Intensive diabetes management and goal setting are key aspects of improving metabolic control in children and young people with type 1 diabetes mellitus

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Abstract
Diabetes control in children remains poor in spite of advances in treatment for last 10 years. The aim of this review was to look at various aspects of intensive therapy in the management of type 1 diabetes such as insulin regimes, role of target setting, psycho-educational approaches and self-management. To achieve good metabolic control, clear goal setting with adequate support for self-management are essential. Psycho-educational and behavioural interventions aimed at specific areas of management have shown significant improvement in quality of life and diabetes control.

INTRODUCTION
Type 1 diabetes is characterised by autoimmune destruction of the β cells leading to insulin deficiency. It accounts for 90% of childhood diabetes in the western world. The incidence has been increasing over past 2 decades and poses a global challenge[1]. The aim of diabetes management in children is to achieve near normoglycaemia without major hypoglycaemic episodes and to prevent long term complications associated with hyperglycaemia[2].

Early normalisation of blood sugars with intensive insulin therapy might lead to improved long term control and higher endogenous insulin production 1 year after the diagnosis[3]. Good glycaemic control in patients with Insulin Dependent Diabetes mellitus delays the onset and slows the progression of long term complications. Several approaches are taken when aiming for low glucose targets. The Diabetes Control and Complication trial
Insulin Delivery and Regime

Treatment with insulin is the mainstay of therapy in type 1 diabetes mellitus. Many formulations are available but with the advent of newer analogues, they are mainly used in treatment in children. There is no data on the long term benefits of these analogues but they provide more flexibility and some improvement in the care of diabetes.

The choice of insulin regime depends on the individual. The basal bolus therapy or multiple daily insulin (MDI) regimes consists of long or intermediate acting insulin is given once or twice a day with boluses of rapid acting insulin analogue with meals. Insulin pump or continuous subcutaneous insulin infusion (CSI) works on similar principles but delivers short acting analogue continuously with boluses at meal times. After DCCT trial, these modalities have become the norm of diabetes treatment. Other methods include use of pre-mixed insulin which contain fixed ratio mixtures of short and intermediate acting insulins. They are given as two injections a day. Currently, there is no clear evidence that one insulin regime is superior to other on its own.

There are various cross-sectional studies looking at different insulin regimes (Table 1) but none of them have found any clear evidence that one is superior over the others.

Insulin pumps

There are several systematic reviews and meta-analysis including a Cochrane review comparing CSII to MDI. Most of them have favoured CSII for better control but recent meta-analysis comparing CSII to MDI showed no significant change in HbA1c from baseline level after 16 wk or more of follow up in children. Overall CSII has been found to yield better quality of life compared to MDI, however benefit to glycaemic control is variable.

Sensor augmented pump therapy (SAP) which integrated CSII with a continuous glucose sensor. In a comparative meta-analysis sensor-augmented insulin pump use resulted in a statistically and clinically significant greater reduction in HbA1c levels than with MDI or self-monitoring of blood glucose (SMBG) in persons with type 1 diabetes mellitus. Sensor-Augmented Pump Therapy for A1C reduction, STAR 3 study has shown that compared to MDI, SAP offers rapid glycemic advantage in children and adolescents which lasted for the entire year of study phase.

SMBG is the key to achieving main goals of insulin therapy. Several studies have established that frequent

### Table 1 Review of studies comparing different insulin regimens

| Ref. | Method/population | Outcome |
|------|-------------------|---------|
| de Beaumont et al. | Observational cross-sectional international study/2036 patients (11-18 yr) | No improvement in glycaemic control over a decade |
| Holl et al. | Multicentre observational study/872 patients (11-18 yr) | Deterioration in metabolic control in all three groups over 3 yr period |
| Haller et al. | Observational Study (enrolled patients were on preferred regimes from 12 paediatric endocrinologists)/229 patients (9-15 yr) | One group had moved from twice daily to multiple injections |
| Nordly et al. | Multicentre cross-sectional study/874 (< 16 yr) | Increased number of insulin types correlated with increased HbA1c |
| Paris et al. | Multicentre cross-sectional study/2743 patients (< 20 yr) | Children with 2 injections a day had significantly better control than children on 3 or 4 injections a day |
| Jakisch et al. | Multicentre matched patient cohort analysis, comparing CSII to MDI/434 matched pairs | Insulin pump users had better control. No difference between MDI or 2-3 injections a day |

MDI: Multiple daily insulin; CSII: Continuous subcutaneous insulin infusion; HbA1c: Hemoglobin A1c.
of SMBG is directly proportional to improved HbA1c levels[12,24].

