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REVIEW ARTICLE

The Artificial Pancreas: How Sweet Engineering Will Solve Bitter Problems

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Abstract

An artificial pancreas is a closed-loop system containing only synthetic materials which substitutes for an endocrine pancreas. No artificial pancreas system is currently approved; however, devices that could become components of such a system are now becoming commercially available. An artificial pancreas will consist of functionally integrated components that will continuously sense glucose levels, determine appropriate insulin dosages, and deliver the insulin. Any proposed closed loop system will be closely scrutinized for its safety, efficacy, and economic impact. Closed loop control utilizes models of glucose homeostasis which account for the influences of feeding, stress, insulin, exercise, and other factors on blood glucose levels. Models are necessary for understanding the relationship between blood glucose levels and insulin dosing; developing algorithms to control insulin dosing; and customizing each user's system based on individual responses to factors that influence glycemia. Components of an artificial pancreas are now being developed, including continuous glucose sensors; insulin pumps for parenteral delivery; and control software, all linked through wireless communication systems. Although a closed-loop system providing glucagon has not been reported in 40 years, the use of glucagon to prevent hypoglycemia is physiologically attractive and future devices might utilize this hormone. No demonstration of long-term closed loop control of glucose in a free-living human with diabetes has been reported to date, but many centers around the world are working on closed loop control systems. It is expected that many types of artificial pancreas systems will eventually be available, and they will greatly benefit patients with diabetes.

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Abbreviations: (ADICOL) Advanced Insulin Infusion using a Control Loop, (MPC) model predictive control, (PID) proportional integral derivative control

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