DESIGN OF INSULIN INJECTION PRODUCTS FOR CHILDREN WITH DIABETES

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Current status of onset and treatment of T1DM in children: T1DM, also known as type 1 diabetes, is a type of diabetes [1] with ketosis tendency due to the absolute scarcity of insulin caused by the damage of islet B cells. The incidence of T1DM is concentrated in children. In recent years, the incidence of T1DM has gradually increased worldwide, which seriously threatens the physical health of children. At present, there is no radical treatment for T1DM in children, but long-term insulin injection is needed to alleviate the condition. The main injection methods include subcutaneous injection and continuous insulin pump injection [2].

Research status of foreign countries: According to the data of the World Diabetes Federation in 2019, the number of new cases of T1DM in children under 15 years of age in the world is estimated to be 98,200, and the number of cases is about 600,900, with an average annual increase of about 3%. Since only 45% of countries worldwide have reported the incidence of T1DM, The actual incidence and number of cases should be much higher [2]. The incidence of T1DM varies greatly in different regions. The overall incidence of T1DM in Europe is relatively high. Finland is the country with the highest incidence of T1DM in children in[3] the world. Other European countries such as France were slightly lower, and the incidence of T1DM in children was 19.1 in 100,000 people per year in 2015, with an average annual increase of 4% [4]. In recent years, the incidence of T1DM in children in western countries has gradually slowed down. For example, the annual average increase of T1DM in children in New Zealand from 1977 to 2006 was 2.9%, but the annual average increase was only 0.3% from 2006 to 2019. The incidence of T1DM in children aged 0 to 4 years did not increase significantly from 2003 to 2009. It suggests that the incidence of T1DM is slowing down [5].

According to a study of children with T1DM in 5 regions of the world, the treatment, and outcomes of children with T1DM vary significantly in different [6] regions. The main reasons for the observed differences may be the differences [7] in health care systems and the accessibility and quality of diabetes care. In high-income countries, resources to achieve comprehensive diabetes care are usually provided by national health systems. From this, there is a strong link between the treatment of children with T1DM and the quality of their daily care and quality of life.

Domestic research status: According to the incidence of T1DM in domestic children, the incidence of type 1 diabetes in Chinese children is increasing year by

year; The incidence increased with the increase of age; There is a 12-fold difference between ethnic groups; The incidence was significantly lower in the south and higher in the north among [8] different regions. The results also showed that the incidence in large cities such as Shanghai and Beijing were significantly higher than that in other small and medium-sized cities in non-ethnic autonomous regions. These results all support the fact that people with the same genetic background have different risks of developing type 1 diabetes due to different environmental factors, in addition to the influence of genetic factors. Data from 7 regional centers showed that the confirmed adjusted incidence rates of type 1 diabetes in urban and suburban (rural) children were 1.12/100,000 population years (95%CI: 1.07 ~ 1.18) and 0.38/100,000 population years (95%CI: 0.34 ~ 0.43), respectively. The incidence of type 1 diabetes in urban children was significantly higher than that in suburban and rural areas. On the one hand, it is due to the high living standard in urban areas or the higher possibility of exposure to environmental hazard factors, which needs to be further verified. On the other hand, due to the relatively poor medical conditions in rural areas, unreported or undiagnosed coma deaths may occur more in rural areas. From the quality of registration, the overall certainty level of urban and rural sources is 93% and 89%, respectively, and the quality of registration in urban areas is slightly higher than that in rural areas.

At present, T1DM in children cannot be cured radically, and the symptoms of the disease usually need to be alleviated by long-term use of drugs. Since the disease requires long-term treatment, it is necessary not only to effectively monitor the metabolic indicators of children, but also to carry out appropriate intervention [9-10] in all aspects of children. High quality care can significantly improve the treatment of diabetes, which indicates that the living environment and quality have a relatively large impact on the treatment of children's T1DM. For children, the family environment and family relationship have a great impact on the treatment of diabetes. T1DM intervention in children often requires the cooperation of parents to achieve better results. Previous studies have reported that family-based nursing intervention can effectively improve the family intimacy and adaptability of children with T1DM as well as improve blood sugar level [11-13]. There are also some domestic research results in this regard. For example, the implementation of nurse-dependent-patient cognitive interaction mode intervention in T1DM patients can improve their blood sugar level, improve their self-management ability, quality of life and treatment compliance [14].

