



DR 1.2: Design and ontology of PAL prototype supporting knowledge and awareness

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Executive Summary This report presents the first user needs analyses, designs and evaluations of workpackage 1 (WP1) of the PAL project. The first general objective of WP1 is to identify the user needs, human factors knowledge and technological opportunities for the project and to take care that these needs, knowledge and opportunities are well-addressed throughout the development process. The specific challenge is to ensure that the PAL support functions fit with the stakeholders needs for situated care in the Netherlands and Italy. The second WP-objective is to develop and maintain a reusable, evidence-based, design knowledge-base that specifies these functions and their effects on self-management. Progress has been made on all four tasks:

T1.1. Domain and support analysis. The domain and support analysis is construed from three viewpoints: Stakeholders, human factors and technology. The stakeholders (children with diabetes, informal and formal caregivers) have been involved intensively in the analysis: During interviews, focus groups and diabetes camps. They provided (1) detailed insights in the situated user values and needs, and (2) input and feedback for the PAL designs. For the human factors, literature on behavioral change, developmental psychology and diabetes have been studied, this resulted, among other things, in the identification of key elements of the Self Determination Theory (SDT) for PAL-support. From the last, technological viewpoint, we provided a state of the art overview of apps and platforms for diabetic users.

T1.2. Design specification. A semi-formal structure or template for design specifications was constructed for defining, maintaining and sharing a re-usable design rationale (i.e. capturing the evolving design knowledge). Personas, scenarios, use cases and storyboards were created to derive the first set of PAL requirements and corresponding claims (specified according to the template). Subsequently, these requirements have been prioritized for the functionality of the first PAL prototype (PAL Actor, MyPAL, PAL Control and PAL Inform).

T1.3. Ontology engineering. A network of connected ontologies ("frames") have been constructed, each consisting of general concepts and their relations: (1) roles and actors, (2) emotion and sentiment, (3) task, goal, activity and context, and (4) diabetes self-management. For these frames, existing knowledge models are being adapted and extended to meet the PAL scope and objectives. A specific ontology frame is being worked out for the PAL reasoning and querying.

T1.4. Evaluation. A formative prototype evaluation has been conducted to refine the initial design specifications and collect child-robot interaction data to "feed" the first modeling activities. The evaluation protocol for the "first cycle evaluation" in Italy and the Netherlands is being worked on.

1 Embedding in project

1.1 Envisioned PAL system

This workpackage focuses on the general design and evaluation of the envisioned diabetes self-management support system for children. This system consists of the following components:

- PAL will incorporate an *Embodied Conversational Agent (ECA)* for consistent, personal and engaging interactions that evolve over time and can take place in many different situations. Such an ECA binds the child to use mHealth applications. A major innovation is the combination of a physical and virtual ECA. A physical ECA is used (i.e., a social robot like the Nao), because it showed to provide substantial motivational and educational benefits for children [1, 12, 15]. In addition, an avatar of the Nao is used, as the availability of the physical robot is constrained to specific situations (e.g., a hospital or diabetes camp). The avatar can be available at other places and times (e.g. at home and school) and on a range of devices. The ECA is intended to be the child's pal or companion for collaborative learning, to acquire the knowledge and skills for self-management of T1DM.
- PAL will support caregivers involvement in the child's self-management with an *authoring & control tool* for health professionals and a *monitor & inform tool* for parents. These tools help to harmonise the caregiver-PAL assistance and, furthermore, caregivers can use them to learn from and to tailor the assistance in practice. Here, PAL is intended to be an information gatekeeper to personalise the coaching and to provide explanations to the caregivers on the desired activities of the children.
- PAL will provide an extendable set of *mHealth applications*, starting with two core mHealth applications (timeline and educational quiz) and, subsequently, extend the set with additional edutainment applications to foster the child's interests to use PAL over time (e.g. a sorting game and miniApps). Data on the mHealth app usage and ECA-interactions will be processed and recorded in a common knowledge-base, and used for learning and reasoning. The timeline is one of the core mH-Apps in PAL. It is the basis for (i) personalised goal-setting with feedback, (ii) monitoring progress, and (iii) planning and tracking of the usages of other mH-Apps (like the educational quiz). Other applications and devices, like a glucometer or personal health record (PHR) can be connected to PAL, by allowing them to exchange data with the platform. Through all applications, PAL collects information and data on the child, related to health (blood glucose levels,

carbohydrate intake, insulin doses and exercise, illness, and fever), mood (appetite, energy, emotion), and daily life (reflection on how the day went). PAL provides open Interfaces to its platform, based on standards that support syntactic and semantic interoperability with connecting services and apps

1.2 Role of needs analysis, design and evaluation in PAL

WP1 contributes to the development of the PAL system by ensuring that user needs, human factors knowledge and technological opportunities are systematically generated and addressed during the development process. The processing of these needs, human factors and technology into design specifications is being done in such a way that a reusable, empirically founded knowledge base unfolds that describes PAL's functionality and corresponding effects on self-management.

The requirements derived from the user needs, human factors knowledge and technological opportunities provide input and focus for the developments in WP2, WP3, WP4 and WP5. On the other hand, the requirements are also guided by the developments in these WPs. The requirements are implemented as functionality of the PAL system (PAL Actor, MyPAL, PAL Control and PAL Inform) connected to hypotheses (i.e., claims) and then evaluated within T1.4. In addition to the joint evaluations (of the integrated system), smaller (formative) evaluations will be performed (e.g. during the camps) to get more knowledge on the user needs and to refine the design before the joint evaluation.

The general process from needs analyses, via design generation & specification, to evaluation is done in 3 cycles. This report covers the tasks performances of the first phase of the first cycle (i.e., needs analyses and first designs for the first evaluation).

1.3 Contribution to the PAL scenarios and prototypes

WP 1 provides the foundations of the design specifications and evaluations in such a way that they are theoretically and empirically grounded. Concerning the empirical grounding, we have done the following. Scenarios, requirements, prototypes and evaluation protocols have been specified. For this specification process, stakeholders, such as health care professionals and children with T1DM in Italy and the Netherlands, have been closely involved in user needs analyses and design creations, and the application of relevant theories and models. Concerning the theoretical grounding, we have done the following. Key elements of (1) the Self Determination Theory (SDT) and (2) the specific theoretical drivers of the other work packages (i.e., emotion regulation, action selection, dialogue management & gamification) have been worked in the scenario descriptions and prototype components. These

description and components have been iterated, based on periodic feedback from prototype developers, working for the PAL project, to ensure technological feasibility.

2 Tasks, objectives, results

WP1 is divided into four main tasks that run in parallel: Domain & support analysis, design specification, ontology engineering and evaluation. The first phase of the project shows a strong emphasis on the “Domain & support analysis” (T1.1) task, as it provide the general foundation of the PAL-system. Further on, more emphasis is put on the “Design specification” (T1.2), “Ontology engineering” (T1.3) and “Evaluation” (T1.4) tasks. Consequently, deliverable D1.2 will provide more elaborate outcomes on T1.1, than on T1.2, T1.3 and T1.4. The current focus is on supporting the *knowledge and awareness* (whereas in the subsequent project cycles, the focus will be extended to respectively diabetes regime adherence and shared child-caregiver responsibility). This in line with the the project road map, with three specification-evaluation cycles with an increasing scope, see Figure 1.

	<i>Knowledge & Awareness</i>	<i>Diabetes Regimes Adherence</i>	<i>Shared Child-Caregiver Responsibility</i>
Child: age claims	7-10 yr: + knowledge + awareness + attitude + self-efficacy + skills	7-12 yr: + regime adherence + glucose monitoring	7-14 yr: + shared responsibility + coping with anomalies - hypos/ hypers + glycemic control
Usage	1 month	4 months	9 months
Caregivers: claims	professional: + trust + acceptance parent: + attitude + knowledge	professional: + awareness parent: + trust + skills	professional: + tailoring parent: + shared responsibility
Settings	hospital, home	hospital, home, camp	hospital, home, camp, elsewhere
mHealth apps	diary, quizzes	diary, quizzes, sorting game, miniApps	diary, quizzes, sorting game, miniApps

Figure 1: Project road map: three specification-evaluation cycles with an increasing scope

In this way, during the first year, WP1 investigated and supported the “Design specifications, ontology and test protocol for PAL prototype supporting knowledge and awareness” (MS2). The concrete objectives were:

- To derive the first versions of the PAL requirements baseline from an

analysis of the domain and stakeholder needs & values.

