiency (absolute or relative) + an increase in counterregulatory hormones (glucagon, cortisol, catecholamines, growth hormone)

▼

Hyperglycaemia due to increased glucose (due to glycogenolysis, gluconeogenesis and lipolysis), leading to the production of ketone bodies, acidosis and lower peripheral glucose utilisation

▼

Osmotic diuresis that causes dehydration

▼

Vicious circle in which the hyperglycaemia, acidosis and ketosis will continue to increase if treatment is not started

Among patients who have not previously been diagnosed with T1D, the population with the highest risk of DKA is children < 5 years old and, **among previously diagnosed patients**, a major risk is the omission of treatment (deliberate or inadvertent).[14] **In the physical examination of a child with possible DKA**, it should be taken into account that there may have been ketoacidosis without particularly high blood sugars, especially in patients treated with sodium-glucose transport protein 2 (SGLT2) inhibitors.

> ***To distinguish DKA from other symptoms typical of childhood (at the general practitioners), it is important to note whether there are symptoms of dehydration that do not fit with either the degree of diuresis or with normal or high blood pressure (BP).***

Key points in the treatment of DKA
In the first hour, resuscitate the patient by correcting the dehydration.
• *First, start fluid replacement therapy as soon as DKA is diagnosed* with a 10–20 mL/kg 0.9% saline bolus over > 1 hour.
In the following 2–48 hours, gradually correct the hyperglycaemia/acidosis/ketosis and continue replacing the fluid deficit.
• *At least 1 hour after starting resuscitation fluid replacement, start a low-dose insulin infusion (0.05–0.1 U per kg/h). Avoid an insulin bolus.*
• Maintain the fluid replacement needed for 48 hours (4–6 hours with 0.9% saline and in the following hours with 0.9% to 0.45% saline). Add 40 mEq/L of potassium if there is no renal impairment. Do not use bicarbonate.
• Analyse the serum beta-hydroxybutyrate to consider switching to subcutaneous (s.c.) insulin. *It is better to wait to switch to s.c. insulin on the basis of the acidosis and not on the blood glucose.*
• Once the blood glucose has dropped to 300–250 mg/dL, gradually introduce the dextrose. *If the glucose drops too much, it is better to increase the glucose in the fluids than to reduce the insulin too much.*
• Monitor the patient very closely during treatment.
Prevent future complications and try to identify the causes of the DKA to be able to prevent them.

The most serious and feared complication of DKA is cerebral oedema, with an incidence of 0.5% to 1% of cases and relatively high mortality.

In DKA it is important to treat the cerebral oedema as soon as it is suspected and not to wait for the results of neuroimaging tests.

To prevent DKA in patients with no previous diagnosis of diabetes, *provided that there are symptoms of diabetes, it is advisable to perform a simple capillary blood glucose test.* **For patients with diabetes**, the most important thing is to offer good education and follow-up.

When would you recommend giving a basal analogue subcutaneously to be able to discontinue the infusion?

The s.c. basal insulin can be given in the morning and the infusion maintained until mid-morning so that breakfast can be digested with intravenous (i.v) insulin. ***Giving the basal insulin before removing the infusion allows adjustments to be made more easily.***

HYPOGLYCAEMIA

Presented by Dr. Isabel Leiva - Hospital Carlos Haya, Malaga

Dr. Isabel Leiva Gea started by explaining that HbA1c levels are known to be exponentially associated with a higher risk of complications in T1D.

> ***The general aim of treatment for T1D in paediatric patients is to maintain HbA1c levels < 7.5%, although the ideal is to reduce it to < 6.5–7%.***[15]

Hypoglycaemia is considered to be level 1 when the glucose level is < 70 mg/dL, level 2 when it is < 54 mg/dL and, according to the American Diabetes Association, level 3 denotes severe cognitive impairment that requires external assistance for recovery.[15]

> ***Paediatric patients always require assistance to recover; therefore, cognitive alterations are usually taken more into account when considering hypoglycaemia as level 3.***

Glucose (mg/dL)	Hypoglycaemia symptoms
80	Insulin secretion decreases
70	Increase in glucagon, epinephrine, adrenocorticotropic hormone, cortisol and growth hormone
50	Sweating and tachycardia
40	Cognitive dysfunction, strange behaviour, fits, coma
20-10	Neuronal death

