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A Review on Oral Insulin Drug Delivery System

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Abstract: Oral insulin drug delivery system main aim making the diabetes management less invasive and more convenient. Oral route is the safest route for administration. It can be most preferable route. Oral insulin can directly deliver into the mouth. Traditional insulin therapy is more painful and convenient for the patients. from this system, insulin deliver through GI tract, which can be absorbed into bloodstream. This system enhances the absorption of insulin through insulin tract by using absorption enhancers to improve bioavailability. Oral insulin drug delivery system includes used of liposomes, polymer-based carriers, nanoparticles, intestinal patches and iconic liquids.Clinical trials are typically in progress for evaluate the safety and efficacy of oral drug delivery system for providing convenient and patient friendly option for diabetes management.
Keywords: Blood glucose control, Diabetes management, Insulin therapy, Metabolism, Microparticles, Nanoparticles, Oral insulin drug delivery, Oral preparation, Ph responsive polymers.

I. INTRODUCTION

According to oral drug delivery system it is the preferrable treatment because of minimal invasiveness and patient compliance. Oral insulin manages the hyperglycemia which caused by TYPE-1 Diabetes and TYPE-2 Diabetes. oral insulin is poorly absorbed. In this oral drug delivery system, there is no chance of kin infection it can avoid side effects such as hypoglycemia, weight gain, hyperinsulinemia [1],[2].

It can reduce skin infection. TYPE-1 diabetes mellitus is metabolic disorder which arises major health problems. TYPE-2 diabetes mellitus it has insulin resistance. In this condition body cannot produce enough insulin. Due to this oral route, there is flexibility in formulation and patient compliance [3],[4].

Oral insulin drug delivery system is the technology which can reduces the effectiveness of drug which can metabolize in liver before reaching systemic circulation for first pass metabolize. Oral insulin drug delivery system is used in nanoparticles, nanocarriers and in nano- structured materials to deliver drug through nasal route. Oral insulin has 98.5% bioavailability. There is the stabilization of glucose in diabetes management. It can enhance glucose control. In this there is controlled release. This insulin is protected from gastric enzyme. Oral insulin is the natural secretion process and it can be life transformative solution for diabetic patients. This oral insulin saves the life of thousands of peoples [5].

II. DEFINITION AND SCOPES

Definition: Oral insulin drug delivery system is the technology which can used to deliver the insulin through mouth and there is absorption of insulin into bloodstream through mouth. This can include targeted drug delivery system, controlled release drug delivery system and designing of insulin formulations [6],[8].

A. Scopes

1) Technological innovations: In this technology it includes microencapsulation, transdermal patches and injectables which can improve pharmacokinetic of insulin.
2) Patient compliance: It is acceptable by patient other than injections. It involves better management for diabetes.
3) Clinical trials: In this there is new treatment options for patient in treatment of diabetes and more effective.
4) Bioavailability: In this dose administered that can reaches to systemic circulation.
5) Targeted drug delivery system: Designing of insulin formulationIt is Noninvasive route to deliver insulin to patients with diabetes and it increase their quality.
6) Mucoadhesive system: In this oral insulin drug delivery system, it enhances absorption and retention in GI tract.
7) Diabetes management-Insulin is used to help control blood sugar level.
8) Insulin therapy: In this if you have TYPE-1 diabetes then you need this therapy to stay healthy [6],[8].

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III. TYPES OF ORAL INSULIN DRUG DELIVERY SYSTEM

1) Controlled release drug delivery system: It releases insulin at predetermined rate and it maintain consistent therapeutic effect for prolonged period of time.

2) Mucoadhesive oral insulin drug delivery system: Through mucosal membrane in GI tract, it can enhance absorption of insulin and allowing prolonged retention.

3) Targeted oral insulin drug delivery system: It has design for delivering insulin at specific site for absorption in GI tract for minimizing its effectiveness. This system protect insulin from enzymatic degradation.

4) Nanoparticle based oral insulin drug delivery system: In this there is used of nanoparticles for innovative approach to administered insulin through GI tract.

Nanoparticles size ranges:
Small = 10-50 nm in diameter.
Medium = 50-200 nm in diameter.
Large = 200-1000 nm in diameter [9],[10].

5) Nano emulsion based oral insulin drug delivery system:In this there is used of nano emulsion it can enhance delivery of insulin through oral route it enhances absorption and protecting from degradation.

Nano emulsion size ranges:
Nano emulsion droplet size = 20-500 nm
Mini emulsion droplet size = 50-5000 nm
Micro emulsion droplet size = 10-100 nm

6) Nano carrier based oral insulin drug delivery system: In this there is used of nano carriers it can effectively deliver the insulin through GI tract it enhances absorption and protecting from degradation. It includes dendrimers, nano gels, liposomes, micelles and nano tubes.Nano carriers size ranges = 1 – 100 nm

7) Insulin microencapsulation: Insulin microencapsulation increases absorption and reduced first pass metabolism. It encapsulating the insulin in a polymeric material to protect it from degradation in the GI tract. Sustained release of insulin reduces frequency of administration.

