Empowerment of diabetic patients through mHealth technologies and education

Development of a pilot self-management application

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Monitoring and empowerment of chronic diseases

Heart Failure - Diabetes

Proximity Labs
Point-of-care testing

mHealth App
Self-monitoring tools

La Région et l'Europe investissent dans votre avenir ! • Het Gewest en Europa investeren in uw toekomst!
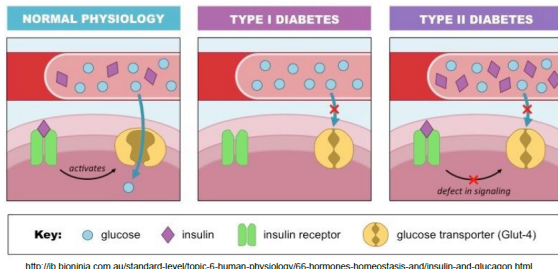
Union Européenne

# Outline

1) Diabetes is a major, global and increasing challenge

2) The need for BGL monitoring (1/2)

- Chronicity of hyper-/hypoglycemia can lead to severe complications that may be life-threatening
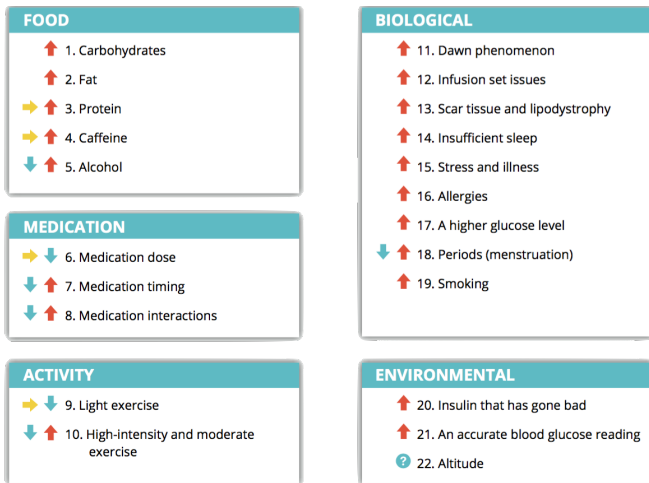
BLINDNESS HEART ATTACK KIDNEY FAILURE AMPUTATION

Every **6 seconds** a person dies from diabetes (5.0 million deaths)

- Hypoglycemia affects all aspects of life for the person with T1D, including employment, school, social interactions, driving, sport, and even sleep.

HEADACHY HUNGRY SWEATY CONFUSED SHAKY DIZZY GRUMPY
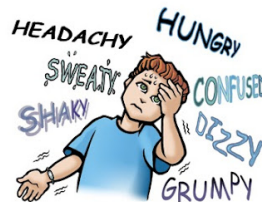
2) The complexity of BGL monitoring (2/2)

- *BG prediction is a complex, dynamic and multifactorial problem*
- *Figure : 22 factors that affect blood glucose*

FOOD
- ⬆ 1. Carbohydrates
- ⬆ 2. Fat
- ➡ ⬆ 3. Protein
- ➡ ⬆ 4. Caffeine
- ⬇ ⬆ 5. Alcohol

MEDICATION
- ➡ ⬇ 6. Medication dose
- ⬇ ⬆ 7. Medication timing
- ⬇ ⬆ 8. Medication interactions

ACTIVITY
- ➡ ⬇ 9. Light exercise
- ⬇ ⬆ 10. High-intensity and moderate exercise

BIOLOGICAL
- ⬆ 11. Dawn phenomenon
- ⬆ 12. Infusion set issues
- ⬆ 13. Scar tissue and lipodystrophy
- ⬆ 14. Insufficient sleep
- ⬆ 15. Stress and illness
- ⬆ 16. Allergies
- ⬆ 17. A higher glucose level
- ⬇ ⬆ 18. Periods (menstruation)
- ⬆ 19. Smoking

ENVIRONMENTAL
- ⬆ 20. Insulin that has gone bad
- ⬆ 21. An accurate blood glucose reading
- ❓ 22. Altitude

3) The need for education and tailored coaching

- 1 in 20 Google searches are Healthcare related. How reliable are search engine results ?