Different aspects of hypoglycaemia:

- Inadvertent hypoglycaemia occurs when hypoglycaemic episodes are frequent because the release of counterregulatory hormones is carried out at lower blood glucose levels. Exercise and sleep enhance the phenomenon of loss of awareness of hypoglycaemia. The presence of inadvertent hypoglycaemia makes the occurrence of severe hypoglycaemia more frequent.[16]
- Patients with T1D lose the glucagon response very early after the onset. Peptide C has a significant role in the recognition capacity of hypoglycaemia. The presence of residual amounts of C-peptide is of vital importance to avoid inadvertent hypoglycaemia and thus contribute to the decrease of severe hypoglycaemia.[17]

> ***Patients with T1D who maintain a C-peptide reserve greater than 0.04 ng / mL have a better management of hypoglycaemia.***[18,19]

- High HbA1c does not protect against severe hypoglycaemia. Patients with HbA1c in range even have a lower risk of severe hypoglycaemia.[20]
- It is important to relate HbA1C with other parameters to make an appropriate consideration of the metabolic control.The incorporation of technologies has modified not only the management of hypoglycaemia but the adequate diagnosis, recognizing two parameters; such as the percentage of hypoglycaemic episodes or the time in hypoglycaemia. The established objective is to have less than 10% of hypoglycaemic episodes in a 14-day discharge.[21]

A target HbA1c ≤ 6.7% (≤ 50 mmol/mol) seems achievable without increasing the risk of severe hypoglycaemia.[20]

- Nasal glucagon (2 and 3 mg) was shown to be equally as effective as intramuscular (i.m.) glucagon for treating severe hypoglycaemia. It is also easier to administer and has fewer side effects than the i.m. route, without presenting interferences with nasal congestion.[22]
- Hypoglycaemia is a cardiovascular risk factor in patients with T1D.[23,24]
- Fear of hypoglycaemia is the greatest perceived limitation for patients with T1D to do physical exercise.[25] Strategies for preventing hypoglycaemia (especially nocturnal) after physical exercise, apart from the classic ones, include the combination of aerobic and anaerobic exercise.[26,27]

There is a higher risk of nocturnal hypoglycaemia after exercise performed from lunchtime onwards, so the safety limit in the paediatric population (if they have done any exercise) has been established at 120 mg/dL before going to bed.[26]

An extract from Dr. Leiva 's presentation is available here

- Longer periods with normal glucose values corresponds to better outcomes in terms of cognitive function in patients with T1D.[28] The response to hypoglycaemia corresponds with increased connectivity in the prefrontal cortex and patients with inadvertent hypoglycaemia present less connectivity at this level.[29]

Action guidelines for problematic hypoglycaemia are:[30] *a*) structured education; *b*) consider the use of a pump or maintain multiple doses but with a real-time continuous glucose monitoring system (CGM) with predictive capacity; *c*) use a continuous insulin infusion pump combined with an interstitial blood glucose monitor with predictive low glucose suspension, and *d*) consider a pancreatic islet or pancreas transplant.

Why do some diabetic children experience the symptoms of hypoglycaemia worse than other children?

This is a challenge that we face in the paediatric population, because recognition of symptoms, or not, has more to do with behaviour (children prefer to continue with their activities rather than tell their caregiver) than with their pathophysiological conditions.

CHRONIC COMPLICATIONS

Presented by Dr. Roque Cardona-Hernández - Hospital Sant Joan de Déu, Barcelona

Dr. Roque Cardona-Hernández provided an overview of chronic micro- and macrovascular complications and their long-term problems.

In terms of the pathophysiology of T1D chronic complications, chronic hyperglycaemia linked to lipid alterations and insulin resistance is known to trigger a series of metabolic cascades that end up causing, firstly, endothelial cell destruction, resulting in microvascular complications, and secondly, atherogenesis in addition to chronic hyperglycaemia causing macrovascular complications.[31-33] It is therefore equally as important to control lipid concentrations in people with T1D.[34]

The main causes of mortality in people with T1D due to chronic complications are severe hypoglycaemia and ketoacidosis in the early years; as the years progress, microvascular complications; and after more than 30 years, macrovascular complications.[35]

An extract from Dr. Cardona-Hernández 's presentation is available here

Intensive treatments for T1D can reduce the complications associated with diabetes.[36] In the Diabetes Control and Complications Trial,[36-38] it was observed that, patients who followed conventional treatment had a higher risk of complications, and that afterwards, despite managing to reduce their HbA1c to values associated with the use of intensive treatment, they continued to have a much higher number of complications than those who had received intensive treatment from the start.

