ISPAD Annual Conference 2016 Highlights

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The 42nd annual ISPAD meeting took place from 26 to 29 October in Valencia, Spain. The roving reporters present an overview of the scientific highlights of the meeting. Videos of presentations are available on line: http://2016.ispad.org/
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Diabetes at 212 degrees: Confronting the Invisible for the Next Generation

Is diabetes hot enough, or do we need to truly light a fire? It is sometimes necessary to find new approaches to obtain a higher goal. A large percentage of children with type 1 diabetes (T1D) still present in diabetic ketoacidosis, and a large number of youth did not achieve targets for diabetes control. There is a change in the characteristics of patients with T1D (younger, higher BMI, different HLA genotype) and in many places diabetic ketoacidosis is also increasing. Similarly T2D incidence is rising in youth globally, and although there may be a reduction in chronic complications, the prevalence of diabetes is increasing worldwide. Costs of diabetes accounted for 12% of global health expenditures in 2015. Insulin is not a cure and much is needed on advocacy, education and research for diabetes worldwide. Our goal is to cure and prevent diabetes, don’t adjust the goals, adjust the actions steps!
Genetics and Environmental factors

There are now more than 50 genetic regions linked to T1D, with either deleterious or protective effects. The balance between destructive and protective genes will determine the destruction of Beta-cells. Genetics of diabetes allows identification of mechanisms of disease, defining genetic risk, defining genetically at risk cohorts for natural history studies (TEDDY; DAISY; BABYDIAB) and ultimately primary prevention of diabetes. The protective genes (like HLA DRB1*15:01-DQA1*01:02-DQB1*0602 haplotype) are usually related to 1 antibody (AB) positive, and this is generally GAD. Patients with Insulin AB are more likely to develop diabetes than GAD AB. There is also a need to consider expressed genes and ongoing gene regulations (miRNAs, epigenetics for example).

There is still work to be done in the environmental triggers for T1D, and no “smoking gun” has been identified yet, though the evidence is mounting for a role of enteral virus infections. There is well documented up-regulation of MHC class I in association with T1D. Something may happen before the progression to diabetes, as shown by studies with pro-insulin that is differently expressed in patients with T1D. In humans, the beta cell alteration is lobular, and MHC class I is up regulated during T1D pathogenesis. The question is what causes this up-regulation? In this regard there is a known association between enteroviral VP1 expression with T1D development. A combination therapy approach for T1D will ultimately be needed. Therapies will be needed at an antigen specific level, and in association with a range of current or considered therapies (GLP-1, anti-inflammatory agents, anti T- or B-cell agents).

Understanding the legacy of hyperglycaemia in diabetes: metabolic karma; “Good karma“— efforts today have long-term pay-back or “Bad karma“— inadequate control can cast a long shadow. Metabolic control diminished diabetes complications both in the DCCT and EDIC, or, in other words, showed positive Karma for those better controlled from the beginning of the disease. There was a one third mortality reduction in those enrolled in the intensive arm, and life expectancy was equal to the normal population. The Steno 2 study showed the same follow-on benefit for T2D, even without significant results during the 6.5 years of intensive control, suggesting that prior glucose control can have a legacy on vascular complications. The possible mechanism would be via epigenetic modulation: hypomethylation appears early and is maintained for a long period of time, suggesting imprinted modification histones modifying the gene expression after hyperglycemia induction, even for a short time, increasing NFKB, and maintaining the gene expression. Linking epigenetic changes to
hyperglycaemia induced changes in gene expression, and understanding the histone code will no doubt provide more clues to come. The quote “we get crusty as we age” will be remembered for some time.

**Autoimmunity and diabetes**

T1D has a long asymptomatic phase before progressing to a metabolic disease, the presence of multiple autoantibodies against beta cells has a lifetime risk of developing T1D approaching 100%. The Fr1da screening study in Bavaria is aiming to screen 100,000 children to prevent DKA and to set new standards for early diagnosis and teaching. Using a novel capillary test for GADA, IA-2A and ZnT8. To date 50,000 children <6 years of age have been screened and 165 (0.33%) have stage 2a T1D (early diabetes). Most parents recall the most important symptoms of T1D; there is no evidence for a “high level” of psychological distress for the families, and no case of DKA. The cost of 20 Euros per child is relatively moderate, and similar programs are being rolled out in in Germany and Sweden.