Materials used for microencapsulation:
Natural polymers – Gelatin, Chitosan
Synthetic polymers – Polyvinyl alcohol, Polyethylene glycol
Biodegradable polymers – Poly lactic acid, Poly lactic co- glycolic acid [11],[12].

IV. BARRIERS FOR ORAL INSULIN DRUG DELIVERY SYSTEM

1) Pharmaceutical barrier: In this there is insulin is a large peptide molecule which makes it difficult to cross the intestinal barrier in the intestinal absorption. First pass effect can reduce the amount of insulin that enters in the bloodstream. The formulation ensure that insulin is released at right rate and in the right location within GI tract. Insulin has limited stability and solubility in aqueous environment. In patient compliance if oral insulin drug delivery system is complicated patients may be less likely to use it consistently.

2) Variability in GI tract: In this condition like Crohn's disease ulcerative colitis can alter GI environment and affect in absorption in GI diseases. Developing delivery systems can target specific site of GI tract such as small intestine can optimize insulin absorption in targeted delivery system.in the presence of food in GI tract can influence the insulin absorption by enhancing and inhibiting its uptake. The variability can affect how effectively and quickly insulin is absorbed.

3) Physiological barrier: In GI tract has various enzyme can break down peptides and protein including insulin. Intestinal barriers make challenging for insulin to pass through and enters in the systemic circulation. Epithelial cells in the intestine can limit insulin absorption. Mucus layer in intestine can hinder insulin absorption. First pass effect can have substantial reduction in the amount of insulin that reaches the systemic circulation and can be utilized by the body.

4) Immunological barrier: In this insulin deliver orally immune system may recognize as a foreign substance. This can trigger immune response which reduces the efficacy leading to production of antibodies against insulin. When immune system becomes less responsive to insulin then it would diminish the therapeutic effect of drug over time.

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Mucosal immunity has immune reactions or inflammation that could affect bioavailability and absorption. This barriers consist of both innate and adaptive immune responses that work together to protect from infection

5) Poor absorption: Presence of food can impact the absence of oral insulin. Food can affect the PH of GI tract both of which can influence absorption and insulin stability. In GI tract if insulin is not absorbed quickly, it may be subjected to more degradation. In GI tract it has complex structure that can hinder the absorption of large molecule like insulin. To improve the absorption of oral insulin exploring various strategies that can includes used of absorption enhancers, delivery system that can protect insulin from degradation and novel formulations.
6) Degradation in GI tract: In this, by developing analogs with reduced susceptibility to enzymatic degradation or improved the stability in the GI tract. Insulin has formation of inactive and toxic compound by oxidation reactions. The degradation reduces the amount of active insulin that reaches the bloodstream. By encapsulating insulin in microspheres to protect it from enzymatic degradation and acidic environment.
7) Technological barrier: For controlled release of insulin in the GI tract mimicking physiological insulin secretion. Recent formulations may not provide the desired release profile which leads to suboptimal absorption. Technological barriers ensure the quality consistency of oral insulin formulations is crucial in quality control. It ensures the stability of insulin in liquid or solid formulation is crucial for maintaining the efficacy and stability.
8) Mucosal barrier: Insulin may struggle to penetrate the mucosal layer effectively. Intestinal mucosa can act as a barrier in drug absorption. Mucosal barriers regulate the passage of ions, nutrients and water. These barriers can prevent the entry of harmful substances such as pathogens and toxins. Mucosal barrier has unique immune system, known as mucosal immunity. This barrier is essential for maintaining homeostasis and preventing functions. This barriers secrets various antimicrobial peptides and enzymes such as lysozyme and defensins which help to neutralize pathogens. Mucosal barrier is complex and dynamic system which plays vital role in protect body from external threats for essential physiological functions [13],[14].

V. GOALS OF ORAL INSULIN DRUG DELIVERY SYSTEM

A. *Clinical goals*

1) Increase patient satisfaction: Improve patient satisfaction with regimen treatment.
2) Improved patient compliance: It enhances patient health outcomes.
3) Reduced healthcare costs: It minimizes costs of healthcare associated with diabetes management.

B. *Pharmaceutical goals*

1) Targeted delivery system: In this, insulin deliver at target site. e.g. Pancreas, liver.
2) Controlled release system: In this, insulin release in controlled and sustained manner.
3) Enhanced bioavailability: It increases amount of insulin which absorbed into the bloodstream

C. *Therapeutic goals*

1) Increase patient compliance: It encourages patient to adhere to regimen treatment.
2) Improve glycemic control: It maintain blood glucose level.

D. *Technological goals*

1) Quality control and assurance: It can establish quality control measures to ensure efficacy and consistency.
2) Developing stable formulations: In this, create formulations which can stable during transportation and storage.

