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
Outline

1 Diabetes e-management: Motivations

2 Our mHealth App: Eglé
   - Health Tracking
   - Treatment Assistant
   - Educoaching
   - Interoperability
   - Communication

3 Further work
1) Diabetes is a major, global and increasing challenge

![Diagram showing normal physiology, type I diabetes, and type II diabetes]

Key:
- glucose
- insulin
- insulin receptor
- glucose transporter (Glut-4)


By 2040, 1 adult in 10 (642 million) will have diabetes

12% of global health expenditure is spent on diabetes
2) The need for BGL monitoring (1/2)

- Chronicity of hyper-/hypoglycemia can lead to severe complications that may be life-threatening.
  - Hypoglycemia affects all aspects of life for the person with T1D, including employment, school, social interactions, driving, sport, and even sleep.
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

**BIOPHYSICAL**
- ↑ 6. Medication dose
- ↑ 7. Medication timing
- ↑ 8. Medication interactions
- ↑ 9. Light exercise
- ↑ 10. High-intensity and moderate exercise
- ↑ 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
- ↑ 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
   - Complex, dynamic, multifactorial condition

3. The need for education and tailored coaching
   - 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.
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3. Further work
Health Tracking

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

Our mHealth App: Eglé
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Treatment Assistant

- Insulin Bolus Assistant
- Informally validated by experts (CUSL)
- 3 cases
  - Before meal (prandial dose)
  - Before physical activity
  - Between meals (correction dose)
Our mHealth App: Eglé Treatment Assistant

**Treatment Assistant**

![Image of Eglé app]

**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:

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

1. **BEFORE MEAL - PRANDIAL BOLUS**

(a) No physical activity is planned:

\[ B_k = B_{meal} + B_{cor} - IOB \]

\[ = \text{CHO}_{real} \times \text{ICR}(t) + \frac{B_{cor} - B_{opt}(t) \times \frac{\Delta k}{\text{DIA}}}{\text{IE}} \times B_{k-1} \]

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

\[ B_k = (B_{meal} + B_{cor} - IOB) \times \text{SPA}(i, d) \]

2. **BEFORE PHYSICAL ACTIVITY**

\[ \text{CHO}_{PA}(w, i, c) = \left( \frac{B_{cor} - IOB}{\text{ICR}(t)} \right) \]

3. **BETWEEN MEALS**

If \( B_{cor} > IOB \) then:

\[ B_k = B_{cor} - IOB \]

else:

\[ \text{CHO}_k = \frac{B_{cor} - IOB}{\text{ICR}(t)} \]
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Savoir calculer le nombre de glucides

Etonnement, la majorité des produits alimentaires emballés vendus sur le marché comporte un tableau de valeur nutritive. Ce tableau fournit des informations précieuses quant au contenu de l’aliment, entre autres en ce qui a trait à sa teneur en glucides et ses divers constituants.

Valeur nutritive / Nutrition Facts

Par plat (330 g) Per package (330 g)

Teneur % valeur quotidienne
Amount % Daily Value

Calories / Calories 392
Lipides / Fat 10 g 15 %
Saturés / Saturated 3,8 g
+ trans / Trans 0,3 g 21 %
Cholestérol / Cholesterol 60 mg
Sodium / Sodium 165 mg 8 %
Glucides / Carbohydrate 45 g 15 %
Fibres / Fibre 8 g
Sucres / Sugars 7 g
Protéines / Protein 30 g
Vitamine A / Vitamin A 9 %
Vitamine C / Vitamin C 57%
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Communication with HCP’s (to be continued)

**Figure:** Egle video conference tool

*A typical Physician Dashboard.*  
*Figure: https://www.tactiohealth.com/accueilv2/*
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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

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