

Application of Insulin Glargine in Type 1 Diabetes Mellitus

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Abstract. Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease characterized by the destruction of pancreatic islet beta cells, leading to insulin deficiency. Patients with T1DM require lifelong exogenous insulin therapy to maintain blood glucose homeostasis. Insulin glargine, a long-acting basal insulin analogue, plays a vital role in T1DM management by providing stable and prolonged insulin coverage. It effectively reduces blood glucose fluctuations, lowers glycosylated hemoglobin (HbA1c) levels, and minimizes the frequency of insulin administration, improving patients' quality of life. Additionally, combination therapy with insulin glargine and rapid-acting insulin mimics physiological insulin secretion, leading to better glycemic control and a reduced risk of long-term complications. However, challenges remain, including high production costs limiting accessibility in low-income regions, potential weight gain, and the persistent risk of hypoglycemia despite advancements such as Gla-300. Future research aims to address these limitations, enhance insulin glargine's efficacy, and explore innovations such as artificial pancreas systems to further optimize T1DM treatment. The continuous development of insulin therapies offers promising prospects for improving patient outcomes and overall quality of life.

Keywords: A chronic autoimmune disease, insulin glargine, limitations and innovations.

1. Introduction

Type 1 diabetes mellitus (T1DM) is an autoimmune disease and millions of people are affected by this disease. The incidence is still increasing globally, especially the young. Insulin glargine as a long-acting insulin, which is widely used to manage T1DM which also have had great effect on treating the disease. After taking a program about the structure and function of protein, DNA and RNA, and their application in medicine and vaccine, the application of insulin glargine in the treatment of T1DM is closely connected to the program and could be a good choice to explore further.

The most progressive glargine Gla-300 can reduce the hypoglycemia comparing with Gla-100 [1], and still an effective glucose-lowering agent as other insulins can provide. It can increase the safety of the treatment. Additionally, continuous Subcutaneous Insulin Infusion (CSII), as an insulin pump to meet the basic needs and can replace the need for rapid, intermediate and long-acting insulin, like multiple daily injections (MDI) and adjust the glucose based on physical activities and exercises [2]. In this case, the living standard of patients for T1DM can be improved by reducing the number of injection and lowering the worry about hypoglycemia. Subcutaneous MYL1501D insulin glargine 100U/mL, once injection can maintain a long-term effect on glycated hemoglobin-lowering without other insulin's effect [3]. In the future, the medical research could focus on reducing the cost of making insulin glargine and combination therapy.

In this paper, the focus could be the application of insulin glargine in T1DM, including the principle which contains the basic description and mechanism of insulin glargine, the application situation containing some basic insulin and the combination with insulin glargine and new therapy and its effectiveness of treatment. Moreover, the drawbacks of nowadays research for insulin glargine and try to find out the solutions, also the development tendency in the future. What's more, this topic can give basic information and the deeper understanding of the insulin glargine.

2. Description and Mechanism

T1DM is a chronic autoimmune disease due to the islet beta cells are destroyed by the interaction of genetic susceptibility and could also cause the deficiency of insulin, so patients need to depend on

exogenous insulin to maintain the balance of blood glucose. In terms of the mechanism of T1DM, the immune system problem is a main factor. The pancreatic beta cells produce insulin in the pancreas, but when t-cells lose their self-tolerance, they will attack pancreatic beta cells to influence the production of insulin [4].

The reason is that dendritic cells and macrophages transport antigens, like Zinc transporter 8 (ZNT8) or Islet Antigen2 to helper T cells to recognize the antigen after that, it will release inflammatory signals, like IFN-gamma or TNF-beta to increase the immune responding and cytotoxic T cells to release toxic molecules and attack beta cells directly.