- Lifestyle behaviors (e.g. diet, exercise, sleep, alcohol, smoking, socialization) account for a substantial ($> 40\%$) portion of premature mortality [1]
    - Poor health habits are difficult to eliminate, and new ones to maintain.
    - Coaching tailored to individuals are more effective than generic one
    - Timely feedback plays an important role in changing a behavior

- In a recent study [2], it has been shown than around 64% of patients estimated their prandial insulin need inappropriately

4) The need for enhancing Healthcare communication
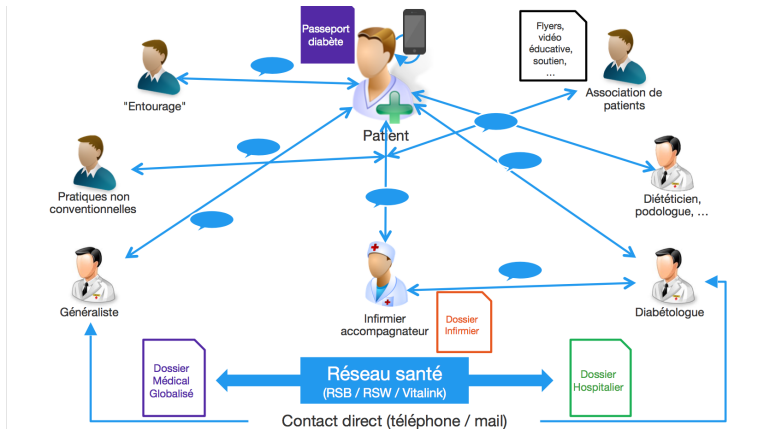
- Patient records are not "designed" for the patient himself.
- The sharing of patient records between HC professionals is complex.

Towards the essence of Eglé

Diabetes is a global, major and increasing challenge

1. The need for enhancing Healthcare communication

2. The need for accurate BGL monitoring
   - X   Complex, dynamic, multifactorial condition

3. The need for education and tailored coaching
   - X   Face-to-face coaching ($=$ the ideal) is expensive

Towards the essence of Eglé

Basic idea : *support patient empowerment through the development of a scalable platform of self-management tools, designed to improve medical care and foster communication between the patient, the family and HCPs.*

- *A communication tool allowing the patient & relatives to receive/send data;*
- *A dedicated area for information exchange between health professionals;*
- *A personalized system for monitoring the patient's health on a daily basis;*
- *A structured set of medical knowledge for 'educoaching' purposes.*

Outline

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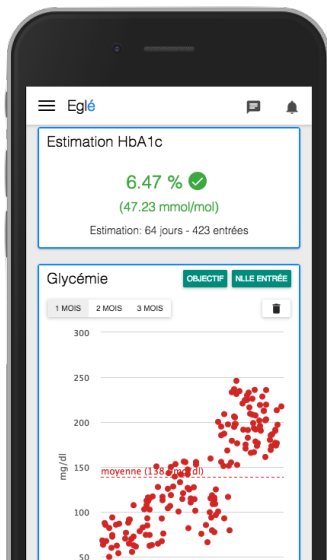
Health Tracking

- HbA1c estimation
- Self-monitoring widgets
  - Glycaemia
  - Physical activity
  - Medication
  - Diet
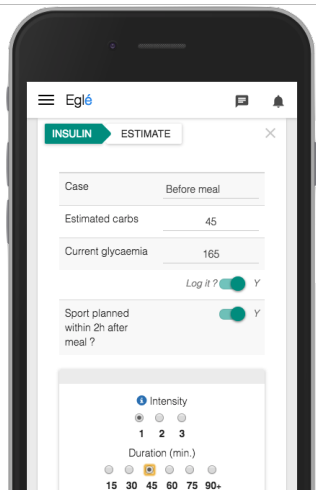 - Blood Pressure
  - Mood
  - Weight
  - ...