“Double diabetes” is at present a clinical concept; but it has been suggested for patients who are overweight, have a family history of T2D, gain much weight over the time, have high insulin requirements and show signs of insulin resistance. Use of metformin in addition to insulin therapy failed to improve glycaemic control in a 6 month multicentre randomised trial of 140 adolescents (aged 12.1 to 19.6 years) with mean type 1 diabetes duration 7.0 (3.3) years, mean body mass index (BMI) 94th percentile. Metformin was effective in reducing insulin requirements and BMI as well as LDL cholesterol however the young people in the metformin arm were more likely to have had a severe hypoglycaemic event and also had more gastrointestinal side effects. However, the combination of insulin and metformin could be useful in improving insulin sensitivity and preventing CVD.

Are we ready to screen the general population for T1D and celiac disease? The etiology of organ specific autoimmunity is linked to genetic HLA DR-DQ, environmental and contributing genetic factors. In the pathogenesis, a prodrome is common and autoantibodies are strong biomarkers. Triggers in etiology are being searched for: environmental factors and/or gene-environment interactions.

The etiology of celiac disease is associated with HLA-DR3 –DQ2 and Non HLA genes. The amount of gluten consumed until 2 years of age increases the risk of celiac disease. A two-hit hypothesis indicates that gluten and virus infections may play a role in the pathogenesis.
JDRF symposium Exercise

Highlighting the integral role that nutrition plays in the management of T1D especially for peak exercise performance. As well as a strong support team, the support “team” of a balanced lifestyle includes: proper nutrition, adequate sleep, academic development, psychological well-being. Appropriate energy balance coupled with good glycemic control supports the recommendations as applied to children with T1D. Balanced carbohydrate, protein and fluid for the sport and level of energy expenditure are keys to success. Insulin adjustment strategies and flexibility are key to ensuring safe, effective and optimal sports performance.

When exercise is unplanned, prevention of hypos is more dependent on nutrition. How much carbohydrate is needed depends on the individual & circumstances; Frankie’s rule of, “check, top up, check, top up!” is clinically very useful. Other top tips include not taking your pump off unless absolutely necessary and that supplements are rarely advised for young athletes; in particular, creatine should not be used in under 18’s.

Both hypo- and hyperglycaemia (>8mmol/l) have multiple deleterious effects on exercise performance. Exercise is challenging due to non-physiological insulin treatment, variable effects of exercise types, timing of insulin action, competitive stress, fear of hypoglycaemia and inter and intra patient variability. Intermittent high intensity exercise is protective of hypoglycaemia and incorporating sprints during warm up for example. Avoid insulin bolus stacking after evening exercise. High CHO and Protein meal (3:1) post exercise will maximise glycogen recovery and reduce nocturnal hypo risk.

A very personal perspective was presented, through an ultra-run (consisting of 30 consecutive 30 miles/day with only 7 mild hypos), talking about his journey physically and personally. The importance of each person as an individual and earning knowledge through trial and error, and with persistence feeling like "the Einstein of diabetes."
ESPE/ISPAD symposium: Rare diabetes

Registries are essentials for rare diseases, EuroWABB Registry is a project to try to gather information about Wolfram, Wolcott-Rallison, TRMA, Allstrom and Bardet Bidel Syndromes, with the objective of better understand and treat these conditions, as well as support access to genetic testing. So far, there are 388 participants. There are partnerships with industries in progress to develop new molecules to treat these conditions. For patients with WS, there is some data with Sodium Valproate to treat the disease, and a phase 2 international study is starting in 2017 to assess the efficacy. The timeline for repurposed drugs is ~10 years, and that of new drugs is 15 years.

Neonatal diabetes can be caused by mutations in KCNJ11, treatment with sulphonylurea (SU) started in 2004 and treatment for long periods is reported in two cases, and it seems that there is no reduction in SU action. A new long-term follow up study is being done with 79 patients from different centres, with the objective to evaluate efficacy, metabolic control, mortality and other factors related to diabetes. Treatment with SU have lower HbA1c, 94% on SU only efficacy, and 100% with SU + Insulin, metabolic control is excellent, with A1c dropping from 7.9% to 5.8% after the change, and to 6.3% at year 10. Side effects occurred in only 11%, all mild and transient (nausea and GI symptoms), and none of the patients discontinued SU.

