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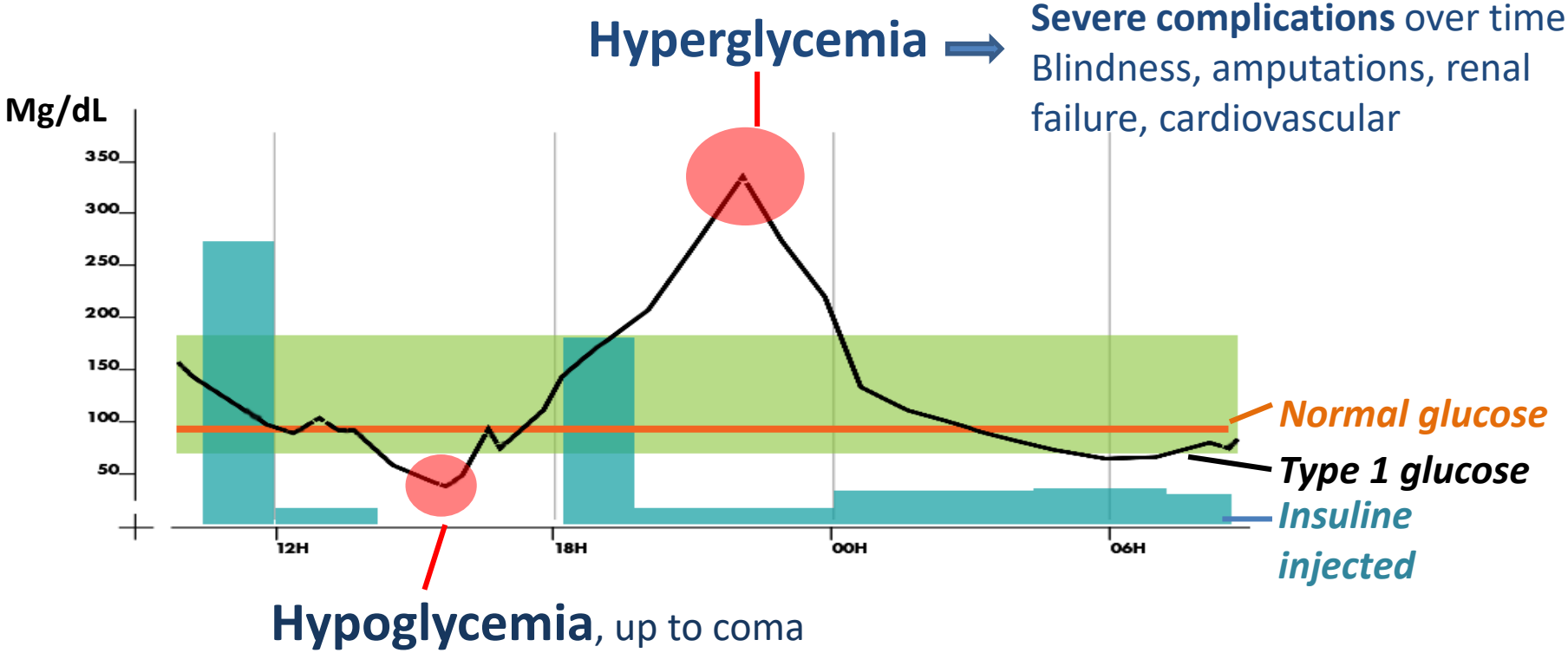
Artificial Pancreas for Type 1 Diabetes

Towards a carefree life


Troyes


Type 1 Diabetes:
3.5 M people US & Europe
200,000 in France
+4% / year
Can happen to ANYONE
50% of cases start under 20yrs old

Life with Type 1:
up to 30 therapeutic decisions every day



Cloud connected & Therapeutic support

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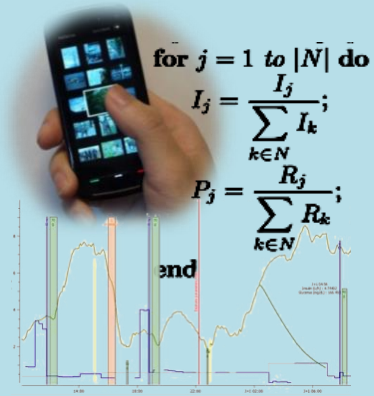
Glucose sensor

