Insulin administration skills of children with type 1 diabetes

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Article points

1. Growth and development is an important factor in the participation of children in their diabetes treatment.
2. Insulin administraton skills vary during childhood, depending on age. Increasing age is associated with improved insulin administration skills.
3. No statistically significant correlation was found between insulin administration performance and gender, HbA_{1c} level and duration of diabetes.

Key words
- Children
- Injection skills
- Insulin administration

Increasing age in childhood is associated with progressive development of psychomotor, mental and emotional skills. Where appropriate, a child with diabetes should be given responsibility for insulin administration suitable to his or her stage of development, as it is important that parents should provide that autonomy to the child (International Society for Pediatric and Adolescent Diabetes, 2000; Streisand et al, 2002). This study was undertaken to assess the insulin administration skills of children with diabetes in different age groups, and to see whether age, diabetes duration or HbA_{1c} level had an effect on these skills.

Type 1 diabetes is the most common endocrine disease in childhood. The condition is characterised by a complete lack of insulin and the individual will need exogeneous insulin treatment for their whole life (International Society for Pediatric and Adolescent Diabetes [ISPAD], 2000; American Diabetes Association [ADA], 2004).

For diabetes management to be successful it is necessary that insulin is administered correctly. It is important that both the child and parents know how to do this (Streisand et al, 2002; Canadian Diabetes Association Clinical Practice Guidelines Expert Committee, 2003).

The ADA (2004) states that the child can start taking responsibility for insulin administration at around 10–12 years of age, but that this responsibility should be given gradually. However, it should be noted that every child's development level varies. There is great individual variation in the appropriate age for children to self-inject. The appropriate age relates to developmental maturity rather than to chronological age. For instance, while one child's hand skills can develop at 7 years of age, that of another can be at 10 years of age. Most children older than 10 will be able to administer their own injections or help with them. In rapid periods of development, the child should be assessed individually in terms of physical and emotional development (Pinar and Yazici, 1996; ISPAD, 2000). During this transition, however, the family must remain involved in the education and treatment of the child, despite the child taking more responsibility (Silink, 1996; Silverstein et al, 2005).

Younger children can manage their injections successfully in later periods by sharing the responsibilities, such as preparing the injection, choosing the site, etc. When a child starts school, time is spent away from home, and friends start to gain importance in the child's life. Time spent at school, as well as attendance on diabetes camps and visiting friends is going to be beneficial for the child to acquire self-administration skills by themselves (Silink, 1996; Palmer et al, 2004; Leonard et al, 2005).

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Aims

This study was undertaken to:

- Assess children's insulin administration skills according to their age.
- Determine the mistakes that children make during insulin administration.
- Assess the effects of age, HbA_{1c} level, and duration of diabetes on insulin administration skills.

Methods

Forty-five children with type 1 diabetes between 7 and 18 years of age were included in the study. These children were registered to the Trakya University Health Research and Application Center Child Endocrinology Policlinics. Clinical controls are performed on a regular basis, and the children are able to administer insulin by themselves. The children were divided into three age groups: 7–9, 10–12, and 13–18 years of age. Prior to the study, the parent and the child were informed about the objectives and content of the study, and written permissions were obtained.

Two data collection forms were developed by the authors for use in this study: the "diabetic child diagnosis form" and the "insulin application form". The diabetic child diagnosis form collects data about the children's age, gender, diabetes duration and last HbA_{1c} values. The insulin application skill form is an 18-item skills list, which was prepared according to injection technique proposed by the ADA (2004).

The diabetic child diagnosis form was completed after meeting with children face to face. HbA_{1c} values are taken from the child's medical records.

For the assessment of insulin application skills, the child was observed directly by a nurse experienced in diabetes, and the form filled in. Although insulin administration skills were being evaluated, the child's choice of insulin pen was not taken into consideration, as they used their own equipment.

Before the observation, the equipment required for insulin administration was prepared. The children were asked to administer their insulin in the way that they usually do, without help from a nurse. On completion, the children were informed whether they did anything wrong, and then were taught the right methods if necessary.

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Table 1. Clinical characteristics of the children with diabetes by age group.