- To build a first ontology in which the main aspects of PAL-supported self-management are defined and related to each other.
- To generate and assess a first design.
- To define the test protocol.

2.1 Domain and support analysis (T1.1)

Within T1.1 we looked at the domain from three points of view: the user in the operational context, human factors and technological opportunities. For the technological point of view, we did an analysis of the state of the art (SOTA) of applications and platforms that are currently used for diabetes management. For the user's and human-factors point of view, we studied literature and organized different stakeholder meetings to extract user needs with *health care professionals*, *children* and *parents* in the context of T1DM care and self-management in the hospital, at home and outdoors (e.g., at diabetes camps).

2.1.1 Health Care Professionals

In the Netherlands, two focus group sessions were conducted with the PAL researchers (TNO and DUT), caregivers (Meander hospital and Gelderse Vallei hospital) and representatives of the Diabetes Association. The first focus group resulted in a mind map (see Figure 2) scenarios, personas, use cases, storyboards, and a first set of requirements (see annexes 5.10, 5.12 and 5.13). The second focus group provided reflections on and further input for the ontology that was under construction.

In Italy, during the first project months, different meetings with the caregivers of the diabetological division of the Paediatric operative unit of San Raffaele Hospital and volunteers of the Diabetes association “SOSstegno70” have been carried out, in order to firstly understand what exactly is the process of education and care delivered to children (and their families) experiencing the onset of Type 1 Diabetes Mellitus (T1DM). This preliminary analysis allowed the Consortium to gain a proper idea of what is the reality of children, both inside and outside the hospital environment, in which the PAL technological solutions could be inserted and (possibly) be a valid educational support. The results are: the schematic overview of the hospitalization flow and care process reported in Annex 5.2 and the Personas shown in Annex 5.11. Within the Dutch hospitals (ZGV and MMC) a similar exercise was performed, resulting in Annex 5.3 and Annex 5.4

In addition, during the Educative Summer Camp held in August 2015 in Italy (see next paragraph and, for the detail of the activities, Annex 5.5),

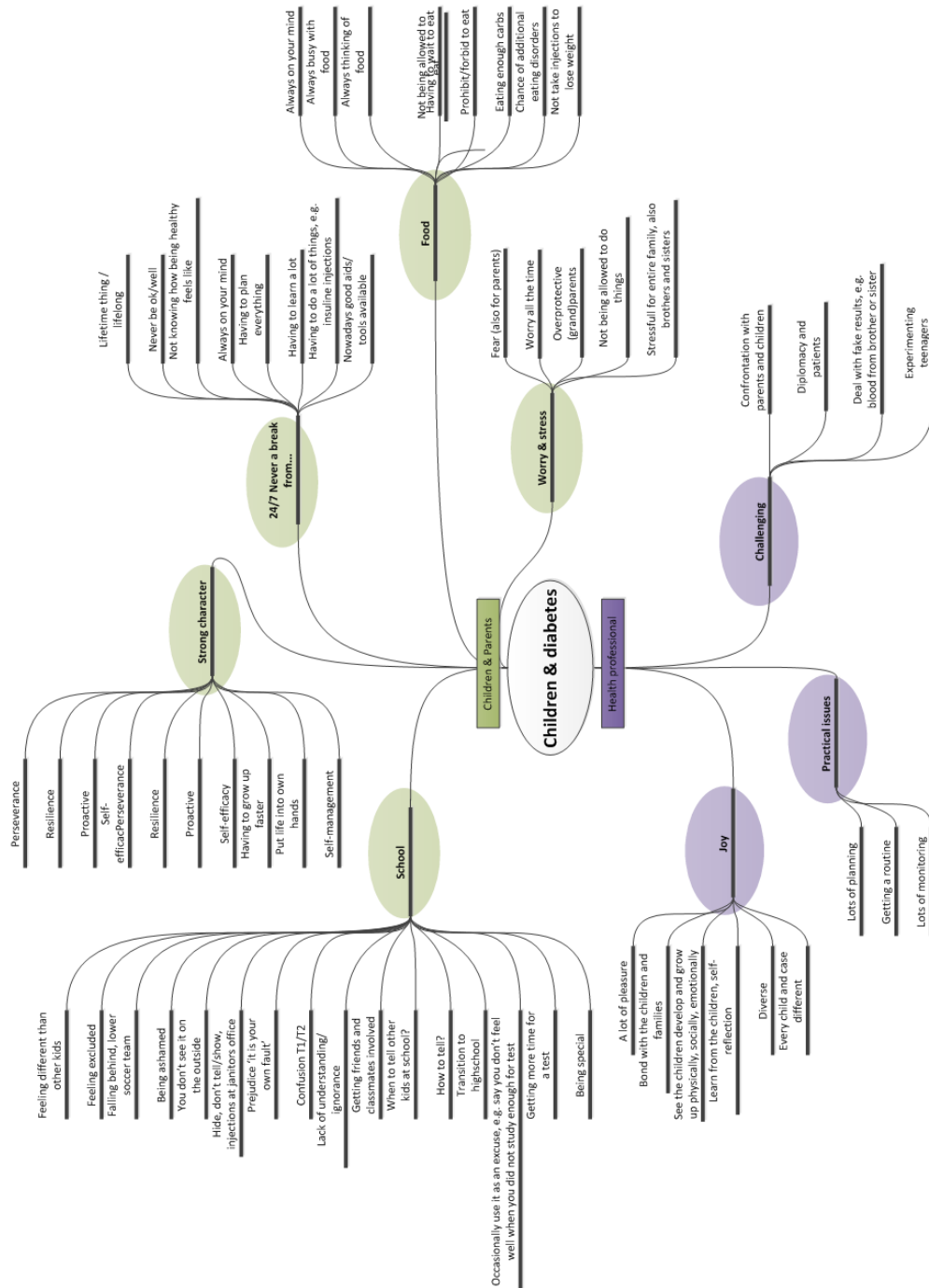


Figure 2: Mind map of diabetes type 1 in children

the researchers interviewed the attending healthcare professionals for 40 minutes: 2 Diabetologists, 4 Pediatricians, 1 Nutritionist, 2 Psychologists, 4 Nurses. This activity was aiming at exploring their point of view and experiences in regard of precise diabetes-related topics as, for example: (i) the importance of communication and interaction with their young patients and their families, (ii) their opinion on the role that technology could play as an educational or motivational reinforcement and the characteristics that this kind of technology should have, (iii) the most important educational contents to be conveyed to the patients, (iv) the environments in which children with T1DM and their families need support and the main issues arising in these situations, etc. The topics covered through the interviews are schematized in Figure 3. These insights constituted a first ground on which deriving the PAL functional requirements.

2.1.2 Children

In 2015, three diabetes camps were organized to acquire more insights in the needs of the children.

Pilot Camp in the Netherlands: Creative methods. In July 2015 several participatory creative methods to elicit user needs and robot requirements were explored during a camp (Cowboys and Indians) organized by the Dutch Diabetes Association (DVN), see also Annex 5.7. The study had three purposes 1) to explore general needs and experiences of children with diabetes, 2) to investigate what PAL should do to become an integral, supportive, component in their everyday life and 3) to test the effectiveness of the four applied creative methods, which were photo elicitation, drawing-and-tell, image-theater and storytelling.

Nine children (age 8-12, M=10.4) participated in the camp (Cowboys and Indians) and all participating children took part in the photo elicitation assignment. They made a photo-collage of the pictures they took the week before camp (they were instructed to take diabetes related pictures) and additional materials such as emoticons, coloring pens and stickers. After a day and a half there was a group discussion on the photo-collage. Subsequently, the PAL robot (NAO) was introduced to provide some context of what to expect from the PAL self-management support. After this introduction, children took part in a specific workshop of their choice: (1) Drawing how the robot could help, (2) making a still tableau with peers that is interpreted by other peers of how the robot could assist, or (3) creating a story together, line after line, with the title “NAO, the diabetes robot buddy”.