Dedicated Handset



Complex **algorithms**

Insulin dose

Insulin Pump

Patient input

Meals
Activity

Prescription
Parameters

Diabetologist

Cloud Connected

- Telemedecine
- Dedicated nurses
- Monitoring 24/24

Physiology modelling

Hovorka's equations :

Meal system

$$\frac{dD_1}{dt}(t) = A_g d(t) - \frac{D_1(t)}{\tau_D}$$

$$\frac{dD_2}{dt}(t) = \frac{1}{\tau_D}(D_1(t) - D_2(t))$$

Insulin system

$$\frac{dS_1}{dt}(t) = u(t) - \frac{S_1(t)}{\tau_S}$$

$$\frac{dS_2}{dt}(t) = \frac{1}{\tau_S}(S_1(t) - S_2(t))$$

$$\frac{dI}{dt}(t) = \frac{S_2(t)}{\tau_S V_i} - k_e I(t)$$

$$\frac{dx_1}{dt}(t) = -k_{a1}x_1(t) - k_{a1}S_{i1}I(t)$$

$$\frac{dx_2}{dt}(t) = -k_{a2}x_2(t) - k_{a2}S_{i2}I(t)$$

$$\frac{dx_3}{dt}(t) = -k_{a3}x_3(t) - k_{a3}S_{i3}I(t)$$

Glycemic system

$$\frac{dQ_1}{dt}(t) = \frac{D_2(t)}{\tau_D} - \underbrace{F_{01}\frac{\frac{Q_1(t)}{V_g}}{\frac{Q_1(t)}{V_g}+1}}_{F_{01}^c(t)} - \underbrace{\max\left(0\,;\, R_{cl}\left(Q_1(t) - 9V_g\right)\right)}_{F_R} - x_1(t)Q_1(t) + k_{12}Q_2(t) + \underbrace{max\left(0\,;\, EGP0(1 - x_3(t))\right)}_{EGP(t)}$$

$$\frac{dQ_2}{dt}(t) = x_1(t)Q_1(t) - \left(k_{12} + x_2(t)\right)Q_2(t)$$

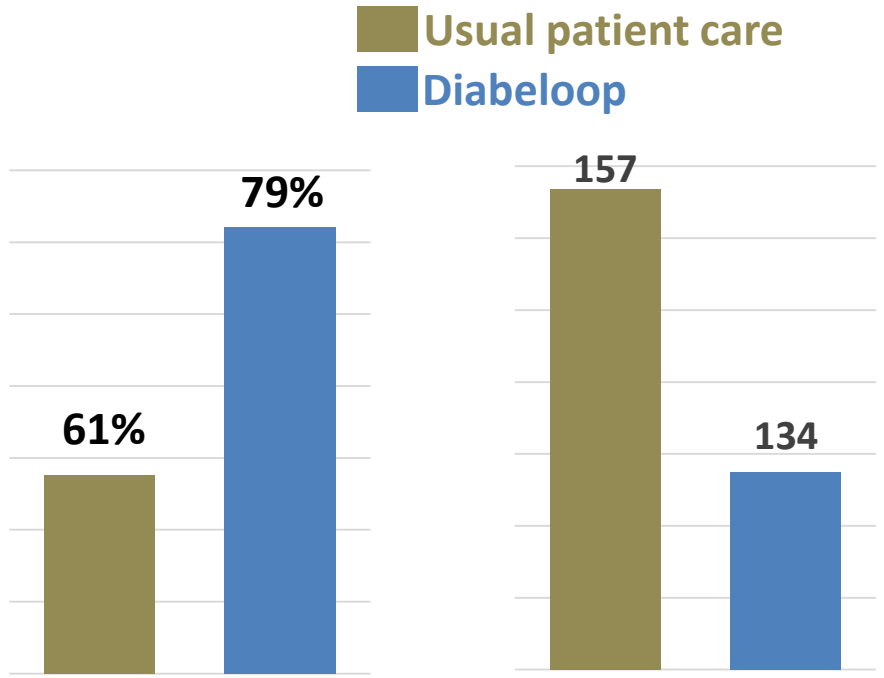
$$\frac{dC}{dt}(t) = k_{a\_int}\left(\frac{Q_1(t)}{V_g} - C(t)\right) \quad \Rightarrow \textbf{Sortie glycémie interstitielle}$$

