Background and Aims

Fully automated blood glucose (BG) control without meal announcement is a considerable challenge for artificial pancreas (AP) systems due to the slow subcutaneous (SC) insulin absorption and delayed effect on glucose homeostasis. Intraperitoneal (IP) insulin with a faster absorption rate is suggested. In addition, single hormone APs are shown to be conservative in dealing with exercises and sudden drops in the BG. Therefore, we use both insulin and glucagon infusions intraperitoneally to achieve a tight glycemic control without meal and exercise announcements.

Method

A combination of nonlinear model predictive control (NMPC) and Zone MPC algorithms is used to control the blood glucose level (BGL). The penalty used for different BGLs is shown in Fig.1.

Results

The designed AP kept the BGL in the target zone (3.9-10 mmol/l) at 87%, 93% and 94% of the time for the three experiments. This was achieved without informing the controller about the meals and exercise. The performance of the designed controller for the second experiment is shown in Fig. 3. It is important to note that the operator gave an insulin bolus instead of glucagon by mistake at 14:25. Therefore, two "rescue food" glucose infusions are given to prevent hypoglycemia at 14:45 and 15:05.

Conclusion

The preliminary results in three animal experiments indicate that the fully automated bi-hormonal IP AP achieves satisfactory glycemic control. More realistic situations can be investigated in the future by conducting experiments on awake animals.

References