Children with T1DM need long-term insulin injection to alleviate the condition. Since most of the patients are children and young adults, who are just in the growth and development age, the insulin injection dosage required by patients of different ages is also different, to ensure the normal growth and development [15] of the patients in childhood.

Types of insulin injection products: Insulin syringes are used for subcutaneous injection rather than intravenous injection, so the level of hygiene requirements is relatively low, and the use of insulin syringes does not require a sterile en-

vironment, which also reduces the requirements for the use of insulin syringes. Insulin syringes are mainly divided into the following types: 1. Insulin pump, namely, subcutaneous insulin injection system, achieves the purpose [16] of artificial islets by inputting insulin through microcomputer intelligent control. 2. Insulin injection pen is easy to carry and can be injected several times a day. Attention should be paid to avoid multiple injections into the same site to prevent hyperplasia [17] of subcutaneous fat; Also need to pay attention to replace the needle on time, repeated use will lead to needle wear, worn needle cannot easily enter the skin as a new needle, so it will increase the pain of injection, in addition, it is more likely to cause skin damage. 3, insulin needle-free syringe, using high pressure to let the liquid flow through the skin into the body. Because it does not use a traditional needle injection, it can solve the problem of some people's fear of metal needles. But needle-free syringes can be expensive compared to pens.

At present, the design of insulin syringes at home and abroad pays more attention to the function, appearance and ergonomic suitability of the product, and the operation and use of injection is more complicated, causing inconvenience for some patients with physical defects or mental development deficiencies. These lack of a more user-friendly design for the product, which is easy to make users more resistant to the behavior of injection. However, with the development of science and technology, higher requirements are put forward for products to meet people's psychological needs. People are no longer satisfying simple material needs, but their needs are developing towards emotional interaction level. The humanized design of products will gradually increase in the proportion of product design, and only products to meet the functional needs and psychological needs of consumers can better survive in the fierce market competition, the attention to the humanized design of products will be the inevitable trend [18] of the market.

Analysis of the characteristics of children users: the research object of this topic is the patient group of type 1 diabetes, which is mainly concentrated in children and adolescents under the age of 15. The treatment of this disease is mainly insulin injection, that is, patients need to inject insulin all year round.

The brain of children is still in the developing stage, the younger the age, the weaker the self-control. They are easily distracted, easily affected by one thing, easily excited, and more easily stimulated. During insulin injection treatment, child patients are more likely to have a fear of injection and pain, which will lead to psychological problems in the long-term treatment process. It is possible to have a fear of needles. Long-term repeated treatment is also easy to make patients have a psychological [19] resistance.

In the process of using insulin syringe, the user needs to change the needle and inject it by himself. The needle is exposed for a long time, and children are more likely to have a fear of the needle. In addition, since the detachable parts of the insulin syringe include the syringe cap and the syringe needle, during the operation of the insulin syringe by children, due to lack of concentration, the parts may

be lost, such as the loss of the needle and other parts, which will also increase certain safety and health risks, which is not conducive to the formation of a good injection habit for children.