This combination of creative methods proved to work well for eliciting the needs and values in children, regarding diabetes management. During the different methods, different aspects PAL could provide support for came up. For example, children expressed their needs for emotional support. Also, they asked for additional aid in counting carbohydrates. These methods en-

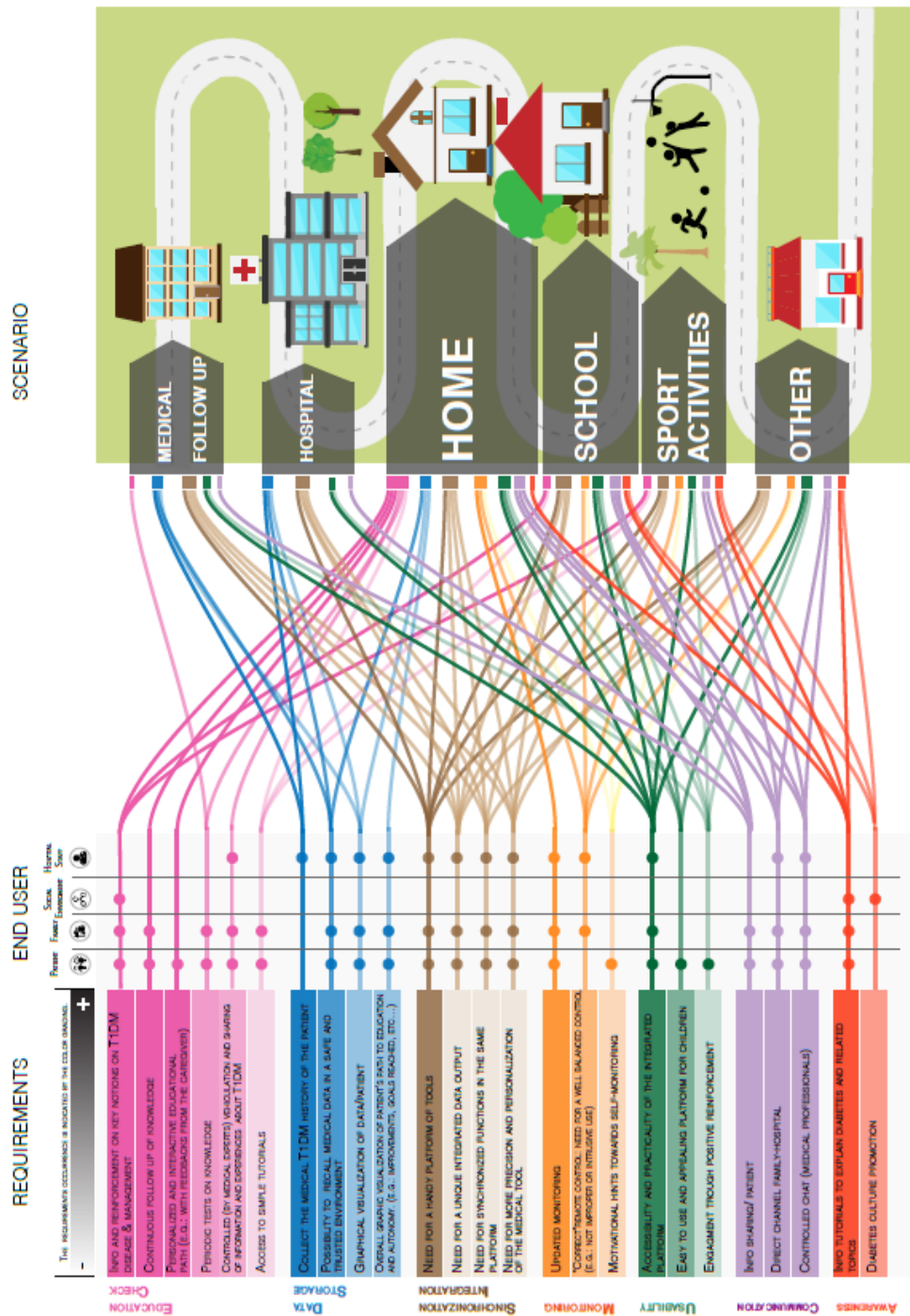


Figure 3: Schematic overview of the insights gained through the interviews with the HCPs at the Educative Summer Camp.

abled the children, also, to provide directions for future PAL applications, such as automatic monitoring of daily glucose values and emotions. Moreover, they would like to see functions in PAL that aids them to cope with the pain of the pricks and make children more resilient towards bullying. These needs, values and suggestions for PAL functions were taken into consideration during the construction of the PAL requirements baseline (see section 2.2).

Despite these positive results, the creative methods also had a number of limitations, which were addressed in the second camp in the Netherlands (Fall 2015). Mainly, to elicit a representative view of children's diabetes management needs in daily life, photo-elicitation has to be conducted at home in the period before the camp. Children were not enough involved in the storytelling and it is advised to let the children tell the story themselves. Image theater requires a larger number of participants (minimum of 6) to elicit requirements for future development. For the drawing activity, it is important to have the photo-collage at hand.

The methods and experiences with these methods were presented at the first international workshop on Evaluating Child-Robot Interaction at the ICSR-conference in Paris.

Robot camp in the Netherlands: User needs. In October 2015 (during Fall break), a diabetes camp was organized by the Dutch Diabetes Association. The camp was built around the research project with the PAL Actor (robot and avatar) as the main focus point. There were 21 children, age 8-11, staying at the camp. Before the camp started, parents and children were given information, asked to sign a consent form, asked to complete a short questionnaire with background information and preferences for creative methods. Furthermore, they were asked to make and send photos illustrating their daily life with diabetes. As a refinement of the pilot camp, multiple creative methods were used to acquire the children's values and needs. These methods were set up to follow a certain sequence 1) introduction of robot, 2) user values, 3) interaction with robot, 4) user requirements with creative methods as described above.

The results can be summarized as follows:

- The experience with the robot tutor showed that children liked it when the robot is used a tutor and learned a lot from him when questioned. We can see the role of tutor and pal being used alternating depending on the context.
- The results of the photo work groups showed three topics that are important for children
 - Support of others; support of significant others and/or others with diabetes.

- Maintaining self-management is important but can sometimes be difficult, it is nice when they have things that help them.
- It is nice to be able to do normal activities (like sports and school) and even excel at this, despite the diabetes.
- The children enjoyed the interactions with the robot and these were videotaped. When there were two children playing with the robot there was more interaction between the children themselves and between the robot and the children. The children preferred for the new functionalities that they were able to adjust, individualize or develop themselves.
- Requirements were obtained from the creative methods and used to complete the list with requirements for the PAL system.
- The children like the creative methods and additional information was obtained by using these methods.

For more details on the camp, please refer to Annex 5.8

Educative camp in Italy: User needs. The Italian summer camp took place between the 24th of August and the 2nd of September 2015 at a seaside location (Misano Adriatico) and was organized by the patients' association SOSstegno70. Thirty-four children participated, aged between 10 and 14. The camp focused on learning to live with diabetes: it provided informational moments, practical training and structured lessons about T1DM and related topics (e.g., nutrition, physical activity, etc.) supervised by an expert medical staff (doctors, nurses, psychologists and nutritionists). A day consisted of lessons on how to correctly manage diabetes and its relation to daily life. There were also moment of free discussion with the doctors, nurses and psychologists. In the evening and afternoon it was possible for the children to engage in activities organized by the animation, and sparsely during the day, depending on their will, children had the possibility to engage in the proposed activities with the PAL research team and to interact with the NAO robot. The main focus of the PAL-related activities was to understand the needs and challenges faced everyday by children with T1DM (in order to derive specific User Requirements to be implemented in the first prototype of the PAL system) and their expectations and desires towards a possible customizable supporting technology. To this purpose, different investigation methodologies were exerted: (i) qualitative questionnaires, e.g.: related to lifestyles and technology level of confidence, in order to have an overall characterization of the population involved; (ii) interactive co-creation tools, e.g.: the Journey Map and the PAL game, to derive children's point of view - in terms of tasks, emotions, needs, desires, etc.- on how it is living with T1DM; (iii) unstructured Child-Robot Interactions, to study new possible interaction dynamics to be used in the following project's stages.

The results can be summarized as following:

- through the questionnaire it was possible to draw a preliminary overlook of the participating pool, in terms of knowledge and habits related to diabetes, confidence with technology and its perception;
- different insights arose from the co-creation methods, especially about the issues and problems to be faced about type 1 diabetes, both from the therapy management and the emotional/social sphere points of view;
- children provided different hints on the possible functionalities that the PAL system should have in order to support them in managing the diabetes;
- children were free to choose if interacting singularly or in couple with the Nao robot. It was evident that children interacting in couple were more activated and engaged.

