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REVIEW ARTICLE

Impact of Nanotechnology in Diabetes

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ABSTRACT
Nanotechnology plays a focal point in diabetes and shows a great promise in improving the treatment and management of the diabetes. Diabetes is a rapidly growing problem that is managed at the individual level by monitoring and controlling blood glucose levels to minimize the negative effects of the diseases. Nanotechnology can now offer implantable or wearable sensing technologies that provide continuous and extremely accurate medical information. Nanomedicine has offered new solutions, for already existing drugs.
KEY WORDS: *Diabetes, Nano medicine, Nano sensors*

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INTRODUCTION
Diabetes the most common metabolic disorders worldwide.The disease is generally believed to be incurable; and the few orthodox drugs available to manage the disease are not readily affordable to all. Over the past 30 yr, the status of diabetes has changed from being considered as a mild disorder of the elderly to one of the major causes of morbidity and mortality affecting the youth and middle aged people its prevalence is seen in all six inhabited continents of the globe [1].
Nanomedicine in therapeutics has revolutionized the field of medicine where nanoparticles of dimensions ranging between 1 - 100 nm are designed and used For diagnostics [2]. NT involves monitoring, repairing, construction and control of human biological systems at the cellular level by using materials and structures engineered at the molecular level [3]. NT is likely to have a significant impact on society, and is perceived as a human affair designed to serve human purposes [4,5].
The application of nanotechnology to medicine is called nanomedicine, the functional properties, of nanotechnology is a natural progression of many areas of health-related research such as synthetic and hybrid nanostructures that can sense and repair biological lesions and damages just as biological nanostructures [6].

Nanotechnology in Medicine
Nanotechnology in the detection of insulin and blood sugar plays a vital role in diabetes: A new method that uses nanotechnology to rapidly measure minute amounts of insulin and blood sugar level is a major step towards developing the ability to assess the health of the body's insulin-producing cells. It can be achieved by following ways-

Nanotechnology in Monitoring Insulin Level
Microphysiometer
The microphysiometer a multiwalled carbon nanotubes, which are like several flat sheets of carbon atoms stacked and rolled into very small tubes , measures insulin production at intervals. The sensor detects insulin levels continuously by measuring the transfer of electrons produced when insulin molecules oxidize in the presence of glucose. When the cells produce more insulin molecules, the current in the sensor increases and vice versa, allowing monitoring insulin concentrations in real time.

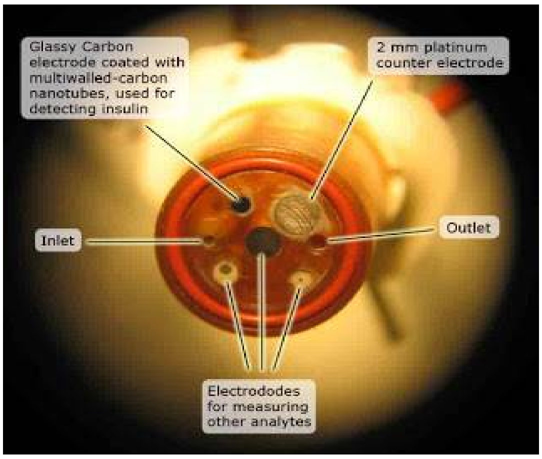
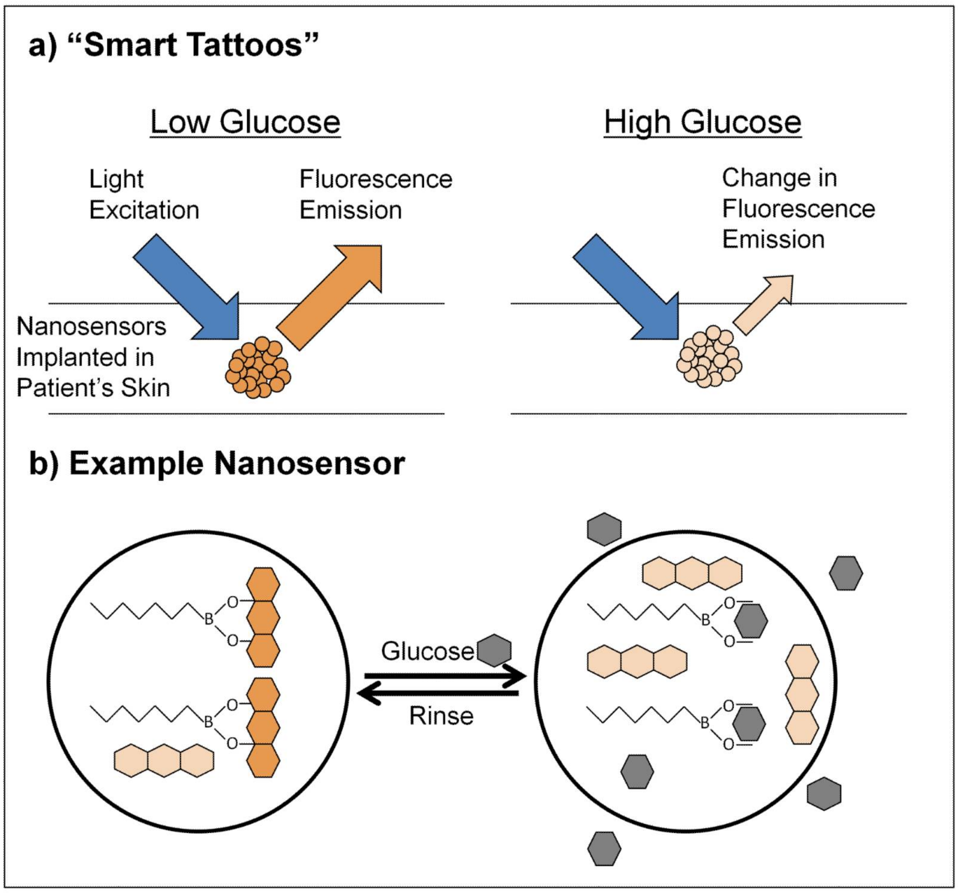