Insulin syringe research focusing on children: no matter which injection method is used, patients are more likely to be afraid of injection and pain, which will lead to psychological problems in the long-term treatment process. Long-term single treatment is also easy to make patients resistant [19]. Therefore, children's injection products need more emotional design to relieve children's negative emotions [20]. In the existing family medical design, the medical product design suitable for adults is relatively common, and the products are scattered, the way is mechanical, and the treatment information is difficult to read. Combining the existing products such as insulin pen, insulin pump and needle-free syringe, three problems in the injection behavior were analyzed. First, the small and portable insulin pen is the preferred product in the treatment plan of multiple daily injections. It can save the unit of measurement and the time since the last injection, but it cannot carry out more detailed record and monitoring. Secondly, patients often have visual problems, and this product is not conducive to the use of patients with visual impairment alone, and if more than one insulin drug is used in the treatment, different injection pens must be used respectively. In the early stage, parents mainly guide children to participate in the treatment, but it limits the children's learning and the guardian's follow-up in the later stage. Third, patients with long-term acupuncture have sensitive heart. No matter the existing insulin pump or syringes without needles, they are large in shape, too mechanical and programmed in use, which is easy to cause patients' resistance, and can not achieve the purpose of educating children to actively recognize diseases and self-treatment. The contradiction that the hardware of related products cannot keep up with the special needs of children has existed [21] for a long time.

To solve the problems in children's insulin injection, there are also some improvement methods. On one hand, it is guided by encouragement and guidance to assist children to carry out insulin injection [22] independently, such as increasing the auxiliary positioning device to reduce the difficulty [23] of operation, sticking the positioning stickers on the skin to guide children, and designing the stickers into different patterns. To increase the interest, in the growing process of children, gradually get used to self-injection insulin, to ensure that school-age patients and in the absence of other parents can also complete their own injection; On the other hand, it can reduce negative emotions during the injection process, such as hiding the needle to eliminate patients' fear [24] of needles.

Compared with insulin injection, the current research on injection design is more focused on the emotional design of syringe, to increase the fun of injection process and relieve children's fear of injection. However, compared with ordinary injection, insulin injection often needs to be carried out in daily family life and may need to be injected by children's parents or children themselves. Therefore, it lacks certain professionalism and safety in operation. Therefore, it is necessary to pay attention to the process of insulin injection and analyze possible problems from it.

Conclusion: With the gradual increase in the number of children with T1DM at home and abroad, the demand for insulin injection for children is also increasing, and more problems will be exposed during injection. The treatment process of children T1DM is very long, not only needs to meet the material conditions, but also needs psychological and spiritual care. A better family environment and a more convenient and reassuring injection experience are all favorable conditions for treatment. At the same time, the development of science and technology also makes people put forward more demands for such products, eager for a more user-friendly design. Therefore, the design and research of children's insulin syringes not only pay attention to the functional design, but also pay more attention to the humanized and emotional design.

References

1.Hou L, Luo Xiaoping. Status and diagnosis of type 1 diabetes mellitus in children [J]. Chin J Diabetes,2016,24(05):472-474.
2.Zhang Y. Effect of different insulin injection regimens in the treatment of type 1 diabetes mellitus in children [J]. Diabetes in the new world, 2020, 23 (13) : 32-34. DOI: 10.16658 / j.carol carroll nki. 1672-4062.2020.13.032.
3.Patterson CC, Karuranga S, Salpea P, et al. Worldwide estimates of incidence, prevalence and mortality of type1 diabetes in children and adolescents: Results from the-International Diabetes Federation Diabetes Atlas, 9thedition Diabetes Res [J]. Clin Pract, 2019, 157: 107842.
4.Knip M. Type 1 diabetes in Finland: past, present, andfuture [J]. Lancet Diabetes Endocrinol, 2021, 9(5): 259-260.
5.Piffaretti C, Mandereau-Bruno L, Guilmin-Crepon S, et al. Trends in childhood type 1 diabetes incidence in France,2010-2015 [J]. Diabetes Res Clin Pract, 2019, 149: 200-207.
6.Saiyed Mahira, Hasnani Dhruvi, Alonso G. Todd, Richmond Erick, Besancon Stephane, Cotterill Andrew, Ngwu Ursula, Mazza Carmen, Rottembourg Diane, Lanzinger Stefanie. Worldwide differences in Childhood Type 1 Diabetes: The SWEET experience. [J]. Pediatric diabetes,20,22(2).
7.Charalampopoulos D, Hermann JM, Svensson J, et al. Exploring variation in glycemic control across and within eight high-income countries: a cross-sectional analysis of 64,666 children and adolescents with type 1 diabetes. Diabetes Care. 2018; 80-1187, he and I.
8.Wang Ke 'an, Li Tianlin, Li Xinhua, Yang Ze, Wei Yi, Yan Chun, Liu Zunyong, Ni Guichen, Jin Shuxiang, Chen Hong, Qin Ru Li, Li Yanqin, Li Yurui. Study on the incidence of Type 1 diabetes mellitus in Chinese children [J]. Chinese Journal of Endocrinology and Metabolism,1999(01):6-10.
9.Wang XM, Wang R, Li F T, et al. Construction of out-of-hospital health management content system for children with type 1 diabetes mellitus based on mobile health care [J]. Chinese Journal of Modern Nursing, 201, 27 (6) : 708-714.
10.Liu Haiou, Zhang Chunxia, Ye Xiaojun. Effects of home care combined with intensive lifestyle management on glycated hemoglobin level and quality of life in