Additionally, it is relevant to genetics, HLA which includes two specific proteins for T1DM. They are HLA-D3 and HLA-D4, and these could cause the acquisition of autoantibodies, they are anti-islet cell, anti-gad and anti-ZNT8 antibodies [3], each antibody targets each enzyme by easier recognized by t cells as the external substance. These attack beta cells and pancreas which will cause less or no insulin and lead to T1DM. After 80%-90% of beta cells destroyed [5]. The human body may be lack insulin and cause hyperglycemia and T1DM could form.

3. Application and Effectiveness of Insulin Glargine

Insulin glargine plays an important role in T1DM to control the glucose blood level. Insulin glargine as a basal insulin could provide a continuous supply of insulin which could maintain glucose homeostasis between meals and overnight. It needs about once injection per day [2] depending on patients' needs. The basic method of taking insulin glargine could be the bolus regimen, which is injecting insulin with meals, stimulating the insulin which produces in the pancreas. The combination of insulin glargine and rapid-acting insulin, such as insulin aspart [6], to mimic the natural insulin production process. In this case, patients can be provided with more consistent blood glucose level. Moreover, the insulin pump therapy could also be used for some patients rely on rapid-acting insulin to stimulate basal and bolus insulin (Figure 1) [7].

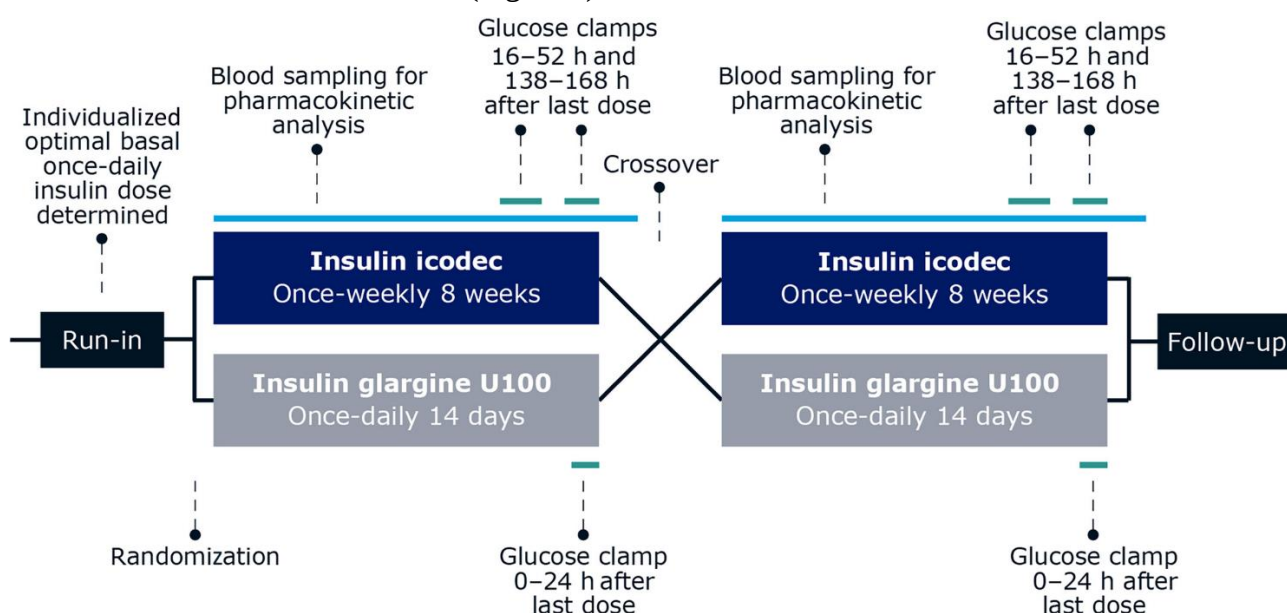


Figure 1. The overall of the trail design [7]

The insulin glargine can provide an effective treatment for T1DM. First of all, it can effectively control a stable blood glucose by reducing glycemic variability and reducing large fluctuations [4], as the most progressive insulin glargine, it can Gla-300 can reduce the hypoglycemia comparing with Gla-100 [1], and still an effective glucose-lowering agent as other insulins can provide. Insulin glargine can also help patients acquire an optimal HbA1c level [8], and reduce risk of long-term complications of diabetes, such as retinopathy, neuropathy, and nephropathy [9].