For a detailed description of the activities proposed and of the obtained results, please refer to Annex 5.5.

Comparing Children in Italy and the Netherlands. Next to the individual results of the camps we are also interested in cultural comparisons. During the camps we observed the behavior expressed by the children when interacting with the robot and looked at what words were used in the open text of the questionnaires used. For the observed behavior we looked at four dimensions (familiarity, attitude, liking and benevolence) and how these were expressed in speech and dialog. Corresponding to cultural expectations, Italian children seemed to be more open and expressive, and more close to the robot compared to the Dutch children. Part of these differences could be caused by the fact that the Italian children were slightly older and because the settings of the camps were different. However, it provides context-rich information on the variety of experiences that the robot has to accommodate. A paper that summarizes these results has been accepted for the international Human-Robot Interaction conference in 2016 5.14.

2.1.3 Parents

Parents activities in Italy: User needs. In Italy, specific activities with parents of children with T1DM were also carried out, in order to derive their specific user needs and desires. To this extent, two dedicated occasions were organized: the former with parents of children (11-14 y.o.) participating to the Misano Adriatico camp, the latter with a group of parents of younger children, aged 8-10 y.o. In this way it was possible to cover the entire project's age range of interest.

In the first organized meeting (Milan, September 2015) it was proposed to the participant pool (21 parents) to compile a specific questionnaire in order to obtain information about the dynamics regarding diabetes management in their own families, the level of confidence with technologies related to T1DM and their major needs regarding their sons/daughters' condition. The results can be summarized as follows:

- The majority esteems their own, and their children, knowledge of T1DM good;
- Management indicators of their sons were *Autonomy* (insufficient) *Collaboration* (wants a confirm) *Awareness* (partial);
- All parents, after the onset, would like to have in depth information about the management of the hypo/hyper episodes, the possible medical complications of the disease and how to deal with carbohydrates in foods;
- They wished an app simple to use, with the possibility to share real-time information with their children;
- Their main concern was the impossibility to control their sons when they are out of home.

For what concerns the second meeting, the association SOSStegno70 organized an educational week end for children aged 6-10 y.o. and their parents, which took place between September 25th and September 27th 2015, at the Fortress of Bard, (Aosta). In that occasion the parents of 8-10 y.o. children participated to a brainstorming session with researchers, in order to: (i) identify the moments related to the management of diabetes in their daily lives and related activities and issues, (ii) have a free discussion on their technology-related wishes.

14 parents participated (7 couples) and the brainstorming session was evaluated through the notes and feedback of the attending researchers and also analyzing the video-recordings of the meetings. The parents questionnaire used in the previous encounter was not repeated because specifically designed for parents of older sons (different targets). The main results can be summarized as follows:

- Glycemia value was the most common concern for parents;
- Mothers were more directly involved in therapy management;
- All the parents would like to have more control of their children especially during school time;
- More autonomy was left/recognized at home when in fact children are more under parents' control.

For more details, please see Annex 5.6.

2.1.4 State of the art applications for diabetic support

Using input from health care professionals, children, parents and an app search in the Apple app-store and Android play-store, we created a report with an overview of these apps. Of every app/platform url(s), name, manufacturer, costs, release data and last update, target users, technical features, therapy data, settings, functions (e.g. data input, statistics), differences between versions (e.g. a pro version), accessory applications (e.g. a quiz), strengths, weaknesses and user reviews are provided. Of the thirteen discussed apps a tabular overview of functions is provided at the end of the report (see Annex 5.1).

2.2 Generate and refine specification (T1.2)

PAL will develop user-, domain-, theory- and technology-driven design knowledge during the course of the project. The situated Cognitive Engineering (sCE) methodology [18] will be applied to guide the analysis, specification and evaluation of the drivers and design outcomes. However, the sCE methodology did not yet provide a (semi)formal template to relate the operational demands, socio-cognitive theories, technologies, user requirements, design rationale and evaluation metrics to each other. To establish such a template for an evolving knowledge base that is concise, coherent and reusable, we developed the *situated Design Rationale (sDR)*. A design rationale is an explicit documentation of the design decisions with the reasons behind these decisions. This documentation should provide an argumentation-based structure to key design problems as a means to record and communicate the argumentation and reasoning behind the design process [14], [10]:

- the reasons and argumentation behind the described design decision
- its justification
- possible alternatives considered
- the trade-offs evaluated

When the reasons, argumentation and justification refer explicitly to theories, the design rationale can be viewed as a specification of multi-disciplinary theory, guiding scientific research [4]. By explicitly referring to use cases, the design rationale (and its underlying theory) is situated.

Figure 4 shows the generic format of the sDR which can be instantiated with the objectives, methods, functions etc. relevant for the PAL project. The analyses of section 2.1 provided the first set of *objectives*, *methods*, *functions* (i.e., functional requirements), expected *effects* (i.e., claims) and *instruments* to measure these effects. In a next phase, the *interaction design patterns* will be worked out. The functional requirements were written down

in a specific format and given a priority based on the MoSCoW method (must have, should have, could have). The requirements were then checked by the developers on feasibility and refined. For more detailed information on the current status of the baseline, which will be made final before the first experiment cycle, we refer to Annex 5.15.

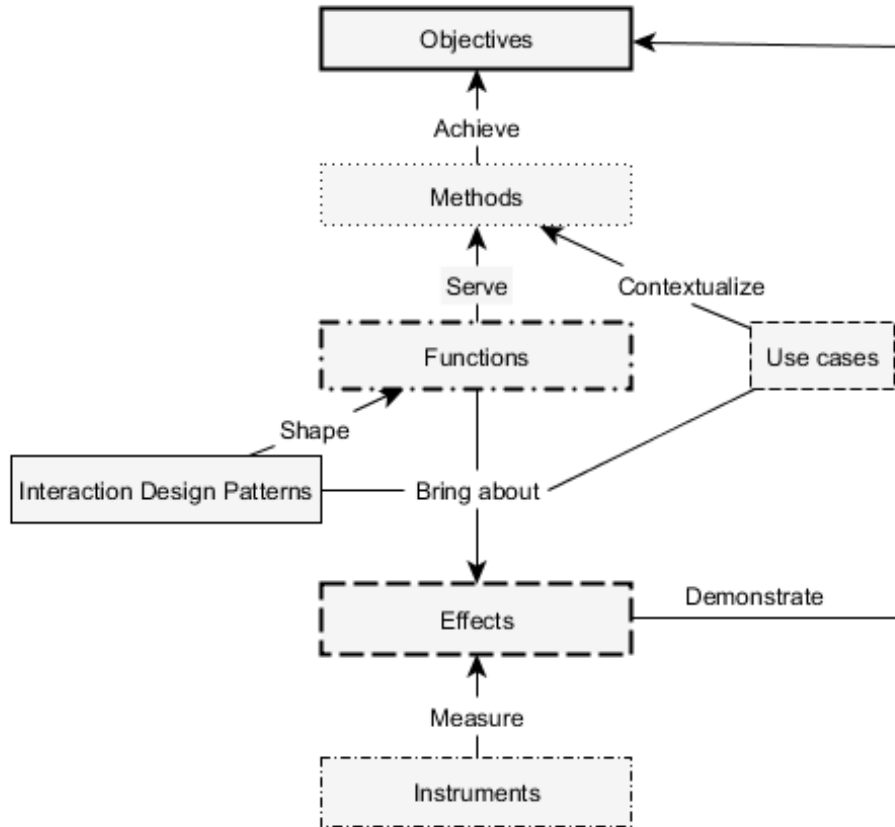


Figure 4: Generic sDR format

2.3 Ontology Engineering (T1.3)

PAL is part of a joint, human-agent, cognitive system, in which humans and agents share information. The (common) ontology refers to a shared understanding and is a basis for communication (e.g. between project partners), for interoperability between system components and roles in PAL context (e.g. patient and avatar) and a basis for system development (e.g. requirements formulation, knowledge reasoning). The approach for ontology development in the PAL project is a systematic, iterative and incremental, development process to establish sound knowledge-based support (including

the reciprocal human-agent information requests and provisions).