Outline
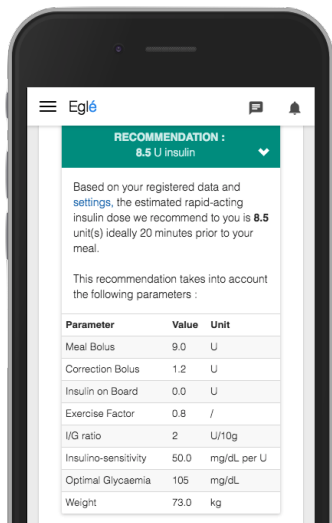
Treatment Assistant

- Insulin Bolus Assistant
- Informally validated by experts (CUSL)
- 3 cases
    - Before meal (prandial dose)
    - Before physical activity
    - Between meals (correction dose)

Treatment Assistant

Eglé

RECOMMENDATION :
8.5 U insulin

Based on your registered data and settings, the estimated rapid-acting insulin dose we recommend to you is **8.5** unit(s) ideally 20 minutes prior to your meal.

This recommendation takes into account the following parameters :

Parameter	Value	Unit
Meal Bolus	9.0	U
Correction Bolus	1.2	U
Insulin on Board	0.0	U
Exercise Factor	0.8	/
I/G ratio	2	U/10g
Insulino-sensitivity	50.0	mg/dL per U
Optimal Glycaemia	105	mg/dL
Weight	73.0	kg

1. BEFORE MEAL - PRANDIAL BOLUS

   (a) *No physical activity is planned :*

   $$B_k = B_{meal} + B_{corr} - IOB$$

   $$= CHO_{meal} \times ICR(t) + \frac{BG_k - BG_{opt}(t)}{IS} - \frac{\Delta k}{DIA} \times B_{k-1}$$

   (b) *A physical activity is planned within 120 minutes after meal ingestion :*

   $$B_k = (B_{meal} + B_{corr} - IOB) \times S_{PA}(i, d)$$

2. BEFORE PHYSICAL ACTIVITY

   $$CHO = CHO_{PA}(w, i) - \left(\frac{B_{corr} - IOB}{ICR(t)} \right)$$

3. BETWEEN MEALS

   If $B_{corr} > IOB$ then :

   $$B_k = B_{corr} - IOB$$

   else :

   $$CHO_k = \frac{B_{corr} - IOB}{ICR(t)}$$
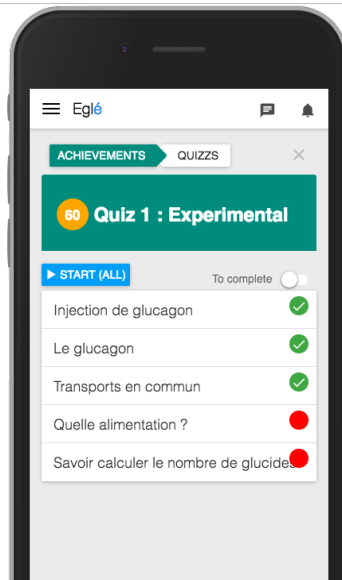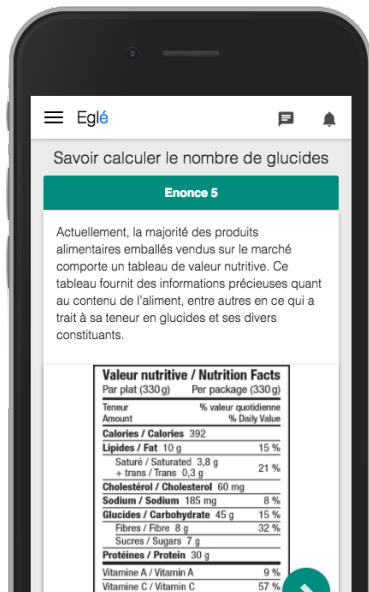
APPROVED