Prevalence of Berardinelli-Siep Syndrome (congenital generalized form) and other lipodystrophies is 10-40 cases per million, patients present with decreased amount of SC fat, generalized or partial, congenital or delayed. It is associated with insulin resistance, diabetes, hypertriglyceridemia, acute pancreatitis, liver steatosis, risk of cirrhosis, hyperandrogenism and PCOS. There are several different monogenic forms of lipodystrophies, with more than 20 different genes involved. Seipin is an endoplasmic reticulum trans-membrane protein, expressed in the adipose tissue, that interacts with lipid droplets. Defects in the seipen gene are responsible for CGL2. Lipodystrophies can appear after immune-inflammatory aggression, and there are other genetic alterations leading to lipodystrophic syndromes. Metreleptin therapy is efficacious in CGD, and leptin treatment may be beneficial if leptin levels are less than 4 ng/ml.
Type 2 diabetes (T2D)

T2D is still a disease ultimately of beta cell failure. Currently only metformin and insulin are licensed for management of young people with T2D, and metformin (and lifestyle intervention) is the management of choice at presentation. However, in the TODAY study (Treatment options for Type 2 diabetes in adolescents and youth); metformin alone was not enough to maintain glycaemic control. The high percentage with positive T1D antibodies also makes it important to check antibodies in all youth with suspected T2D.

A proportion of youth with T2D can attain target HbA1c with Metformin and education alone, but Metformin alone is inadequate for 50% of youth with T2D. The role of lifestyle interventions is unproven, but still considered good practice. A second agent should be added if the HbA1c is > 6.3% at 6 months post diagnosis. The best add on therapy remains unclear; add on insulin in T2D did not correct hyperglycaemia. The use of newer T2D agents remains unproven for children, although studies continue.

Childhood obesity is a multifactorial, complex disorder; including media, transport, family, government, school environment and lack of control, even where people live – socioeconomic predestination. “Honey we are killing the kids? Stigmatization (of the obese child and adolescent) is common and there is a real need to be delicate and respectful with parents and families at all times. However important questions include: Are certain lifestyles and diets a form of child abuse? Should obese children be separated from parents? Does abuse presume motive? Is it fair to single out overweight children, when many children have unhealthy lifestyles and diets but are not obese? One cannot hide obesity - but other lifestyles that are not obvious. Strategies include nudging, (no sweets near checkouts) and designing environments to make healthy choices more available or passive and active energy expenditure.
Obesity and insulin resistance

Obesity is driving the huge problem of youth with pre-diabetes and T2D. Insulin resistance, impaired beta-cell function and impaired incretin effect constitute the pathophysiology of youth pre-diabetes. The problem of translating the complex pathophysiology and measurement of insulin action production and translating to simple, clinic based and reproducible testing is paramount. All classifications come from observations in adults and are beta cell centric in approach, where the disposition index (sensitivity x secretion) may be a more useful measure as it reflects the cross talk of the 2 key measures to produce normal glucose tolerance. In youth there is 25-30% decline in beta cell function per year, which is 3-4x faster than in adults with evolving T2D.

Obesity is associated with poor executive function, a complex system of cognitive schools. Working memory, cognitive flexibility and reasoning is related to obesity; a potential target to improve educational attainment. Convincing negative associations of obesity include executive functioning, attention and visual-spatial skills; however there are inconsistent findings with general intelligence and memory. There is consideration that brain insulin resistance may be at the crossroads of metabolic and cognitive disorders in humans.

Early life nutrition and catch up growth of the infant born SGA is characterized by a recovery of lean mass. Potentially detrimental effects of enriched formula on cardiovascular risk factors and potential for overweight to aggravate this long term are a real concern. It is interesting that large for gestation babies of non-diabetic mothers have longer telomeres and lower myostatin levels and tend to become leaner and have more lean mass; so body composition patterns differ at either side of the U-shaped spectrum of birth weight and nutrition.
Improving diabetes in emerging economies

Current programs to improve diabetes care focus on attaining a multidisciplinary team of doctors, nurses, psychologists, nutritionists, etc. Some areas have difficulty financing diabetes treatment. Intensive, continuing education is emphasized and use of phone or technology-based means of communicating treatment has been shown to benefit patient care.

In Brazil, legislation is patchy whereby insulin and materials are provided, but not pens or needles. The Institute for Children with Diabetes is a partnership between ICD and GHC (Conceição Hospital Group of the Ministry of Health) to provide multidisciplinary care to people diagnosed with T1D between the ages of 0-20 and follows patients long-term to reduce risk of complications.