> ***We can see evidence that metabolic memory exists in the fact that patients with poorly controlled T1D in childhood have more complications throughout their lifetime despite achieving good control in adulthood.***

Microvascular complications

The main microvascular complications associated with T1D are retinopathy, nephropathy and neuropathy.

> ***Pregnancy and coeliac disease are major risk factors for any microvascular complication.[39,40]***

Recommendations for microvascular complications (ISPAD 2018)[13]				
Complication	**Age to commence screening**	**Follow-up**	**Screening method**	**Risk factors**
Retinopathy	11 years old, after 2–5 years' diabetes duration	Every two years (if not high risk)	Mydriatic fundal photography and direct observation	Hyperglycaemia High BP Lipid abnormalities Higher body mass index Duration of the diabetes
Nephropathy	11 years old, after 2–5 years' diabetes duration	Annually	Albumin/ creatinine ratio in first morning urine	Hyperglycaemia High BP Lipid abnormalities Smoking
Neuropathy	11 years old, after 2–5 years' diabetes duration	Annually	Clinical evaluation with history and neurological examination	Hyperglycaemia Higher body mass index Age Duration of the diabetes Genetics

Diabetic retinopathy (DR). DR progresses in various stages, from non-proliferative DR to macular oedema. Although the age at onset affects the pattern of progression of DR, the incidence is currently very low and it is known that when diabetes appears in early adolescence, it has a higher risk of progression.[41,42]

Diabetic nephropathy (DNP). DNP progresses in various stages, from hyperfiltration to end-stage renal disease.[43] DNP is important because it is the primary determinant of cardiovascular (CV) morbidity and mortality.[44] The age at diabetes onset does not have as great an impact on the development of DNP as on DR, but it has been observed that children who present with diabetes after the age of 10 years have a higher relative risk of developing DNP within the first 5 years of the disease, and that at 15 years old, these risks equal those of the rest of the population with diabetes.[45]

> ***The ISPAD recommends that children with persistent albuminuria (with or without high BP) should be treated with angiotensin-converting enzyme inhibitors or angiotensin receptor antagonists to prevent its progression to proteinuria.[13]***

Diabetic neuropathy (DNR). The frequency of DNR varies between 10% and 27% and seems to be increasing.[46,47] In the clinic, it is advisable to find out if there are abnormalities in the pathology of long and short myelinated fibres as well as non-myelinated ones.

Macrovascular complications

Dyslipidaemia screening should be performed from 11 years of age and repeated every 2 years and BP should be taken at least once a year. The risk factors are essentially the same as for DNP, with the inclusion of increased body mass index.

According to the ISPAD,[13] low density lipoprotein (LDL)-cholesterol in children and adolescents should be below 100 mg/dL; if it is higher, dietary intervention and lifestyle changes are recommended; and if it is > 130 mg/dL and coincides with one or more CV risk factors, statin treatment should be started immediately.

> ***Statins have been shown to be safe and effective in children in different studies, compared with placebo.***[48]

In recent years there has been a considerable drop in CV mortality in patients with diabetes, although it still fails to reach the same levels as patients without diabetes.[49]

How do we know that diabetic patients with coeliac disease have more risk of presenting complications?

Because of data obtained from a *Diabetes-patient-documentation* (DPV) observational study, which highlights diabetic retinopathy in particular.

PRACTICAL INSULIN TREATMENT

Presented by Dr. Roque Cardona-Hernández - Hospital Sant Joan de Déu, Barcelona

Dr. Roque Cardona-Hernández started by explaining that the basal–bolus regimens (mimicking the pancreas of a person without diabetes) have become the gold standard in paediatric diabetes.