The PAL context covers a large domain of interest, which means we need to cover many concepts in our ontology. We therefore needed to break down the larger domain in smaller areas of interest (frames). We will first develop the ontology models for the separate frames, as high-level building blocks. We have then determined appropriate representations of the frame, either by constructing the ontology ourselves or by selecting one that covers the topic from the various (global) libraries that hold existing knowledge representations. Because existing knowledge models only roughly cover the intended scope of PAL, adaptation turns out to be required. We both extend the existing ontology models when e.g. concepts are lacking or downsize them when there are too many details/concepts in the model.

The frames we have identified and modeled so far are a.o. (1) roles/actors with various human/machine roles involved in self-management, (2) emotion and sentiment that covers the primary responses of the child to interaction with the robot/avatar and the general state of mind of the child, (3) task/goal/activity/context that includes self-management activities, their associated goals and results and the setting they take place in, (4) diabetes self-management which includes activities the child performs in order to manage his/her disease. A more elaborate overall PAL model will also include interaction and behaviour of robot and avatar (see also DR4.1), a privacy model regarding information of self-management activities and an agreement model to cover the agreements between patient and avatar/robot.

In time, we can reapply ontology engineering to the frames and iteratively extend the ontologies by incorporating new concepts, readjust the definitions according to new academic insights or based on expert reviews/opinions and simply continuous realignment with sources of information in the entire project.

2.4 Evaluation (T1.4)

A formative prototype evaluation has been conducted to instantiate some initial core requirements into a (disposable) prototype and assess children's experience with this prototype in the envisioned hospital and home set-up. Main objectives were to refine the initial design specifications and collect child-robot interaction data that can "feed" the first modeling activities. An important functionality concerned the *timeline* as an environment in which the child can maintain his or her objectives and progress, diabetes-related diary and "normal" diary, post (diabetes related) pictures to support the diary and an agenda to put in activities/appointments (e.g. sport, doctor appointments, school exams).

The Play Framework (Java + Scala + HTML5 + JQuery) was used to build a Fully responsive browser/web app that ran on the protected server of hospital Gelderse Vallei (ZGV) in the Netherlands. Thirteen patients at the

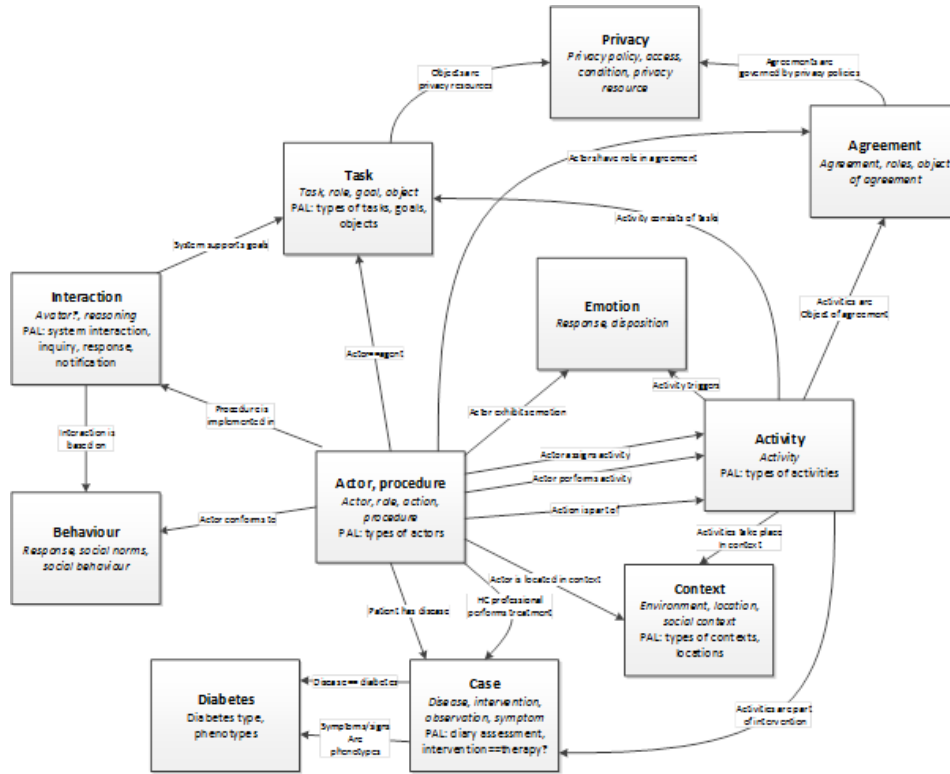


Figure 5: General PAL ontology

Diabetes care unit of this hospital participated in this study (age range: 7-12, median: 10; 4 girls, 9 boys; one invitee did not respond). The participants met Robin the robot at the hospital where they received instructions on the “myPAL” timeline. The children used myPAL at home, on a pc or tablet, for two weeks. Robin was present in the myPAL as a virtual avatar. Timeline use and added content was recorded during this period. After two weeks the children came back to the hospital to evaluate myPAL and Robin. They filled in questionnaires and were interviewed. Children could also say goodbye to Robin. Table 1 shows the how the three high-level objectives of the design rationale (i.e., autonomy, competence and relatedness) were supported by the PAL timeline and avatar.

Figure 6 and table 2 show the results of the evaluation. The *not interested* group consisted of older children (girls) who were not motivated, they hardly used the system even after reminding them. The *needs reminders* group consisted of younger children (boys) with mixed motivations; MyPAL could actively remind these children (maybe due to a bigger role of parents). The *under achieving* group consisted of about 10 year old boys with constant motivation who used the avatar for more mutual self-disclosure (more avatar content); the avatar could actively ask for more content. The *over achieving*

Table 1: High-level design rationale.

	Autonomy	Competence	Relatedness
Timeline	Create (timeline related) goals	Edit activities (e.g. school, sport, meal) and measurements	Add photos, mood and thoughts
Avatar	Guides the children through the selection process	Praises adherence and progress	Discusses activities, matches child mood, shares stories and photos of itself

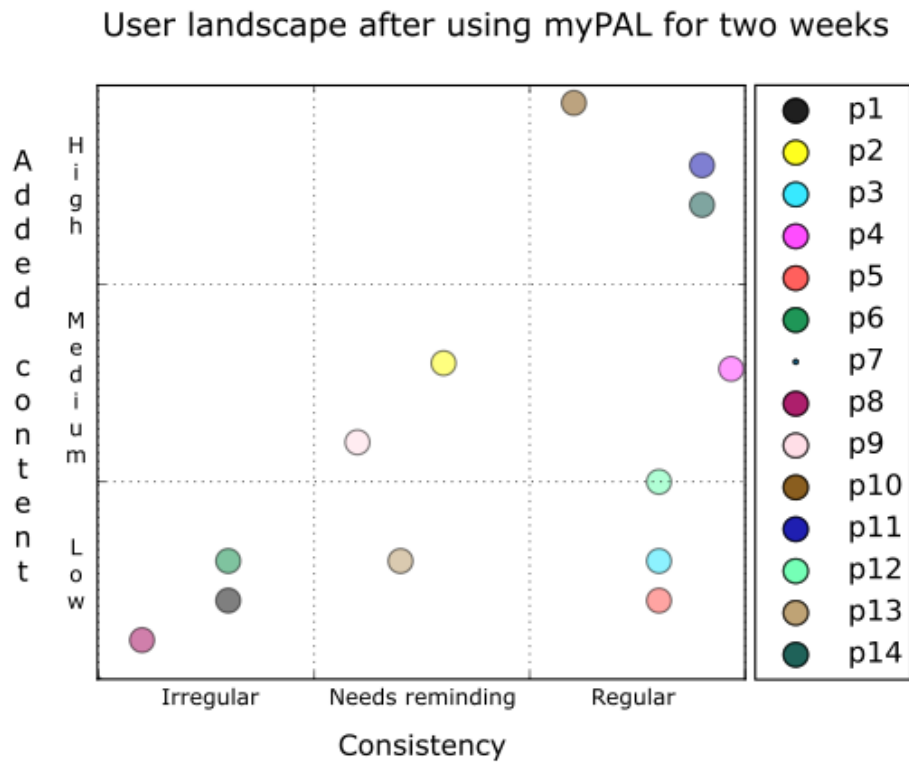


Figure 6: User patterns during the two-week evaluation.

group consisted of about 10 year old girls with lots of interaction, but decreasing motivation. Overall there seems to be a need to further personalize and streamline the interaction process (e.g., prevent peaks) with the use of specific goals. For an overview of the evaluation look at Annex 5.9.