children and adolescents with type 1 diabetes mellitus [J]. Chinese Journal of Medicine and Clinical Medicine, 2019,19 (21) : 3785-3787.
11.Wang Yan, Wu Liping, Lin Qin, et al. Construction of family-centered case management care plan for children with type 1 diabetes mellitus [J]. Chin J Nursing Management, 2020, 20 (1) : 1 45-1 50.
12.Bai Yun. Effects of intensive lifestyle management with Guardian participation on blood glucose control and readhospital status in adolescents with Type 1 diabetes mellitus [J]. Journal of Practical Medical Technology, 20, 27 (6) : 808-810.
13.Tao Hua, Lin Zheng, Huang Xiaoping, et al. Effects of family-centered care on home environment and blood glucose control in juvenile diabetic patients [J]. Chinese Journal of Nursing, 2014,49 (11) : 1342-1346.
14.Wu Feifei, Liu Li 'e, Zhou Yan, CAI Min. Application of nurse-dependent-patient cognitive interaction model in children with type 1 diabetes mellitus [J]. Nursing of Integrated Chinese and Western Medicine (Chinese & English),202,8(09):37-40.
15.Endocrinology, Genetics and Metabolism Group, Pediatrics Branch of Chinese Medical Association, Editorial Board of Chinese Journal of Pediatrics. Expert Consensus on Standardized diagnosis and treatment of Type 1 diabetes in children in China (2020 edition) [J]. Chinese Journal of Pediatrics, 20,58(6): 447-454.
16.Wang JH. "Those mistakes" of insulin injection [J]. Cardiovascular Disease Prevention Knowledge (Popular Science Edition),2016(01):16-18.
17.Li S J. The working principle of insulin pump [J]. PLA Health,2010(05):18. (in Chinese)
18.Zhu Shu. Research on Humanized Design of household medical Equipment [D]. Wuhan University of Technology,2015.
19.Hu Y. Effects of Box Ting Game on insulin injection treatment compliance and psychological state of children with Type 1 diabetes [J]. Drug Evaluation,2019,16(21):21-22.
20.XingXiangLong. Emotional design in the application of children's medical products research [J]. Journal of packaging engineering, 2022 lancet (16) : 284-291. The DOI: 10.19554 / j.carol carroll nki. 1001-3563.2022.16.032.
21.Wang Y, Zhu Y. Design of home injection system for children with T1DM based on framework innovation [J]. Packaging engineering, 2022, lancet (18) : 160-168. The DOI: 10.19554 / j.carol carroll nki. 1001-3563.2022.18.020.
22.Li Zhi-Ping, Lu Jin-Miao, Zhu Lin. A combination tool set for guiding and encouraging children to inject insulin [P]. Shanghai: CN210205488U,2020-03-31.
23.Zhang Zhen, Hu Min, Chen Hongwei, CAI Jin. A child insulin injection auxiliary device [P]. Jiangsu Province: CN212662395U,2021-03-09.
24.Xian Bo, Rob Ryan, Robert Canfield, Zhou Fen. Retractable Syringe needle Device [P]. Jiangsu: CN203389174U,2014-01-15.