In contrast is China where studies show a rapidly rising increase in incidence of both T1D and T2D, but lack of population based surveys make it difficult to track incidence and prevalence. There is also no national healthcare system, a lack of pediatricians and facilities that provide diabetes-specific services. T1D is a large financial burden on families because many must pay out of pocket.

In India, there is no government program to support medication and DKA and death by bad control is not uncommon. However, progress is being made with emphasis on training and increasing awareness of good diabetes control from a multidisciplinary approach. Use of technology, the internet and smart phones has increased awareness of programs as well as provided a means for the healthcare team to provide assistance without requiring a clinic visit. Programs emphasize psychological and psychosocial coping with T1D management and stigma associated with T1D in personal life and school.
ADA/ISPAD symposium: Emerging diabetes therapeutics

Clinical features of KATP channel disease include neonatal diabetes and developmental coordination disorders. Evaluations showed normal muscular conduction, suggesting a central alteration, which is confirmed by MRI. To facilitate the treatment of neonates, oral suspension of glibenclamide was developed, and proved to be as effective as crushed tablets and more convenient to the patients.

Outlining the rationale for disease modifying therapy of T1D, diabetes truly starts with the development of the double antibody state, and clinical progression is highly dependent on age, with children and young people at much higher risk of progression to clinical diabetes. The number needing to treat at the 2 antibody stage with an effective therapy to prevent morbidity and T1D is relatively low compared to blood pressure and cardiovascular outcomes for example. Outlining the intervention studies to date and awaiting the oral insulin trial results at the ADA 2017

The idea of replacing the pancreas is based on old ideas, regarding isolation of islets and transplant them to pigs or mice. Difficulties are related to immune response and, specially, fibrosis. Biomaterials have been developed in the last decades, like polyurethane, silicone and others. Modified alginate have been developed to create spheres with larger size, that are more biocompatible than the smaller ones. New modified capsules proved to be effective in mice and primates, without generating fibrosis, and controlling glycaemia. There is a perspective of allo-transplantation without immunosuppression, with good viability after 4 weeks and 16 weeks. Another question is the source of islet cells - human embryonic stem cell derived beta cells are being studied and first results are on the way.
Economic burden of childhood diabetes

The incidence of T1D worldwide is (as expected) increasing, but does differ in age and various groups around the world. So diabetes is increasing in various places, in various times in various subpopulations. This is what you would expect for a condition that is multifactorial and has an etiology that involves environmental triggers superimposed on genetic susceptibility.

The economic cost of diabetes includes direct and non direct costs, and varies in a U-shaped fashion with child age in Spain. The majority (81%) is direct non-healthcare cost. Poor glycaemic control increased by 28% the direct healthcare cost of children with diabetes.
Beta Cell Therapy

The on-going challenges of generating functional human beta-cells in vitro was well described. The on-going challenges, whether in the field of donated stem cells (lack of supply, risks of immunosuppression), human pluripotent stem cells (debatable ability to produce adequate insulin at the right time) and macro/micro barrier technology. Tantalizingly close but so far away, it is debatable whether beta cell therapy will become a treatment of the future.

An overview of clinical islet transplantation provided a more positive perspective, emphasising that although insulin independence is not always achievable, improved metabolic control and freedom from severe hypoglycaemia was possible. The complications of the procedure itself and the not insignificant risks of long term immunosuppression were discussed.

Possible avenues for gene therapy in diabetes including candidate genes that may allow regeneration of the islet cell mass, production of insulin by non-pancreatic tissue or the prevention of secondary complications.
Diabetes registries

We are in the age of the registries it seems. Comparisons of multiple registries in different parts of the world highlighted similarities and differences in use of registries among clinics, glycemic control, other diabetes-related health outcomes, and demographic factors. Of note, all registries presented showed similar struggles with the majority of pediatric patients not reaching glycaemic target goal. Though each registry may show significant differences between each other in their health outcomes, there exists a struggle to achieve recommended glycemic control globally across sites. They highlight the increasing use of technology, pumps and sensors to varying degrees related to micro-economic factors of the various sites. Open comparison of registries may provide a tool for more collaboration in problem-solving similar issues in different parts of the world. Use of international databases can help pair centres with similar struggles or potential solutions to support each other, increase collaboration, and set the stage for international studies and “open benchmarking”.
**Diabetes and Microbiota**

