Automating glucose control in type 1 diabetes

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Type 1 diabetes (T1D) is a chronic metabolic disease characterised by an autoimmune destruction of the beta cells in the pancreas, responsible of insulin secretion which promotes glucose transport into the cells. The resulting absolute insulin deficiency results in high blood glucose levels (hyperglycaemia). Therefore, people with T1D require exogenous delivery of insulin in order to survive. Sustained elevated glucose levels can lead to long-term complications (retinopathy, nephropathy, heart disease), which place a heavy burden to the healthcare system. Due to the complexity of glucose-insulin metabolism, achieving good glucose control is often a very difficult task. The development of continuous glucose monitoring (CGM) have opened the door to the development of automatic insulin delivery systems, the so-called artificial pancreas (AP). In the past 10 years there has been an intensive research effort from different players in the artificial pancreas development, which has translated into a first system reaching the market in 2017, although patient intervention for meal control is still needed (this is referred as 'hybrid artificial pancreas'). This has been thanks to important contributions from modelling and control engineering, in combination with technological and pharmacological achievements.

Automatic glucose control is a very challenging problem, characterised by large intra- and inter-individual variability, slow insulin action due to unphysiological subcutaneous infusion and large disturbances like meals and exercise, with great physiological complexity. Despite this, clinical studies have demonstrated a clear superiority of the artificial pancreas as compared to standard open loop therapies. However, room for improvement, especially during day time control subjected to the main disturbances, still exists. Besides, fully automation without (or with minimal) patient intervention is desired for improved quality of life. This raises new challenges (and opportunities) in the field, where meal detection, integration of new devices like wearables and learning for a personalized artificial pancreas will be key for second generation artificial pancreas systems. All these aspects will be reviewed in this talk aiming at bringing to the attention of the field a challenging but exciting control problem like the artificial pancreas, from which people with type 1 diabetes are starting to benefit.