Table 2: Groups of PAL users.

	Not Inter- ested	Inter- ested	Needs Re- minder	Under- achievers	Over- achievers
Inter- action	Log in 2 or 3 times in first quarter. Add 2 or 3 content items in total	Log in 5 or 6 times irregularly or with great gaps. Add different amounts of content items per session.	Log in 9 or 10 times regularly. Add in total 1 or 2 content items per session.	Log in 9 or 10 times regularly. Add at least 4 or 5 content items, sometimes 12	
Effect- iveness	Not effective. Possibly some downsides.	Shows promise but needs attention	Effective for regular life; not for data collection	Highly effective for data collection; risk for quitting after a while.	Decrease
Moti- vation	Decreasing over time	Mix of increase, decrease and constant	Constant or slow decrease		
Demo- graphics	M(11), F(9), F(12)	M(8), M(9), M(9)	M(10), M(10), M(7)	F(10), F(10), M(11)	

3 Relation to the state-of-the-art

Below we briefly discuss how the obtained results of the individual tasks relate to the current state-of-the-art (the papers and reports in the appendices provide more detailed references to the state-of-the-art).

3.1 Domain and support analysis (T1.1)

Diabetes Mellitus Type I (T1DM) is an inflammatory autoimmune disease of the pancreas, resulting in a lack of insulin. T1DM typically appears in early life as one of the most pervasive endocrine - metabolic conditions in childhood, which requires intensive self-management by the child, supported by the parents and the health professionals [11]. T1DM is associated with glucose dysregulation episodes (i.e., hypoglycemic and hyperglycemic) and long-term complications that cause high morbidity and mortality, affect the quality of life and increase health-care costs. Despite modern treatment options, more than 50% of children with diabetes develop complications 12 years after diagnosis [5] in regard to major organs as heart, blood vessels, nerves, eyes and kidneys. Research has shown that life expectancy for children diagnosed by age 10 is reduced by nearly 19 years [17]. A youth study [22] showed that 35% of youth with diabetes (aged 0-18 years) have poor psychological well-being (26% experience high levels of anxiety and 13%

depression). Also, 20-39% experienced a detrimental effect on their school performance due to diabetes. Approximately 25% felt that their illness regularly causes them embarrassment.

Severe episodes and complications can be prevented by performing *self-management*. Monitoring carbohydrate intake, physical activity, and blood glucose, recognising symptoms of hypoglycemia and hyperglycemia, and injecting insulin, can help regulate glucose levels and help minimising the impact of the illness on the patients health. Better glycemic control is also associated with better quality of life [9]. Self-management in children with T1DM is influenced by developmental factors. Scott describes developmental milestones (i.e., physical, emotional, cognitive and social) and shows how they impact self-management [24]. For example, children aged 7 years become inquisitive, begin to care about others opinions and become more self-sufficient in their self-management, but they still lack self-control and need reminders. Especially, the transition from childhood into (early) adolescence poses challenges, because (a) physical changes complicate glycemic control, and (b) adolescents have an increasing need for autonomy. These developmental changes also challenge the support parents and health professionals can provide [16].

Parents have to gradually handover self-management tasks to their child, but in such a way that good glycemic control is sustained. This is important for promoting health autonomy in their child. However, parental support and shared responsibilities are still relevant ingredients for good self-management in adolescence [31]. Thus, parents need information and support so that the glycemic control of their child stays optimal, while also the childs health autonomy is promoted.

Health professionals are responsible to provide care according to the national guideline for T1DM treatment. They can decide to change the insulin regime given glucose dysregulation episodes resulting from imbalances between nutrition, physical activity and insulin administration. Health professionals thus need timely information regarding these parameters to provide advice on adjustments in insulin regime. In addition, they need to know which self-management behaviors the child has to improve in order to reach a better glycemic control.

In conclusion, there is a real health and economic demand to advance childrens self-management for T1DM during their development towards adolescence (endurance). This workpackage analyzed and reified this need in detail at focus groups, diabetes camps and formative evaluations of first self-management support concepts. In this way, we identified the stakeholders and their values, theories & methods for child self-management, and current support applications & services. The challenge is to address these values and combine the different methods and technologies to meet the demands of personalisation, situatedness and endurance.

3.2 Generate and refine specification (T1.2)

To meet the challenge of developing integrated value-driven –personal, situated and endured– self-management support, PAL will apply various *behavioural change techniques* [19]. For instance, providing reinforcements when a child shows good glycemic control by complimenting the child or giving extra points in a game. Furthermore, PAL fosters *long-term engagement* on the one hand by personalised adaptive interactions, and on the other hand by extendable content, regarding both the thematic content covered in the interactions as well as the repertoire of activities (mHealth apps). By *mutual agreement*, the health professional and child set self-management-related goals and tasks for the children. The professional can monitor the child's developments through PAL. Child's parents can also be informed by PAL.

A co-design approach is being applied, combining the views, input and skills of the different stakeholders' perspectives to address a specific problem [2, 30]. There is some progress on user-centered design with children (e.g., [26]), but co-design incorporating children as one of the stakeholders is still a rather unexplored area and poses a real challenge.

PAL is unique in specifying the requirements with their (situated) design rationale for this combined social, cognitive and affective support, addressing the needs of the child and his or her social environment. The situated Design Rationale (sDR) provides an argumentation-based, semiformal template to document design solutions for key problems (cf., [14], [10]), addressing relevant multi-disciplinary theories to accommodate the scientific research (cf. [4]). By explicitly referring to the use cases, the design rationale (and its underlying theory) is situated.

The PAL requirements baseline will evolve during the project life-time (i.e., maintained, refined and validated).

3.3 Ontology Engineering (T1.3)

The iterative design of an ontology [8, 25] throughout the engineering phases and application to the entire scope of the project, creates better coherence between project activities, result in more conciseness and precision by catalyzing the design process and applies focus and clarity in a broad discussion with many viewpoints. Many projects involved in knowledge engineering focus on establishing new knowledge models. Ontology engineering in PAL aims to reuse existing knowledge sources as much as possible, due to the large domain scope. Reuse is not trivial, due to the fact that in most cases, a set of concepts available in the existing ontology model only roughly covers the frame of interest. Relating the various individual models by linking specific concepts is also non-trivial due to the disparity in intended meaning of these concepts.

Furthermore, the ontology defines the core vocabulary of the concepts that the users and PAL exchange. A specific part is being worked out to support the child-ECA dialogue management.

3.4 Evaluation (T1.4)

Evaluating child-robot and child-avatar interactions “in the wild” sets specific constraints on the methods and measures. In the Italian and Dutch camps, words and behaviors were analyzed that indicated the sentiment and emotion of the children while playing a quiz and a sorting game with the robot. A specific set of variables was constructed for observer’s recording of childrens speech (dialog) and body language: 4 dimensions of observables on 4 dimensions (e.g., [20, 21]). First, familiarity addresses the personal talk, length of sentences, and distance [27, 13]. Second, attitude was indicated by praise & acknowledgement, eye contact and posture [3, 7]. Third, for liking, laughter, the valence (positive versus negative) of the talk and touch was recorded [29]. Fourth, benevolence was viewed as support, appreciation and disclosure of topic-related personal information, recorded by the diabetes content (i.e., topic specific conversation) and body movement [23, 6, 28].

In this way, we could compare Italian and Dutch child’s experiences, as expressed in speech and body. Corresponding to cultural expectations, Italian children seemed to be more open and expressive, and more close to the robot compared to the Dutch children. Part of these differences could be caused by the fact that the Italian children were slightly older and because the settings of the camps were different.

Furthermore, the child-avatar (and child-timeline) interactions have been evaluated for a usage period of 2 weeks. This evaluation showed 4 user groups that should be approached differently by PAL.

4 Conclusions

The general iterative process from needs analyses, via design generation & specification, prototyping, to evaluation will be done in 3 cycles. This report reports the task performances of the first phase of the first cycle (i.e., needs analyses and first designs for the first evaluation). In close collaboration with the other work packages, the first set of requirements have been identified and prioritized for the functionality of the first PAL prototype (PAL Actor, MyPAL, PAL Control and PAL Inform) connected to hypotheses (i.e., claims). Concerning the empirical grounding, both the stakeholders’ involvement in user needs analyses and design creations, and the application of relevant theories and models have driven the specification of scenarios, requirements, prototypes and evaluation protocols. Concerning the theoretical grounding, key elements of the Self Determination Theory (SDT)

have been worked out and driven the requirements specifications. Concerning the technological grounding, an analysis of relevant eHealth applications and platforms have been provided. From the other work packages, theories, models, methods and technologies for emotion modeling, action selection, dialogue management & gamification) have been identified and processed into the scenario descriptions and prototype components.

