

# Personalised adaptive basal-bolus algorithm using SMBG/CGM data

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A Mobile Platform for Personalization of Insulin Delivery based on a Patch Pump and Reinforcement Learning

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<b>Industrial partner:</b>	Debiotech S.A.
<b>Starting date:</b>	January 2016

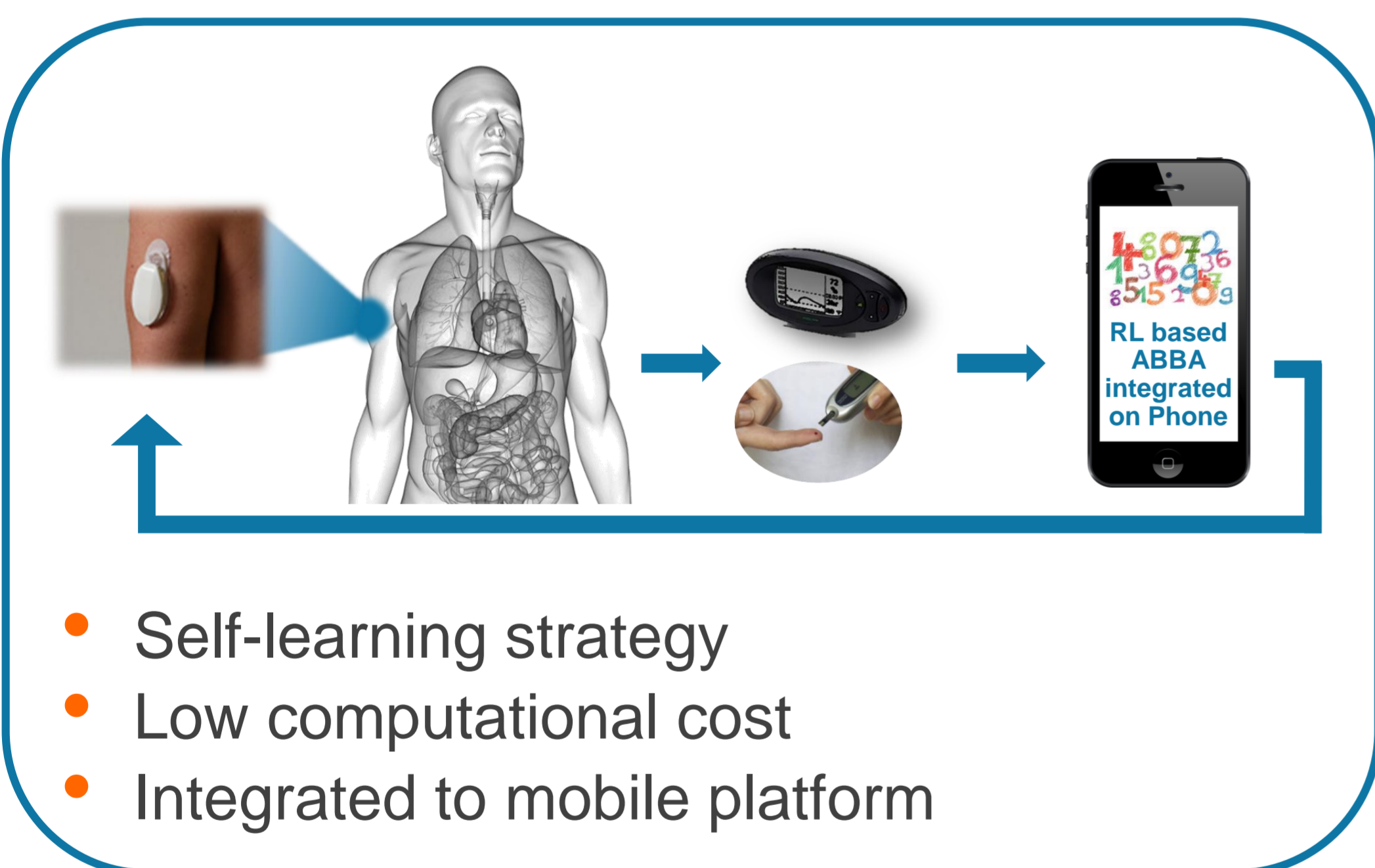
## Background and Aims

An essential component of the diabetes management plan is glucose monitoring using either meters for self-monitoring of blood glucose (SMBG) or more recently continuous glucose monitors (CGM). The main project's objective is the **personalisation of the basal and bolus insulin quantities** to be delivered by a pump **independent of the type of glucose monitoring device (SMBG or CGM)**. An algorithm, named **adaptive basal-bolus algorithm (ABBA)**, allows the daily adjustment of the insulin infusion profile.

## Scientific Innovation and Results

The innovative approach is based on reinforcement learning (RL), a branch of artificial intelligence algorithms, that **allows the system to learn and improve its behaviour based on feedback from the environment**.

ABBA follows a model-free approach, while is initialised using the patient's CGM and pump data for a period of seven days. Then, ABBA estimates the daily adaptation of the basal rate and Carbohydrate to Insulin Ratio (CIR) for each of the main meals: breakfast, lunch, dinner without any external assistance by using either CGM or SMBG data (even with only four SMBG values / day).