Model patient's physiology → **Prediction** → **Calculate insulin doses**

Clinical study results

- 9 Centers
- 36 Patients, 3 days
- Cross-over design
- Includes intense physical activity & heavy meals

- Finished Q3 2016



Time in target range
Over whole day
(70-180mg/dL)

Avg glycemic level (mg/dL)
Link with complication

Patient testimonies from clinical studies

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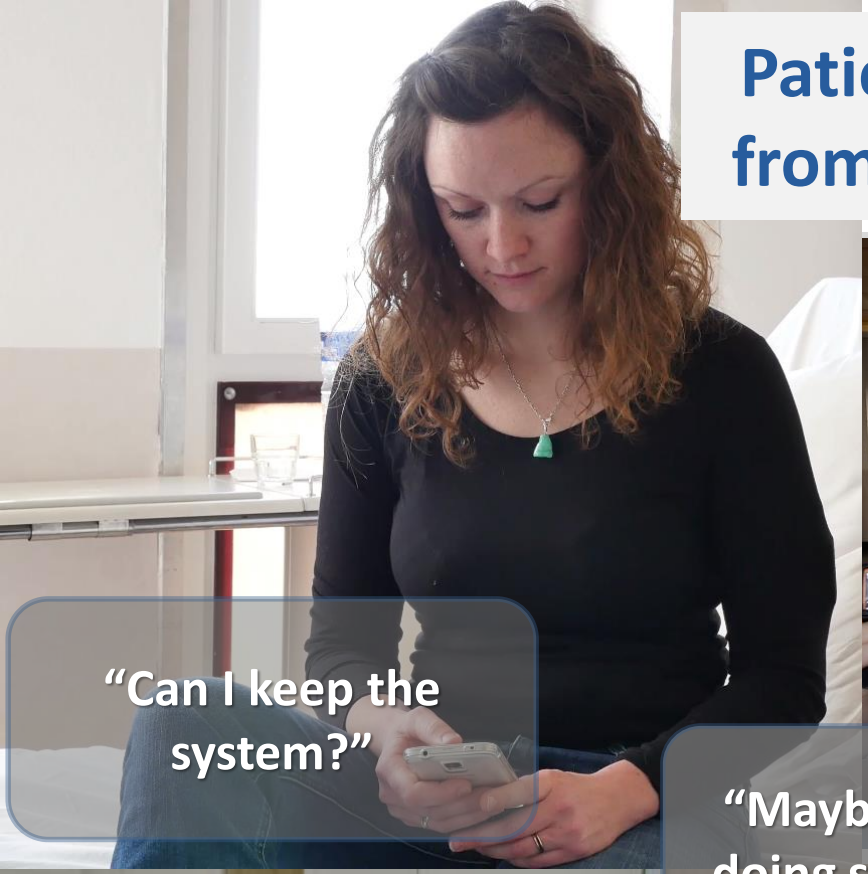
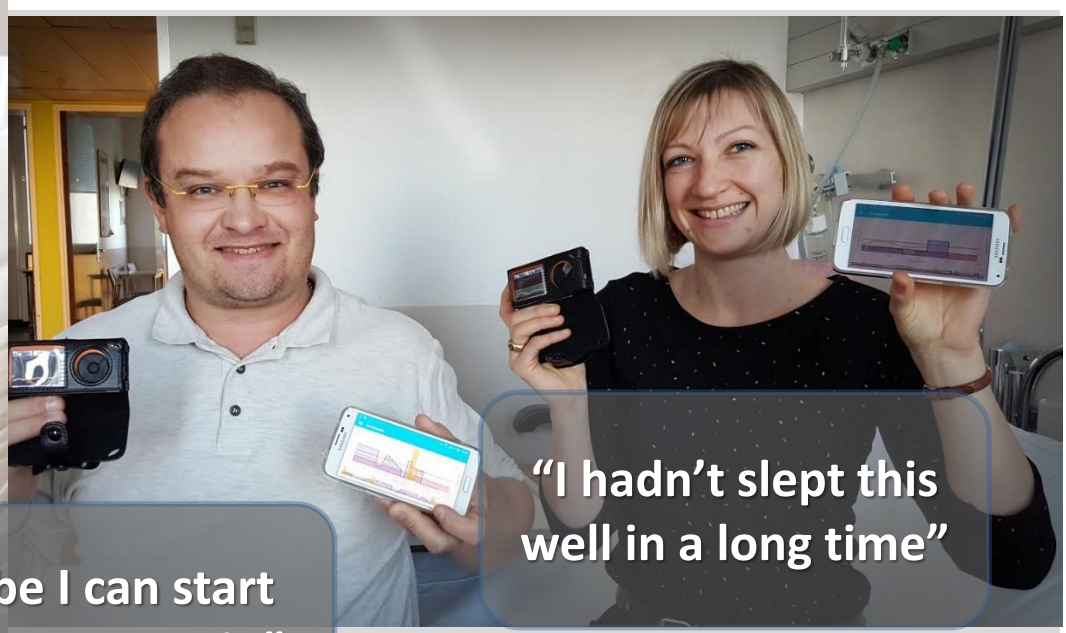
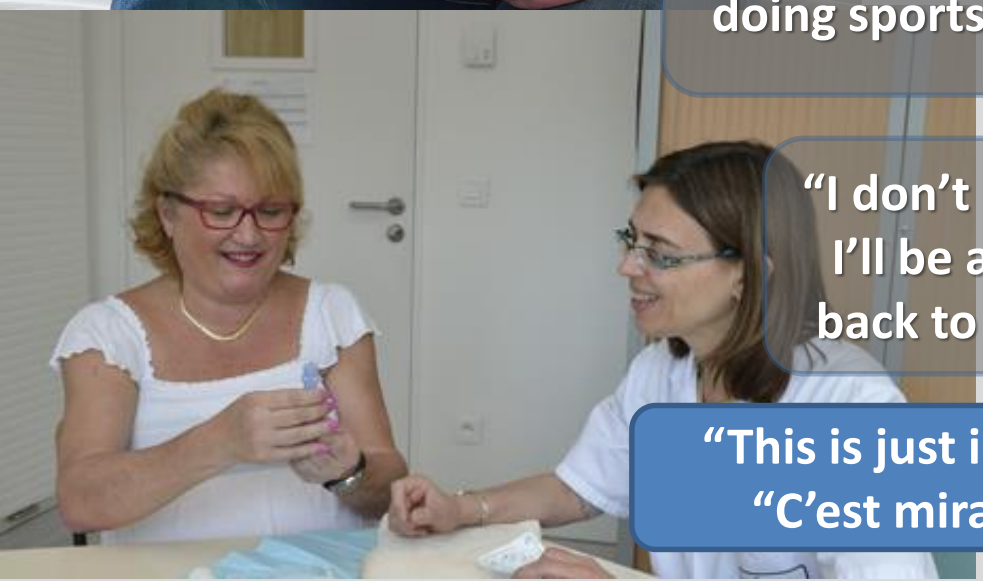


"Can I keep the system?"



"I hadn't slept this well in a long time"

"Maybe I can start doing sports again"



"I don't know how I'll be able to go back to 'normal'"

"This is just incredible"
"C'est miraculeux"

Strong partnerships

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CERITD

cea leti

Dexcom One Step Ahead

cellnovo

Home Care

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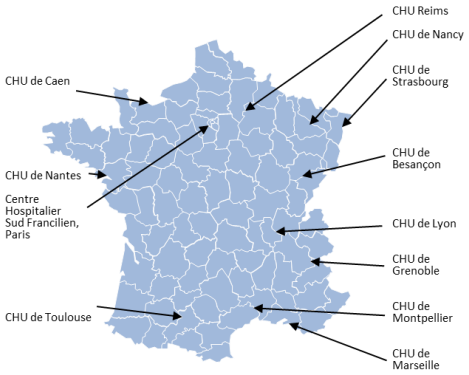
12 CHU



Patients: both directly and through the AFD
(French patients' association)

Next Steps

Now

- 3-month at-home clinical study
- CE marking
- Prepare for market access in Europe

Soon

- Improve algorithm
- Additional sensors
- Reimbursement
- Wider distribution

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