In prepubertal children, it is recommended to start with a dose of 0.7–1.0 IU/kg/day; in puberty, between 1 and 2 IU/kg/day, and during the partial remission phase, < 0.5 IU/kg/day.[13]

> ***The ISPAD establishes that the correct dose of insulin is one which achieves good glycaemic control in each child without causing hypoglycaemia and providing him or her with age-appropriate growth.[13]***

An extract from Dr. Cardona-Hernández 's presentation is available here

Types of insulin

Regular insulin: used classically in regimens that included two daily injections of regular insulin together with NPH (Neutral Protamine Hagedorn). In some countries it is also used in regimens with basal insulin. Some patients are given an occasional dose of regular insulin to cover the ingestion of breakfast. *Generally used intravenously in ketoacidosis protocols or during surgery.*

NPH insulin: generally used in twice- and thrice-daily insulin regimens and sometimes to cover certain times of the day together with rapid-acting analogues. *The ISPAD recommends it in tailored basal substitutions.* It is an insulin that is used increasingly less due to its intra- and interindividual variability.

Rapid-acting analogues (RAA): those used today are *Humalog® (lispro)* in children of all ages, *NovoRapid® (aspart)* in children ≥ 1 year old and *Apidra® (glulisine)* in children ≥ 6 years old.

Comparative studies conducted to date, between different RAAs, have failed to demonstrate superiority of one over another. When RAAs are compared with regular insulin, there is a small reduction in the HbA1c (0.1%) and a significant decrease in hypoglycaemic episodes in favour of RAAs. *The decrease in hypoglycaemic episodes with the use of RAAs gives the paediatric population a greater degree of flexibility.* There are studies which show that their administration 15–30 minutes before eating may be more effective in correcting post-prandial blood glucose and, moreover, can decrease the HbA1c by up to 0.5% in many cases. In the presence of hyperglycaemia, the interval between injection and food may be even longer. *In the case of ketosis, administering RAA subcutaneously has many advantages with respect to regular insulin.*

Long-acting analogues (basal): those used today are *Lantus® (glargine)* in children ≥ 2 years; *Levemir® (detemir)* in children ≥ 1 year; *Tresiba® (degludec)* in children ≥ 1 year and *glargine U300* (not approved in children).

Insulin glargine U100 compared to NPH shows little difference in HbA1c values, but considerably reduces hypoglycaemia. Clinical experience suggests that it lasts around 20 hours, not 24 hours.

Insulin detemir compared to NPH has a less variable, and therefore more predictable, profile of action. If the needs are low and covered with rapid insulins during the day, a single dose of detemir can sometimes be given, although a Swedish study found that in 70% of cases, insulin detemir was administered in two doses. When the switch is made from NPH or glargine to detemir, the detemir dose generally needs to be increased by between 20% and 50%. There is less weight gain with detemir compared with other types of basal analogue. *With detemir, there is a reduction in daytime and nocturnal hypoglycaemia compared with NPH.*

Degludec can last up to 36 hours, which is a great advantage for patients with poor treatment adherence. *Comparing degludec with detemir, no significant differences were observed in either HbA1c or severe or nocturnal hypoglycaemia, but aspects such as the ketoacidosis ratio were lower with degludec*.[50]

Glargine U300 *has still not been approved in children, pending regulatory studies.* It is characterised by its very concentrated formulation, which achieves flatter pharmacokinetic and pharmacodynamic properties that last more than 24 hours.

Ultrarapid-acting analogues: the only one that exists at the moment is insulin Fiasp®. It has been developed essentially for use in insulin pumps and artificial pancreas.

Insulin regimens for children:[51] RAAs should be administered 15–20 min before food and it is not recommended to inject them afterwards. Correction doses should be standardised using a correction factor according to the 1800 rule for RAA. The ISPAR states that needles longer than 6 mm should not be used in children.[13]

> ***The recommendation for children is that the basal insulin should cover 30–45% of the total daily dose and insulin in bolus form should cover 55–70%.***

The glucose targets recommended by ISPAD[52] are: HbA1c < 7.0%; glucose before eating, 70–130 mg/dL; after eating (2 h), 90–180 mg/dL; and at bedtime, 80-140 mg/dL. This has been adapted to the new guideline which has just been published.

The ISPAD guidelines include recommendations for sick days, highlighting that parents should be reminded never to omit insulin and that they have to adjust the dose according to the glucose and ketone bodies.