Characteristic	Age group			Total
	7–9 years	10–12 years	13–18 years	
Number (*n*)	6	17	22	45
Mean age at entry (years)	8.1±0.75	11.1±0.96	15.1±1.89	12.7±2.9
Sex (% female)	50.0	82.4	68.2	71.1
HbA_{1c} level:				
Mean	7.7±1.8%	93.6±2.5%	9.0±2.0%	8.9±2.1%
Range	4.8–10.6%	5.6–13.0%	6.0–13.0%	4.8–13.0%
Diabetes duration:				
0–3 years	3	9	10	20
4–6 years	3	4	2	9
7–10 years		4	12	16
Injections per day:				
2	-	1	-	1
4	6	16	22	44

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1. Forty-five children between the ages of 7 and 18 years (71.1% female) were included in the study.
2. Regarding insulin administration skills, the individual correctness was between 16.7% and 83.3% for children aged 7–9 years; between 5.9% and 94.1% for those aged 10–12 years; and between 13.6% and 100.0% in those aged 13–18 years.
3. Correct application of mounting the needle to the insulin pen, checking the cartridge before the injection for air, adjusting the insulin dose correctly, choosing a suitable injection site and disposing of the used materials significantly increased with age (P<0.05).

Statistical analysis

Data were analysed using SPSS 10.0. Considering the age groups, the ratio of children applying each skill correctly was rationed to the total number. Chi-squared was used to compare correctly applied skills according to different age groups. For the assessment of total skills performance, those children who applied all the 18 items stated in the insulin application skill form correctly were accepted as 100% successful and the other children's mistakes were evaluated depending on mistake numbers.

The Mann–Whitney U test was used to assess whether there was a significant difference in insulin application skill performance values according to gender. A Kruskal–Wallis test was used to compare insulin application skill performance values according to age groups and duration of diabetes. P<0.05 was accepted as statistically significant.

Results

Forty-five children between the ages of 7 and 18 years (71.1% female) were included in the study. The clinical characteristics of these children are shown in *Table 1*.

All participants had been educated about insulin administration: 68.8% had their education from a nurse, 20.0% from a doctor and 11.1% from their parents.

Comparison of insulin administration skills according to age group

The percentage of the children who applied each skill correctly and comparison of these percentages according to the age groups are shown in *Table 2*. Regarding insulin administration skills, the individual correctness was between 16.7% and 83.3% for children aged 7–9 years; between 5.9% and 94.1% for those aged 10–12 years; and between 13.6% and 100.0% in those aged 13–18 years.

Washing hands before administration, waiting for drying of alcohol if applied to injection site, and recording the application into observation form were the skills in which participants in all age groups had a relatively low success ratio. Correct application of mounting the needle to the insulin pen, checking the cartridge before the injection for air, adjusting the insulin dose correctly, choosing a suitable injection site and disposing of the used materials significantly increased with age (P<0.05).

Table 3 shows the average number of mistakes in insulin administration according to age group. Overall, increasing age was significantly associated with a decrease in the number of mistakes in insulin administration (P<0.05).

The relationship between patient characteristics and skill performance

Baseline data (age, gender, diabetes duration, HbA_{1c} level) and total skill performances are shown in *Table 4*. Increasing age was again significantly correlated with an increase in correct administration skills: those in the 7–9 years age group averaged 51.9%; the 10–12 years age group averaged 64.3% success; and the 13–18 years age group averaged 71.0% success. There was no significant difference in administration ability between girls and boys, or between children within different HbA_{1c} brackets.

Discussion

It is generally agreed that technical skills significantly improve in children between 10 and 12 years of age, and children at these ages are ready to take on the majority of responsibility for their insulin administration (Silverstein et al, 2005; Schilling et al, 2006; Swift, 2007). At these ages, hand–eye coordination significantly improves, together with mental and motor skills (Velasco-Whetsell et al, 2000). However, children at these ages should be assessed individually and should take responsibilities for insulin administration according to their knowledge and skills.

In the literature, it is stated that children can start taking responsibility by performing their own insulin injections at the age of 10–12 years (Wysocki et al, 1996; ADA, 2004; Bangstad et al, 2007; Swift, 2007).

The results of the present study suggest that there is an important increase in insulin administration performance as age increases. The

authors, therefore, suggest that the family should reduce the amount of help and control they afford the child, gradually passing full responsibility for insulin administration to the child.

