A Generalized Predictive Control (GPC) algorithm is developed for automatically regulating BG in diabetes. The control algorithm emulates a basal-rate delivery of insulin when online computations reveal no need for additional corrective insulin boluses. The GPC algorithm only requires subject weight for initialization and only regularly sampled BG for control. Untreated diabetic symptoms were evidenced by post-prandial BG levels exceeding 500 mg/dl and are shown below. The experiment involved five diabetic pigs. Top panel in each set of closed-loop control plots shows社會性的比較 of BG in control, and bottom panel depicts corresponding SC doses of insulin and glucagon. Insulin (U) & glucagon (mg/ml) are depicted on the y-axis. The controller successfully scaled its insulin response, in accordance with the pig’s weight, and accounted for a two-fold variation in subject weight. The control algorithm demonstrated critical restraint from administering excessive insulin doses.

**Experimental Methods**

- Sampling of BG was performed every ten minutes using blood samples drawn from the vena cava.
- Insulin and glucagon doses were determined by the control algorithm.
- Blood glucose was measured using blood samples drawn from a central line placed in the vena cava.
- Subcutaneous (SC) doses of insulin and glucagon were determined by the control algorithm.

**Results**

- Effective and consistent control was shown in experiments where the system aimed to regulate BG to within pig’s euglycemic range of 20–80 mg/dl (indicated by the shaded region). In the case of Pig #69 (62 kg body mass), the controller was able to regulate BG to a mean value of 140 mg/dl over a 2.5-h period with no hypoglycemia while the pig ingested 300 g of carbohydrates distributed over three meals. In the case of Pig #36 (50 kg body mass), the controller was able to regulate BG to a mean value of 140 mg/dl over a 2.5-h period with no hypoglycemia while the pig ingested 430 g of carbohydrates distributed over three meals.

- In vivo BG regulation was achieved in response to hyperglycemic states as well as oral carbohydrate consumption.
- Blood glucose was regulated to set point, with the controller tolerating insulinotropic and glucagonotropic BG fluctuations that are not indicative of the general BD trend.
- The control algorithm demonstrated critical restraint from administering excessive insulin doses.
- The controller successfully scaled its insulin response, in accordance with the pig’s weight, and accounted for a two-fold variation in subject weight.
- Postprandial BG was an effective measure for storing of parenteral hormone.

**Summary of Results**

- Effective and consistent control was shown in experiments where the system aimed to regulate BG to within pig’s euglycemic range.
- Blood glucose was regulated to set point, with the controller tolerating insulinotropic glucagonotropic BG fluctuations that are not indicative of the general BD trend.
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**Acknowledgments**

Centralized control for the closed-loop system was provided by a control algorithm implemented on a personal computer running a Linux-based operating system (CentOS 6.6) with real-time support (RTAI Linux). Subcutaneous insulin (Humalog; Lilly) and glucagon (Lilly) were reconstituted from a standard vial. The experiment involved five diabetic pigs. Each pig was fitted with an internal osmotic pump designed to deliver continuous subcutaneous insulin and glucagon. Insulin (U) & glucagon (mg/ml) are depicted on the y-axis.

**Type 1 Diabetic Pig Model**

- A type 1 diabetic pig model was induced in order to mimic the human condition.
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