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REVIEW ARTICLE

The Artificial Pancreas: Is It Important to Understand How the β Cell Controls Blood Glucose?

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Abstract

It has been more than 7 years since the first fully automated closed-loop insulin delivery system that linked subcutaneous insulin delivery and glucose sensing was published. Since the initial report, the physiologic insulin delivery (PID) algorithm used to emulate the β cell has been modified from the original *proportional-integral-derivative* terms needed to fit the β cell's biphasic response to a hyperglycemic clamp to include terms emulating cephalic phase insulin release and the effect of insulin *per se* to inhibit insulin secretion. In this article, we compare the closed-loop glucose profiles obtained as each new term has been added, reassess the ability of the revised PID model to describe the β cells' insulin response to a hyperglycemic clamp, and look for the first time at its ability to describe the response to a hypoglycemic clamp. We also consider changes that might be added to the model based on perfused pancreas data. We conclude that the changes introduced in the PID model have systematically improved the closed-loop meal response. We note that the changes made do not adversely affect the ability of the model to fit hyperglycemic clamp data but are necessary to fit the response to a hypoglycemic clamp. Finally, we note a number of β cell characteristics observed in the perfused pancreas have not been included in the model. We suggest that continuing the effort to understand and incorporate aspects of how the β cell achieves glucose control can provide valuable insights into how improvements in future artificial pancreas algorithms might be achieved.

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Abbreviations: (AP) artificial pancreas, (FFA) free fatty acids, (IFB) insulin feedback, (PID) physiologic insulin delivery, (SC) subcutaneous

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