The high number of mistakes and the low success rate obtained in insulin application skills of younger children indicates that at these ages the family must be present and helping during insulin administration, and some researchers suggest that children should not start taking full responsibility until 15–16 years of age (Silink, 1996; Streisand et al, 2002).

Wysocki et al's (1996) study showed that children can start taking responsibility for performing their own insulin injection at the age of 9.2±1.5 years, and can take full insulin administration responsibility by the age of 16 years through a gradual increase in responsibility during that time. In this study, 83.3% of children 7–9 years of age adjusted the insulin dose correctly, whereas 100% of older children adjusted their dose correctly. Wysocki et al (1996) found out that children can adjust their insulin dose correctly at the age of 9.7±1.8 years. However, as in the present study, the correlation between insulin administration skills and diabetes duration was not found to be significant.

Table 3. The comparison of average mistake number in insulin application according to age group.

Age (years)	Average mistake number
7–9	8.16±4.3
10–12	6.05± 2.1
13–18	4.90±1.7

Table 2. The distribution of correct insulin administration skills and its comparison according to age groups.

Injection skills	Age group			Total	*P*-value
	7–9	10–12	13–18		
Washing hands before the application	16.7	35.3	18.2	24.4	0.417
Mounting the needle to the insulin pen	50.0	88.2	100.0	88.9	0.003*
Check for air bubbles in cartridge	33.3	52.9	81.8	64.4	0.040*
Adjusting the right insulin dose	83.3	100.0	100.0	97.8	0.036*
Choosing the right injection site	66.7	88.2	100.0	91.1	0.034*
Pinches up skin with non-dominant hand	50.0	94.1	54.5	68.9	0.017*
Insulin pen at an appropriate angle	83.3	76.4	90.9	84.4	0.466
Not changing angle while injecting and taking out the insulin pen	66.7	88.2	95.5	88.9	0.138
Waiting for 10 seconds without taking out needle after injection	66.7	70.6	81.8	75.6	0.622
Applying pressure on injection site	50.0	47.1	68.2	57.8	0.382
Removing the needle from the insulin pen	16.7	23.5	36.4	28.9	0.529
Insulin pen's cover to close	83.3	94.1	100.0	95.6	0.200
Removing the used materials	50.0	88.2	90.9	84.4	0.043*
Recording the application on the observation form	16.7	17.6	36.4	26.7	0.355

*statistically significant ($P<0.05$)

"It is necessary for children with diabetes to have enough knowledge and capability to take responsibility for their own insulin treatment, and it is clear that as children age, their ability to administer insulin improves."

Previous studies have indicated that parents and healthcare professionals may cause children with diabetes to take too much responsibility on too soon. Specialists suggest that the expectations of taking responsibility for insulin administration are not reasonable unless the child's motor and mental skills are taken into consideration (Wysocki et al, 1996; Schilling et al, 2006).

Conclusions

Insulin therapy is one of the most important factors of type 1 diabetes management, and can only be possible with the right insulin administration. It is necessary for children with diabetes to have enough knowledge and capability to take responsibility for their own insulin treatment, and it is clear that as children age, their ability to administer insulin improves.

During childhood it is important for the family to take responsibility and gradually make their child to be responsible as his or her age increases while their role as a supervisor continues. The diabetes team and the family should understand the growth and developmental period of the child and adolescent, and should behave sensitively in developmental issues.

It is important that children's insulin application performances be observed in certain periods, and the family and child informed and educated regarding the changes occurring in these periods to enable the child to take responsibility for their condition appropriate to their age. ■

Table 4. Distribution of total skill performance according to variables

Variables	Percentage of skills performed correctly	*P*-value
Age-group (years)		
7–9	51.9 ± 25.3	0.013*
10–12	64.3 ± 12.7	
13–18	71.0 ± 10.1	
Sex		
Male	64.6 ± 18.7	Non-significant
Female	66.5 ± 13.3	
Duration of diabetes (years)		
0–3	62.3 ± 17.8	Non-significant
4–6	69.8 ± 14.8	
7–10	68.3 ± 9.8	
HbA_{1c} level (%)		
<7	66.1 ± 12.8	Non-significant
7–9	66.0 ± 6.9	
9–11	64.2 ± 21.2	
>11	63.1 ± 15.3	

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