The field of microbiota is an enormously complex and intriguing area of active research, with 100 fold more genes in the microbiome than in the human genome. Techniques and data analysis are rapidly evolving to assess the bacteria, type and their 100s of metabolites and potential influences on host health. Interesting work was presented on the influence on artificial sweeteners and effects on glucose intolerance, and a further consortium looking at the influence on gut microbiota on brain function, immune and endocrine function. There appears to be a critical development window pertinent to altering the intestinal microbiota that has lasting metabolic consequences and the question of whether early antibiotic exposure or illness itself shape this interaction. Certainly pulsed antibiotic therapy in the mouse model has effects on growth rate and lean mass, but not in sub-therapeutic antibiotic treatment levels. There are detectable differences in microbiota around the time of diagnosis of T1D but the studies to date are small. The results of the current RCT’s of fecal gut transplantation in obesity, T1D and T2D are awaited.
JDRF/ISPAD Symposium: New technologies in type 1 Diabetes

In addition to hardware, there is a spectrum of different approaches to software; from completely open loop (sensor augmented pump therapy, auto suspend, threshold predictive, programmed basal suspend, adaptive basal) to fully integrated closed loop and in turn to complete replacement with multi-hormone closed loop. As you move across the spectrum there is increased automation, but increased system complexity; so there is a tradeoff between ease of care and safety. In summary, then the loop has been closed, well “sort of”. We have our first systems, though there is still much work to be done: Areas of special complexity include exercise, and closing the loop in the very young.

Participants experience was life-changing for people, though keys include developing trust and managing expectations; however the ‘gung-ho’ vs. the wary groups both became satisfied. Issues to be addressed are the use of bi-hormonal systems, the evaluation of the newer rapid-insulin delivery and consideration by some of portal system delivery.

Each patient age group will have its own challenges and need to validate increasingly complex technology, so the approach to education should focus both on patients/family and the physician. Good education is fundamental because systems are different from each other. Key factors in success when using automated insulin delivery (AID) technologies with children (Adolescents 14+) include: age considerations, high independence - questionable judgment, ease of adaptation of technology, forgetfulness (bolusing, testing, etc.), and burnout. The adolescent group may be the optimal group for AID - missed boluses etc., though again the need to educate on risks of ketosis is emphasized. All brands of AID are all different and it is important that patient and clinicians are well educated on devices. CARE questions: How does system CALCULATE insulin delivery? A: How does user ADJUST insulin doses - immediately and long term. R: REVERT – how/when/why does system revert to standard pump settings. E: EDUCATION or expert help, where will you get this from? Challenges will lie in each individual age group, with adolescents very different physiologically and cognitively from pre-teens and those under 6.

Beyond the closed loop. The future has fully automated closed loop, requirement for faster insulin: incorporating modifications to improve kinetics, intra-peritoneal delivery and adjunct therapies to compensate (glucagon, pramlintide, SGLT2 inhibitors, GLP1 agonists). The day to day challenges will be with glucose sensing accuracy and lag, and infusion set having reduced interruptions and improved longevity. The ability to make it smaller, easier, simpler and less burdensome, and allow big data to
be easy and accessible, actionable, and learn from it is needed. Islet Cell Replacement Technologies should aim to be implanted without the need of immunosuppression and there are many other challenges to be overcome before islet replacement will catch up to the technology side of diabetes care.

**Emotional burden of Type 1 diabetes**

Diabetes is not a “Do it yourself-disease”, except for rare individuals, most need a team and support to cope with the vigorous requirements of good diabetes control; from eating to exercise to exams. Clearly, diabetes makes patients different and they are at the age of invulnerability. Distress happens and is an emotional response to the challenges of living with diabetes. Distress is a better predictor of diabetes control than depression; parental distress is associated with low levels of teen-age self-efficacy. Should health care workers expect teen-agers to be perfect? Interventions focused on resilience improve biological and good psychological outcomes.

Intensified therapy is not the “Nirvana” we hoped for, pumps are not magical and “not all that is new is better”. The perfect storm of increased cost of care, increased government interference and disruptive influence of social media, surrounds the current care of diabetes. Few decisions made in consultations between patients and medical staff are remembered by either party, so communication is not good. Adolescents are no better than the days of Socrates, so where is the age or time of transition best suited! The questions are “Are we on the same page as our adolescents? Have we set achievable goal for them? Do we have an appropriate circle of influence for them? Should we be dogmatic about outcome, but pragmatic in approach?