ADVANCES IN TECHNOLOGY FOR DIABETES TREATMENT

Presented by Dr Patricia Enes Romero - Clínica Dialibre

Dr Patricia Enes Romero started the presentation by explaining that she will review the technology applied to diabetes in three groups: insulin pumps, continuous monitoring and integrated systems.

Insulin pumps

An insulin pump allows the patient to:

- Administer basal insulin in portions adjusting the dose to different needs throughout the day.
- Regulate doses as low as 0.01 to 0.025 IU.
- Use short-term basals that allow the amount of basal insulin to be adjusted in certain circumstances of greater or lesser insulin need (e.g. exercise).
- Use bolus calculators that may be a useful function and the different types of bolus allow adaptation to different types of food.

Insulin pumps improve HbA1c and quality of life and reduce episodes of hypoglycaemia and ketoacidosis in patients with caregivers who have appropriate training. It has been observed that the decrease in HbA1c is maintained up to 5 years.[53-55]

An article on quality of life,[56] based on an interview conducted in parents of children on treatment with pumps, shows the following to be positive aspects: a) fewer injections; b) more flexible lifestyle; c) better control on being able to use the insulin doses needed at each moment, and d) easier to calculate the bolus. Nevertheless, as a negative aspect, they highlighted that it means more work due to the numerous possibilities offered by pumps.

An extract from Dr. Enes Romero 's presentation is available here

Interstitial glucose monitoring

Intermittent monitoring (flash system) shows the glucose figures in interstitial fluid and the trend arrow, but will only give information when the sensor is scanned. *It is approved for children over 4 years old*. Today, the measure to assess the accuracy of monitoring is the mean absolute relative difference (MARD): the absolute difference in means with a specified "gold standard".[56] When the use of a flash system was compared with capillary blood glucose, it gave quite a high MARD result (16.7%).[57]

Continuous monitoring takes the measurement per minute and every 5 minutes in interstitial fluid. With this information, it shows the trend and a graph. In patients aged over 21 years treated with multiple doses, using this system, it was observed that over 24 weeks, the HbA1c, time in range and hypoglycaemia rate improved.[58] It was also observed that not only is the time of continuous monitoring use important, but continued use of the system is important as well.[59] It is useful to use one method and adjust the doses in line with this.[60]

> ***In order for a system to be approved to make decisions using information from the sensor only, a MARD cut-off point of 10 has been established.[61]***

Integrated systems

These systems combine the information from the sensor in the pump with a function called "suspend before low". The system automatically stops the administration of insulin between two programmed parameters. The literature suggests that the system has been able to stop a hypoglycaemic episode in 84% of cases,[62] and that when a pump with a sensor was compared with a pump with sensor and the "suspend before low" feature, the pump with sensor and "suspend before low" function showed a greater reduction in hypoglycaemic episodes.[63]

> ***The use of new technologies should be considered in children who are willing, with motivated families (especially in very small children) and who can potentially benefit from some of the characteristics of the pumps and CGMs to improve their quality of life.***

What decrease is seen in the number of capillary blood glucose measurements taken in patients who use monitoring systems?

We can't specify an exact number, but what is certain is that they are greatly reduced. However it depends on each patient; some do not trust them and continue with multiple checks, while others abandon capillary checks almost completely.

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FURTHER INFORMATION

Medical Education (CME)

An application for CME accreditation of this event has been made to the Comisión de Formación Continuada de las Profesiones Sanitarias de la Comunidad de Madrid

Educational grant

This programme is made possible thanks to an independent educational grant from Novo Nordisk A/S.

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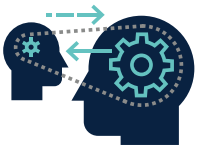

ROADSHOWS

European Roadshow

A collection of five meetings focusing on the diagnosis, management and possible prevention of diabetes in children, including both acute and chronic complications.

These meeting were held in Munich, Madrid, Milan, London and Paris involving leading local experts in the field of paediatric diabetes.

SATELLITE SYMPOSIUM
at ESPE 2018

Insulin Treatment and Advanced Technology in the Management of Children with Diabetes

Saturday 29th September 2018
Athens Megaron Conference Centre, Athens, Greece
With Professor Francesco Chiarelli & Professor Tadej Battelino

CASE STUDIES

Interactive Patient Case Studies

- Renal Complications in Diabetic Ketoacidosis
- Maturity-onset Diabetes of the Young (MODY)
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