E. *Cost Effectiveness*

In this oral delivery system can lowers treatment costs by reducing need for syringes.

F. *Reduction in Side Effects*

In this, effective oral delivery system it should minimize size effects with insulin therapy.

VI. CONCLUSION

From this review we can concluded that oral insulin drug delivery system revolutionizes diabetes management. In these clinical trials are necessary to evaluate their safety, efficacy as a convenient and patient friendly option for diabetes management.

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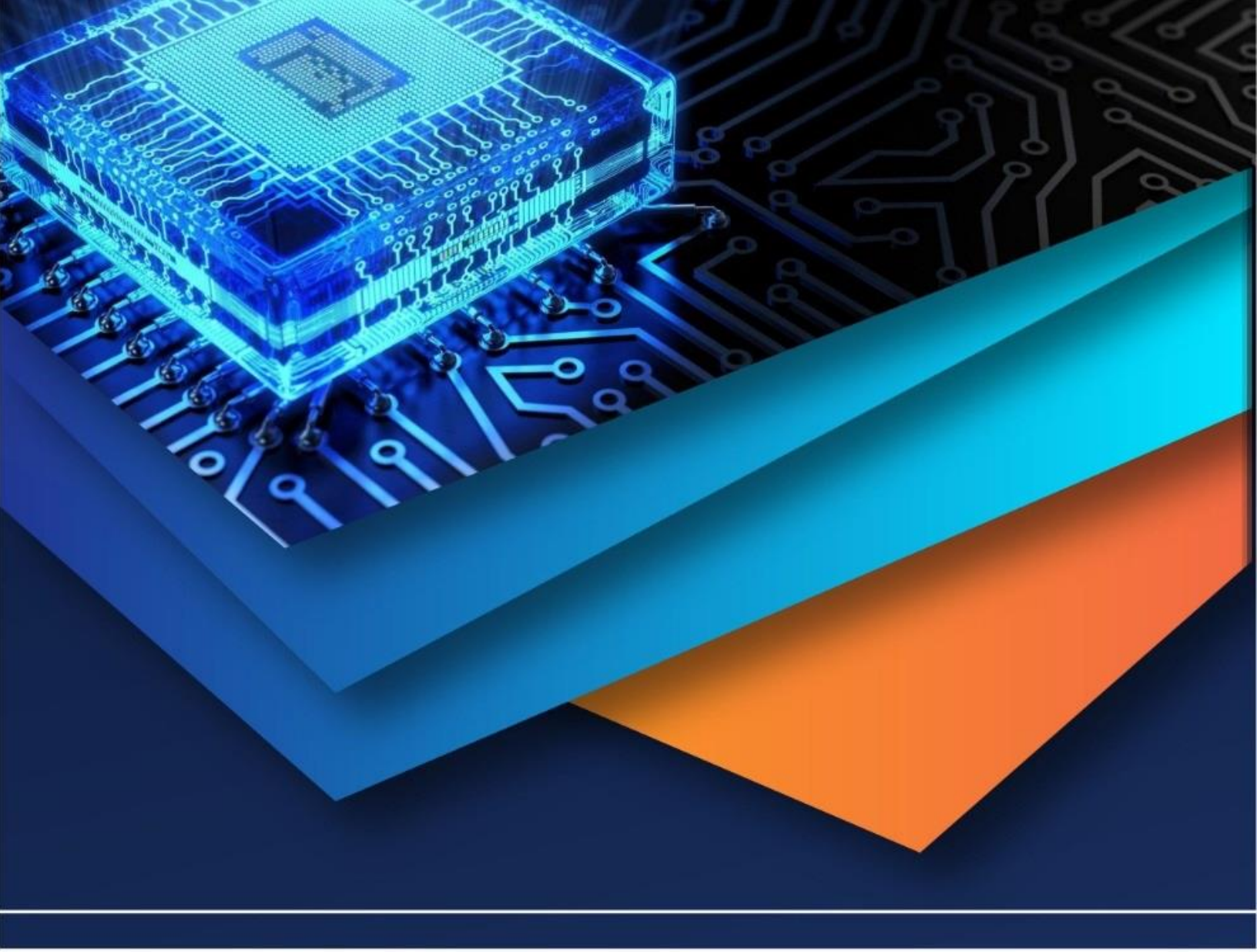
In this, each type has its unique advantage and characteristics. Oral route is the preferable and safest method of administration. This route reduces the risk of skin infections and avoid the side effects like weight gain and hypoglycemia. This system focuses on improving outcomes of patient, reducing healthcare costs and enhancing efficacy of drugs. there are significant challenges to overcome physiological, pharmaceutical and immunological barriers.

In this system by mimicking the natural selection process of insulin this can provides the life transformative solution for diabetic patients. In this system, we can consider numerous barriers and goals that needed to be addressed. This system improves the quality of life for millions of people living with diabetes and saving thousands of lives by making insulin therapy manageable.

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