The impact of diabetes on the entire family is highlighted by the high amount of diabetes related distress in parents and fear of hypoglycemia is common. There are also parental high expectations that technology will reduce hypoglycemia, Parents however are sage, and aware that their attitude and behaviors are not always helpful. One could suggest that we do recall what it’s like to be an adolescent!
The state of the art on Diabetes Complications

The developing brain is a target organ in diabetes, synaptogenesis peaks at the average age that diabetes is diagnosed, and in a child takes up to nearly 50% of the basal metabolic rate. Events at diagnosis and glycemic extremes differentially affect the developing brain. However there is a lot of remodelling of the brain that occurs during childhood and adolescence. The role of glucose metabolism and insulin in the brain is still an area of active research and investigation; however reducing glucose variation in children with diabetes is important to prevent potentially long term effects on brain function.

Current treatment of retinopathy today is initiated only in late phases. Considering the pathophysiology of the disease, it is known that neuro-degeneration is an early event, secondary to apoptosis and reactive gliosis. In mice it is possible to induce diabetes induced retinal neuro-degeneration and this can be measured by multifocal electroRG or spectral domain optical coherence tomography. New therapeutic approach includes GLP1 receptor agonists (GFP1r are present widely in the retina) and experiments are underway with GLP1rag eye drops in the mice. GLP1 drops reduce reactive gliosis and apoptosis via reduction of glutamate concentration in the retina, with subsequent events preventing diabetes induced retinal neuro-degeneration.
Diabetes E-health

This session outlined the impact of “closed data-loop”; enabling a large improvement in metabolic control and empowering patients. Combined with improving contacts, coordinating with insulin pump therapy, and outlining the lag time of 3-6 months to enable engagement of the technology with patients and team. A pragmatic approach for a target of improving control is needed.

The Be He@lthy Be Mobile program outlined the ability to bridge the new problems we face with our new opportunities, in particular the internet of everything. Fascinating approach and outlining the adoption of technology and smart phones in particular in the 3rd world, more receptive than some first world centres. M-diabetes in practice linking the local team to international experts, in turn with ability to provide data, review and disseminate information. Data provided clearly showed efficacy of diabetes awareness messages (special situations and medical conditions).

Have Fun---gaming in diabetes ensured that we know how much we owe to the gamers and game designers of the world. Opening the “diabetes” piñata, opens the world of parent-child interaction over diabetes in a simple and non-confrontational environment. Humans teach skills and survival by games and interaction over millennia, not by sitting in classrooms and with exams, online gaming is the new tool we have to hone and develop this for children with diabetes.
Session: Best Oral presentation
Title: Pharmacokinetics and pharmacodynamics profile of the SGLT2 inhibitor empagliflozin (EMPA) in pediatric patients with type 2 diabetes

The best oral presentation was won by Lori Laffel and team from Harvard Medical school. The authors studied the pharmacokinetics/pharmacodynamics (PK/PD) of a new oral hypoglycaemic agent (Sodium-glucose Cotransporter-2 (SGLT2) Inhibitors) in 27 children and young people (CYP) aged 10-17 years with type 2 diabetes. They were randomly assigned to receive a single dose of either 5mg, 10 mg or 25mg of empagliflozin (EMPA) in addition to life style intervention and /or a stable dose of metformin and/or insulin therapy. There was a dose dependent decrease in fasting blood glucose. The authors also found that the single dose of EMPA was well tolerated by CYP with similar PK/PD as in adult studies.

Best Poster Presentation
Title: Evaluation of a novel method to detect residual B-cell function by dried blood spots.

The best poster was won by R.Willemson (UK). The team from Cambridge (collaborating with other centres in UK) explored the use of a novel method of detecting residual beta cell function by measuring C peptide in dried blood spots (DBS). Following a mixed meal tolerance test in 26 (aged 6.9-16 years) with type 1 diabetes, (within 6 months of diagnosis and 12 months after diagnosis), the authors measured C peptide levels in venous blood and in DBS. Plasma C peptide and dried blood spot C peptide levels correlated well (n=85 paired samples, r=0.95; p<0.001). The authors conclude that DBS C peptide measurement may be a useful tool in measuring beta cell function in intervention studies.