More recently continuous glucose monitoring (CGM) has been used and can provide information on trends of blood glucose levels. It is considered to be useful for children with poorly controlled diabetes. Recent Cochrane review has shown that there is limited evidence of improved glycaemic control in patients with poorly controlled diabetes. But the review found larger decline which was statistically significant in HbA1c for real-time CGM users starting on insulin pump therapy(sensor augmented pumps) compared to patients using MDI and SMBG (conventional therapy)[25].

GOAL SETTING AND PSYCHOLOGICAL INTERVENTIONS TOWARDS SELF MANAGEMENT

Specific goal setting is an encouraging way of improving adherence to diabetes management in young people[22]. As parental support and involvement is associated with better management of diabetes in children and adolescents, their perception of goals for optimal management of diabetes is associated with actual control achieved in children[23]. Hvidoere study group has documented persistent inter-centre differences in the mean HbA1c over 10-year period in spite of changes to the insulin regimes[24]. They concluded that target setting might be the most influential factor in lowering the HbA1c[24]. Key findings from their work suggests that best metabolic results are obtained by physicians who target driven and teams and families have unanimity of purpose[7].

It is important to have necessary self-management skills in order to achieve goals of diabetes therapy. Diabetes self-management is the process of providing the person with diabetes education, knowledge and skills needed to successfully manage diabetes[23]. It is multi-dimensional and refers to the young persons or/and parents sharing responsibility and decision making for achieving optimal control[26]. Goals for self management varies considerably by age, development, family characteristics, duration of diabetes and lifestyle[27,28]. Adolescence could be a challenging time in control of diabetes. It has been recognised that diabetes control tend to decline during this period[29]. As young people strive for autonomy, social influence and peer pressure with desire to fit in can be higher priority than diabetes management for some young people[20,31]. Various psychological and educational interventions are used to empower the young person with necessary self-management skills but efficacy of one over another is not established. Wysocki et al[25] found that youths with suboptimal pre-treatment status with high autonomy to maturity (AMR) did better with intensive treatment over 18 mo period compared to the ones who had low AMR and better HbA1c. An integrated review in 2011 demonstrated that there is a clear relationship between self-management and metabolic control but there

is multitude of factors playing part[32]. Research has also shown that there is an association between psychosocial factors and metabolic control in a large international cohort of adolescents with type 1 diabetes mellitus[33]. Good metabolic control is associated with better quality of life in adolescents[34,35]. It is also associated with families of children with better control reporting lower disease burden. Behavioural interventions for young people with diabetes and their parents have demonstrated improvement in adherence of treatment[36]. Interventions based on clear psycho-educational principles are most effective[37]. In a systematic review of psychological interventions for improving diabetes control, psychological therapies led to significant improvement in glycaemic control in children and adolescent compared to adults[38]. A case study of 9 adolescents with consistently poor control previously has shown has shown marked improvement with coaching[39]. These findings show that assessment of psychosocial factors should be an integral part of the paediatric diabetes care in this population[35,40].

There are various structural education programmes for adults with type 1 diabetes which have shown improvement in their control as well as quality of life[41,42]. However, there is need for practical, clinic based educational interventions for children and adolescents. Various trials have reported disappointing outcomes in improving control when applied to families and children in a real life setting[43,44]. The Kids in control of food is a structured education course based on Dose Adjustment for Normal Eating course which is a current adult education programme. The pilot showed significant improvement in quality of life and self-efficacy at 3 and 6 mo. There was no change in glycaemic control overall but improvement trend in those with poorest control[45]. Results of the randomised trial will hopefully give us more information on the effect of highly structured group education on a population with wide range of glycemic control[46].

In a systematic review by Hampson et al[43], it was concluded that educational and psychological interventions are most likely to be effective if demonstrate an inter-relatedness of various aspects of diabetes management. There is a gap in evidence as no complete understanding of where these interventions to be targeted.

CONCLUSION

Good metabolic control is needed to prevent long term complications of diabetes. It is challenging in the paediatric population to achieve optimal control due to various developmental and psychological factors [47]. Psycho-educational and behavioural interventions play an important role in the diabetes management. However, there is need for practical, cost effective interventions which could be applied to the diabetes population in a clinic setting such as goal setting and psychosocial interventions. Svensson et al[48] have reported significant improvement in diabetes control independent of number of injections per day or insulin regimens but thought to be due to increased focus
on treatment goals, glucose monitoring and optimising care in their population over 10 years period. Overall, this review concludes that clear goal setting with good multidisciplinary team effort working together with families and children towards specific targets may be the key to good diabetes control.

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