The continuous Subcutaneous Insulin Infusion (CSII), as an insulin pump to meet the basic needs and can replace the need for rapid, intermediate and long-acting insulin, like multiple daily injections (MDI) and adjust the glucose based on physical activities and exercises [2]. In this case, the living standard of patients for T1DM can be improved by reducing the number of injection and lowering the worry about hypoglycemia. Subcutaneous MYL1501D insulin glargine 100 U/mL, once injection can maintain a long-term effect on glycated hemoglobin-lowering without other insulin's effect [10].

4. Drawbacks and Future Development of Insulin Glargine

Nowadays, insulin glargine still has some drawbacks of treating T1DM, for example, the high cost could be a burden to patients [11]. The reason is that the research of insulin glargine involves many innovations and developments, which cause a high cost. The government and society are trying to reduce the cost of insulin glargine to help more T1DM patients by offering more subsidies to the company and paying more on healthcare. In addition, although the most progressive insulin glargine can reduce the side effect of hypoglycemia, it still has the risk of that for some patients.

However, modern medicine is working to solve that problem, like using blood glucose monitoring [12] to help patients keep constant track of their blood sugar levels by providing alerts when blood sugar is tending low. Insulin glargine has the risk of weight gain as well [13] due to insulin can promote the storage of glucose and fat. This problem could be solved by balanced diet and regular exercise in some cases, patients can also choose to combine insulin glargine with other diabetes medication to help lower weight, such as SGLT-2 inhibitors [4].

Referring to the future development of insulin glargine, one improvement could be improving the formula of making insulin glargine to reduce the frequency of injections and lower the risk of hypoglycemia. For example, the insulin glargine U-300 is being developed to provide a slower and more consistent release of insulin which could contribute to stable glucose level control [14]. Or using U-100 to satisfy patients' needs which are longer duration of maintenance and higher doses [14]. Moreover, combination therapies are exploring and becoming more popular which as combining insulin glargine with other drugs, like GLP-1 receptor and SGLT-2 inhibitors [4].

The aim of the therapy is to improve the sensitivity of insulin and reduce the requirements, which is proved effectively in managing T1DM. Additionally, as the technology and information develop nowadays, scientists also have been trying to use artificial intelligence and data collection to alter the management of T1DM. The artificial pancreas is one of the most promising AI-driven developments, combining continuous glucose monitoring (CGM) and insulin pumps with AI algorithms [15]. AI plays a crucial role by automatically adjusting the delivery of insulin according to the real-time readings of glucose level. In this case, the risk of hypoglycemia and another side effect can be reduced. The use of AI in treating T1DM could also be a step toward more intelligent treatment.

5. Conclusion

In conclusion, insulin glargine has been proved to be an effective and significant method to treat T1DM. it can offer a long-acting and stable coverage of basal insulin, which could play a crucial role in maintaining stable blood glucose level. The combination therapy with insulin glargine and rapid-acting insulin can help produce similar insulin that occurs in human body. This contributes to the reduction in HbA1c levels and lower the risk of severe long-acting complications.

In addition, insulin glargine can benefit patients with better living standard by reducing the frequency of doses. However, there are also some challenges for insulin glargine. For example, the high cost of production, especially in low-income area, it could restrict the promotion of insulin glargine. Although the risk of hypoglycemia has been reduced by Gla-300, but it still exists. Moreover, it could increase patients' weight by using insulin glargine. In the future, the scientists would focus on these problems to improve insulin glargine. The treatment of T1DM has a bright future, with the potential to provide more efficient care and improve patients' living standard.

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