	BG (mg/dL)	% in target	% in hypo	% in hyper	TDI (U)
<i>(mean ± standard deviation)</i>					
<b>Adults</b>					
ABBA <sub>CGM</sub>	140.9 ± 18.4	87.5 ± 16.1	1.0 ± 1.1	11.5 ± 15.4	43.2 ± 10.8
ABBA <sub>SMBG</sub>	143.5 ± 18.9	86.9 ± 16.7	0.6 ± 0.9	12.5 ± 16.0	42.6 ± 9.9
<b>Adolescents</b>					
ABBA <sub>CGM</sub>	148.1 ± 11.5	75.7 ± 12.2	2.4 ± 2.0	21.9 ± 12.3	31.6 ± 6.7
ABBA <sub>SMBG</sub>	145.8 ± 9.3	77.8 ± 13.6	2.6 ± 2.2	19.6 ± 12.7	31.8 ± 7.1
<b>Children</b>					
ABBA <sub>CGM</sub>	149.3 ± 9.0	75.0 ± 9.8	1.8 ± 1.6	23.2 ± 8.8	15.9 ± 3.8
ABBA <sub>SMBG</sub>	150.5 ± 10.8	75.2 ± 12.4	1.1 ± 1.3	23.7 ± 11.5	15.9 ± 3.7

*In silico* evaluated using a complex scenario characterized by a high degree of variabilities and uncertainties, achieved comparable performances for both CGM and SMBG versions, without affecting the total daily insulin dose.

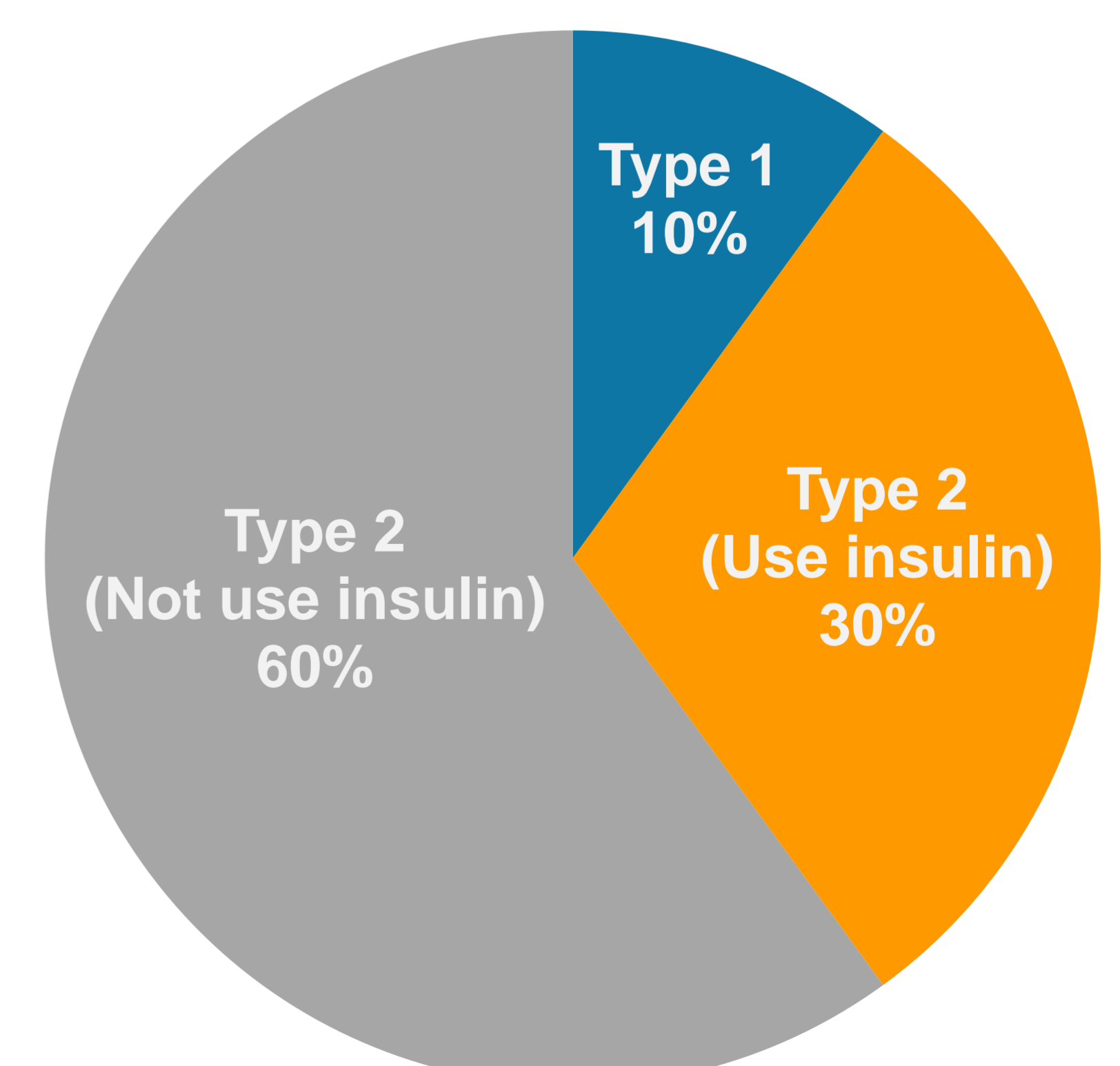
## Business Potential

### Market

- In 2017, 12% of global health expenditure is spent on diabetes (USD 727 billion)  
1 in 11 adults had diabetes (425 million)  
1 in 2 adults with diabetes were undiagnosed (212 million)
- In 2045, Diabetes-related health expenditure will exceed USD 776 billion  
1 in 10 adults will have diabetes (629 million)
- The number of individuals with diabetes under insulin treatment is increasing

### Our Solution

- Provides personalized basal-bolus insulin advice for diabetics using insulin treatment independent of the glucose monitoring system
- Targets individuals with both type 1 and type 2 diabetes (with type 2 being the larger market)



DEBIOTECH: Internal Market Analysis (March 2017)