Overall, the WP-tasks provided four major outcomes:

- A first version of the PAL requirements baseline from an analysis of the domain and stakeholder needs & values.
- A first ontology in which the main aspects of PAL-supported self-management are defined and related to each other.
- A first generate-and-assess cycle for a first PAL prototype.
- A test protocol for the first joint evaluation.

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5 Annexes

5.1 Benchmark analysis

A state of the art analysis of the currently available application for mobile technology or on-line platform aiming at providing supporting tools for the management of T1DM.

Relation to WP This analysis constitutes a starting point in order to understand the design opportunities available for the PAL system, highlighting the most competitive characteristics that it should have and reflect them properly into the User Requirements investigation.

Availability Unrestricted.

5.2 Flowchart of T1DM process of care - Italian case

A schematic overview of the process of care and education offered by the San Raffaele Hospital (Milan, Italy) to children with T1DM and their families.

Relation to WP This analysis constituted a starting point through which understanding the real stakeholder's (both end-users, e.g.: children and families, and expert users, e.g.: healthcare professionals) scenario in which the PAL's solution should be integrated.

Availability Unrestricted.

5.3 Flowchart of T1DM process of care - Hospital Gelderse Vallei case

A schematic overview of the process of care and education offered by the Hospital Gelderse Vallei (Ede, The Netherlands) to children with T1DM and their families.

Relation to WP This analysis constituted a starting point through which understanding the real stakeholder's (both end-users, e.g.: children and families, and expert users, e.g.: healthcare professionals) scenario in which the PAL's solution should be integrated.

Availability Unrestricted.

5.4 Flowchart of T1DM process of care - Meander Medical Centre case

A schematic overview of the process of care and education offered by the Meander Medical Centre (Amersfoort, The Netherlands) to children with T1DM and their families.

Relation to WP This analysis constituted a starting point through which understanding the real stakeholder's (both end-users, e.g.: children and families, and expert users, e.g.: healthcare professionals) scenario in which the PAL's solution should be integrated.

Availability Unrestricted.

5.5 Educative Summer Camp 2015 - Italy

Summary description of the activities carried out during the first Italian Summer Camp (August 2015) and a preliminary overview of the obtained results.

Relation to WP This particular study was focused on deriving useful insights for the project preliminary phase: the User Requirements Analysis. The aim was to define the possible technological and functional requirements of the PAL system, on the base of expectations and real needs of both final users (children and their families) and expert users (healthcare professionals).

Availability Restricted. Not included in the public version of this deliverable.

5.6 Activities with the Parents - Italy

Summary description of the activities, and related results, performed with the parents of children with T1DM, involved in the PAL project.

Relation to WP Also in this case, the study was focused on deriving useful insights for the project preliminary phase: the User Requirements Analysis. This time the end-users involved in the activities were the parents of children with T1DM, ranging from 8 to 14 y.o.; the aim was to collect their personal point of view on diabetes management, with related issues, emotional aspects and desires.

Availability Restricted. Not included in the public version of this deliverable.

5.7 Creative methods 2015 the Netherlands

Short description of the 2015 creative methods experiment that took place in the Netherlands.

Relation to WP This experiment contributed to T1.1 as it had as main focus to get user requirements from children with diabetes. And get feedback on the use of creative methods to elicit those.

Availability Restricted. Not included in the public version of this deliverable.

5.8 Fall camp 2015 the Netherlands

Short experiment description of the 2015 fall camp that took place in the Netherlands.

Relation to WP This experiment contributed to T1.1 as it had as main focus to get user requirements from children with diabetes. And get feedback on the state-of-the-art of our ideas.

Availability Restricted. Not included in the public version of this deliverable.

5.9 Timeline experiment 2015 the Netherlands

Short, preliminary, description of the 2015 timeline experiment that took place in the Netherlands.

Relation to WP This experiment contributed to T1.1 as it had as main focus to get feedback on the state-of-the-art of our ideas.

Availability Restricted. Not included in the public version of this deliverable.

5.10 Personas - Dutch case

A Persona is an archetypal description of a real segment of users directly involved in a product-service system. It aims at facilitating the understanding of users and providing insights for user-centered solutions.

Relation to WP The main reason of setting up a Persona is to have a well-defined realistic reference to guide every phase of the design process of the service, from concept to user experience. It helps researchers, developers and designers in understanding who they are designing for and taking aligned decisions while implementing the project solution.

Availability Restricted. Not included in the public version of this deliverable.

5.11 Personas - Italian case

A Persona is an archetypal description of a real segment of users directly involved in a product-service system. It aims at facilitating the understanding of users and providing insights for user-centered solutions.

Relation to WP The main reason of setting up a Persona is to have a well-defined realistic reference to guide every phase of the design process of the service, from concept to user experience. It helps researchers, developers and designers in understanding who they are designing for and taking aligned decisions while implementing the project solution.

Availability Restricted. Not included in the public version of this deliverable.

5.12 Storyboard input

Based on the interactions with the stakeholders and on literature, use cases were described in which the different stakeholders (child, parent and caregiver) initiated in different interactions with the PAL system.

Relation to WP Use cases contextualize the system and thereby limit the scope. Furthermore, it makes requirements concrete and therefore easier to discuss.

Availability Restricted. Not included in the public version of this deliverable.

5.13 Storyboard

Storyboards were created using the use cases from 5.12. In the annex the storyboard of the child interaction is shown.

Relation to WP The storyboard visualizes the use cases, making it even more concrete and easier to discuss.

Availability Restricted. Not included in the public version of this deliverable.

5.14 Childs Culture-related Experiences with a Social Robot at Diabetes Camps

This paper investigates the experiences of Italian and Dutch children while interacting with a social robot that is designed to support their diabetes self-management. Observations of children’s behaviors and analyses of questionnaires at diabetes camps, showed positive experiences with variation (e.g., Italian children seemed to be more open and expressive, and more close to the robot compared to the Dutch children). A culture-aware robot should be sensitive to such differences.

Relation to WP This paper describes parts of the cultural differences found when comparing the Italian and Dutch camps performed in this WP. Cultural differences might guide user requirements for future versions of the PAL system.

Availability Restricted. Not included in the public version of this deliverable.

5.15 Requirements baseline

The first version of the requirements as they are now for Year 1.

Relation to WP The requirements are the formalization of all knowledge gathered in this WP.

Availability Restricted. Not included in the public version of this deliverable.



eServices for Life and Health

[PAL][WP1] - Competitors analysis PAL system

PAL / European Project

20 October 2015

Author

Sardu Francesco | sardu.francesco@hsr.it



BENCHMARKING

Project Name

PAL (Personal Assistant for healthy Lifestyle)

Activity Scope:

State of art: applications and platforms that provide services to diabetes users and stakeholders.

1

Link: <https://mysugr.com/>

Video: <https://vimeo.com/85338614>

Name:

mySugr - Diabetes Logbook: app (Android e iOS) e platform web.



Factory:

-mySugr GmbH (Austria)

Cost:

free, pro version 28€ for month or 140€ forever

Released:

2011, last version October 2015.

Target:

Child / Boy diabetes type 1

The same factory created "my academy" app for the therapy management training of users with type 2 diabetes.

Technical features:

Data profile:

- Name,
- Surname
- e-mail,
- Gender,
- Date of birth

Therapy data:

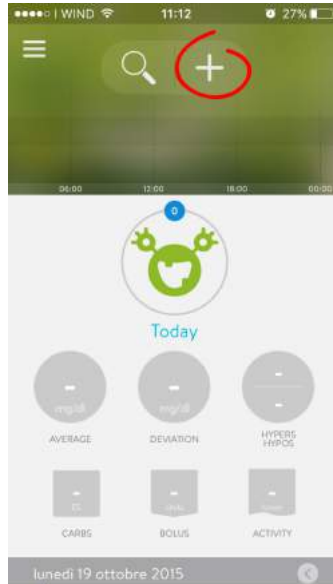
- Diabetes type,
- Onset date,
- Device (pen, insulin pump),
- glycaemia (mg/dl o mmol/l),
- Carb (gr o bred unit),
- Insulin (typology),
- Drugs
- Range - Parameters of hypoglycaemia and hyperglycaemia
- Body weight,
- Blood pressure,
- Haemoglobin A1C,
- Pedometers (daily goal).