Figure 1: Polymeric nanosensors for "smart tattoos."(Billingsley *et al*. 2010)

Implantable Sensor

An implantable sensor capable of long-term monitoring of tissue glucose concentrations by wireless telemetry has been developed for diabetes [7].The implantable sensor is designed to deliver diabetes patients an alternative to finger-sticking or short-term glucose sensors (Figure:1), as well as limit dangerous glucose level fluctuations known as "glucose excursions" [8]. Sensor microchips are also being developed to continuously monitor body parameters including pulse, temperature and blood glucose. A chip would be implanted under the skin and transmit a signal that could be monitored continuously [9].Several subcutaneously implanted needle type enzyme electrodes or microdialysis probes for continuous glucose monitoring are close to marketing [10, 11, 12].



Nanopore Immunoisolation Devices

The pores in nanopores allow oxygen, glucose and insulin to pass through, but are sufficiently small to impede the passage of larger molecules that trigger an immune response, thus rendering the device rejection free in animal models [13]. By implanting the silicon box under the skin of the person with diabetes, it is envisioned that the surface biosensors will monitor and counteract any rise in the blood glucose level by releasing sufficient amounts of insulin, thus converting it into glycogen to be stored in the liver [14].

Use of Nanotechnology in the treatment of Diabetes

Diabetes is the major afflictions of modern society. Diabetic patients control their blood-sugar levels via insulin introduced directly into the bloodstream using injections. This unpleasant method is required since stomach acid destroys protein-based substances such as Insulin, making oral insulin consumption useless. The treatment of diabetes includes the proper delivery of insulin in the blood stream which can be achieved by nanotechnology in the following ways:

Development of Oral Insulin

Krauland *et al* (2004) reported, the oral route is considered to be the least invasive. Production of pharmaceutically active proteins, such as insulin, in large quantities has become feasible [16,17]. The oral route is considered to be the most convenient and comfortable means for administration of insulin for less invasive and painless diabetes management, leading to a higher patient compliance [15].

The mechanism or oral insulin delivery by nanoparticles (NPs) coated with mucoadhesive chitosan has residence in the small intestine, infiltrate into the mucus layer and subsequently mediate transiently opening the tight junctions between epithelial cells while becoming unstable and broken apart due to their pH sensitivity and degradability[15,16,17,18,19,20,21,22]. The insulin released from the broken-apart NPs could then permeate through the paracellular pathway to the bloodstream, its ultimate destination.

Microsphere for Oral Insulin Production

The most promising strategy to achieve oral insulin is the use of a microsphere system which is inherently a combination strategy. Microspheres act both as protease inhibitors by protecting the encapsulated insulin from enzymatic degradation within its matrix and as permeation enhancers by effectively crossing the epithelial layer after oral administration.

Artificial Pancreas

"Long Term Sensor System" (LTSS), which is designed to hold insulin in its inner chambers and a glucose-level sensor on its surface. In the presence of hyperglycemia, the surface sensors are triggered and insulin is released into the bloodstream, thereby restoring normal glycaemia [14,23,24].Development of artificial pancreas could be the permanent solution for diabetic patients. A sensor electrode repeatedly measures the level of blood glucose; this information feeds into a small computer that energizes an infusion pump, and the needed units of insulin enter the bloodstream from a small reservoir [25]. Scientists are also trying to create a nanorobot which would have insulin departed in inner chambers, and glucose-level sensors on the surface. When blood glucose levels increase, the sensors on the surface would record it and insulin would be released, is still only a theory [26].The cells can be genetically altered so that they could not only produce insulin, but could also respond to the rise and fall of blood glucose, just as normal pancreatic beta cells[27].

NANOPUMP

The nanopump is a powerful device and has many possible applications in the medical field. The pump injects insulin to the patient's body in a constant rate, balancing the amount of sugars in his or her blood. The pump can also administer small drug doses over a long period of time [28]. Pumps also offer greater convenience in neuropathy a complicated treatment with disappearance of pain.

SMART CELLS

In Smart-cell technology the presence of hyperglycaemia, glucose will attack the Smart cell by eating away its insulin-containing structure. This damage to the cell membrane will break down the protein matrix to release insulin and normalize blood glucose levels [29].. The advent of NT means that to reach and maintain excellence, healthcare professionals will need to be consistent in pursuing the required courses in advanced technology to deliver care [30].

CONCLUSION

In the foreseeable future, the most important clinical application of nanotechnology will probably be in pharmaceutical development. These applications take advantage of the unique properties of nanoparticles as drugs, drug targeters, and salvage of drugs with low bioavailability. The advent of NT will present new implications for clinicians. In conclusion, the future of nanotechnology in diabetes is open with many possibilities and will no doubt be of huge importance in times to come.

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