Outline

Educoaching

Outline

Interoperability

Outline

Communication with HCP's (to be continued)
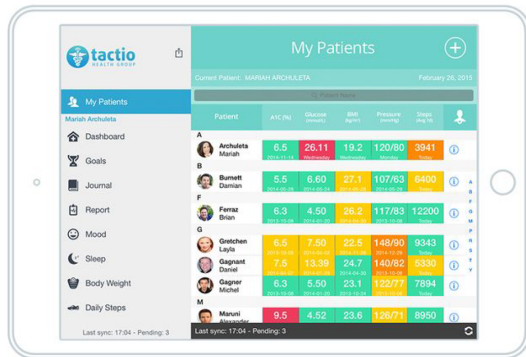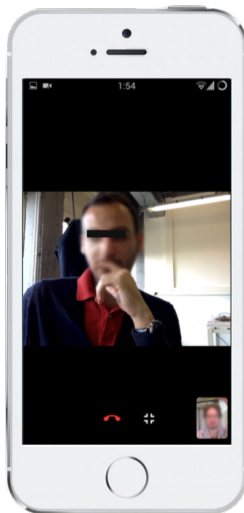
A typical Physician Dashboard.   Figure : https://www.tactiohealth.com/accueilv2/

Figure: Egle video conference tool

Outline

Further work
There is room for improvement !
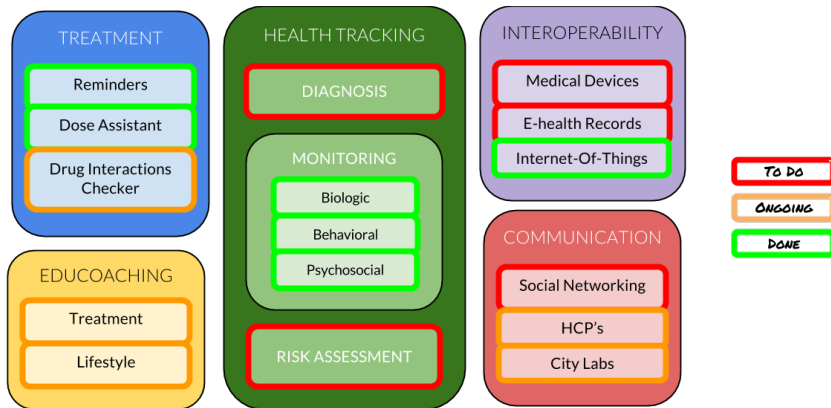
NB : Promising fields related to decision support and patient empowerment : cloud computing, machine learning, behavioral science, gamification, ...
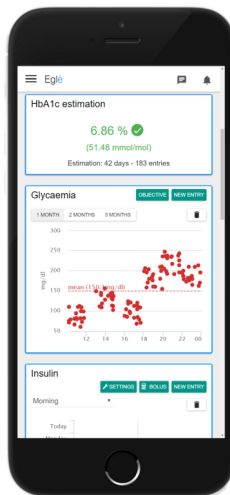
mHealth App : Eglé

Thank you ! Feel free to try me : https://beta.egle.be/signindoe

Votre laboratoire de proximité
Uw lab in de buurt

Tracking tools
- Glycaemia
- Medication
- Physical Activity
- Weight
- Diet

Interoperability with IoT devices
- Physical Activity
- Weight
- Blood Pressure
- Pulse Wave Rate

Empowerment & Education
- Insulin Bolus Assistant
- Tips & Tricks
- Challenges

HbA1C Estimation

Try Me

References I

[1] M. Pavel, H. B. Jimison, I. Korhonen, C. M. Gordon, and N. Saranummi, "Behavioral informatics and computational modeling in support of proactive health management and care," *Biomedical Engineering, IEEE Transactions on*, vol. 62, no. 12, pp. 2763–2775, 2015.

[2] A. J. Ahola, S. Mäkimattila, M. Saraheimo, V. Mikkilä, C. Forsblom, R. Freese, and P.-H. GROOP, "Many patients with type 1 diabetes estimate their prandial insulin need inappropriately," *Journal of diabetes*, vol. 2, no. 3, pp. 194–202, 2010.