Setting:

- Glucometer synchronization
- Insulin pump synchronization,
- Health app synchronization,
- Newsletter.

Functionalities:

This app basically provides a glycaemic and nutritional diary where the child will add his values by selecting the key events during the day. At the top of the screen an icon with a plus sign [+] allows you to enter in the diary.

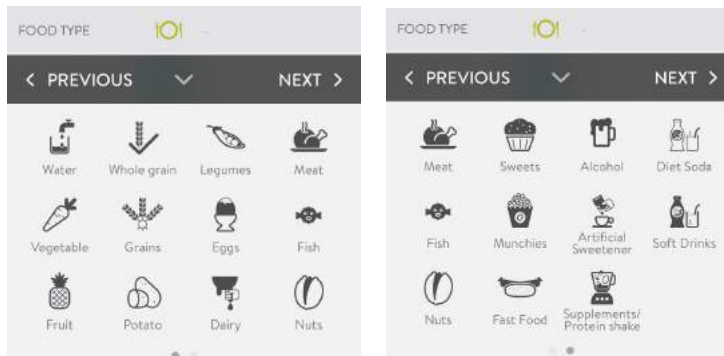


Then automatically the system detects date, schedule and position, (based on setting).

Data input:

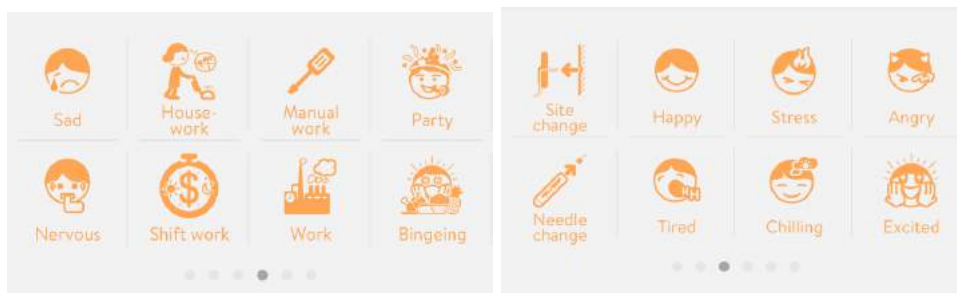
- Activity picture (meal / sport / etc.)
- Glycaemia
- Carb
- Meal description (note, text)
- Meal typology:

TIME	21 ott 2015, 11:19
LOCATION	eServices for Life...
PICS	  
BLOOD GLUCOSE	 - mg/dl
CARBS	 - ES
MEAL	 Description
FOOD TYPE	 -
INSULIN (FOOD)	 - Units
INSULIN (CORR.)	 - Units
INSULIN LONG ACTING	 - Units



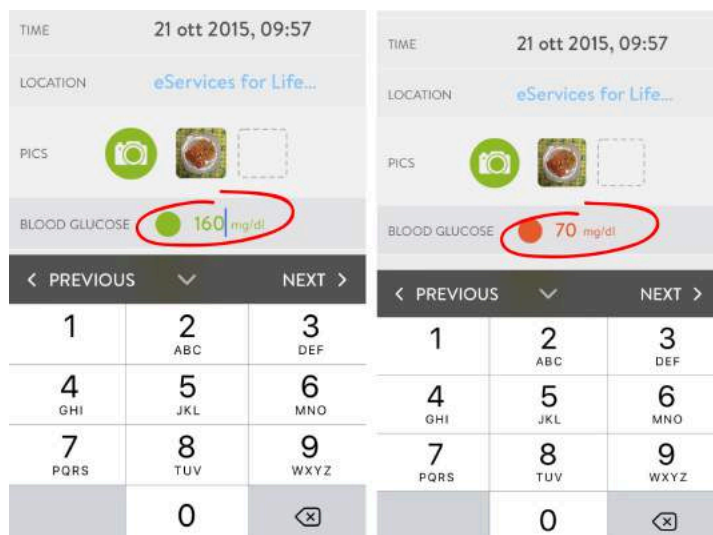
icons: meal typology

- Insert glycaemia values
 - Insert activity (sports, etc.) and duration
 - hypoglycaemia and hyperglycaemia
-
- With the PRO version would be possible to add other details like: Feelings e other specific moments of the therapy management.



icons: extra features by pro version

* When the user inserts the data about the blood glucose, the system uses a colour code (green, yellow, red) to communicate a feedback of the value inserted.



Based on the data entered, the application performs a number of statistics available on the homepage within a chart, which shows the trend of the blood glucose level during the day, the average blood sugar, the number hypo- and hyperglycaemia and various other data related to the values of the disease and the variation of these in a given period of time.

Based on these data the avatar interacts to give feedback, encourage, motivate, etc.

In addition, based on the number of details provided for each task the user can earn bonus points that can be used to unlock other features and games "challenge" (motivational activities - Avatar).

The PRO version allows:

- Create a **report pdf**, Excel e CSV (weekly) overview.
- Challenge system**: motivational tasks – activities provided by the avatar
- Automatic data import from the meter: available in Germany with iBGStar, Italy Beurer GL 50 evo.
- Reminder**: reminds the management practices at the appropriate times (measuring blood sugar before meals).
- **Synchronization** of data between device and platform.

Accessory applications:

Quiz, collection of questions divided into categories of difficulty:

- Starter (20 questions)
- Rookie (40 questions)
- Pro (40 questions)
- Insulin (30 questions)

Strengths:

- Powerful tool to create statistical trends glucose.
- Customize the name of your avatar.
- Gamification: The app has a "playful" approach aimed to reward any action / interaction that added details, information, etc., about the therapy management.
- Newsletter: According to the usage, the app reminds to take quizzes and activities to promote proper therapeutic management.
- Pedometers: It represents a hypothetical tool used to fix a certain goal, like for instance a challenge where is required a minimum number of steps to get daily (valid for bonus points).
- Quiz: improve knowledge of diabetes (chance to win premium version of the app).

Weaknesses:

- When the user needs to add his activities into the diary the system shows all possible parameters to be filled and then asks to specify the activities. It would be better to define first the activity and then based on it to present a menu of related options, ousting what is not connected.
- There is a monitoring system for medical staff and parents.

* Note: Would be possible to reduce the number of options shown on the display, like, lunch, breakfast, dinner, etc., simply based on the time schedule. (e.g.: at 22.00 o'clock the breakfast option will not be visible, or in case of physical activity / sport will not be displayed how much carbohydrates to add.

User Reviews:

1. “Since then, I've been pretty bad at counting carbs and looking for patterns. Nine years later, this app and a healthy diet have helped me get back on the right path” [Apple Store - Customer Reviews]
2. “This app is so easy to use! You can add your sugars, the time, insulin info, and add comments if you had to decrease insulin for any reason. It is specific for any type of diabetes. The only thing I wish it had, would be if it had a location where you can add your insulin to carb ratios, that could be in the pro version though” [Apple Store - Customer Reviews]

2

Link: <http://www.diabetespilot.com/iphone>

Name:

Diabetes Pilot - app iOS

Diabetes Pilot Pro
By Digital Altitudes, LLC
Open iTunes to buy and download apps.

[View More by This Developer](#)

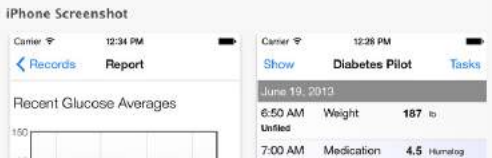
 **Description**
Diabetes Pilot Pro is the best app for managing your diabetes! Download it for free -- see why thousands of people around the world love the no-nonsense speed, flexibility, and complete features of Diabetes Pilot! Diabetes Pilot is developed by professionals, backed by an established company, and designed and supported by people with...
[Digital Altitudes, LLC Web Site](#) • [Diabetes Pilot Pro Support](#) • [...More](#)

What's New in Version 6.1.1
Fix report export function for compatibility with iOS 8.3

[View on iTunes](#)

Free
Category: Medical
Updated: Apr 28, 2015
Version: 6.1.1
Size: 6.1 MB
Language: English
Seller: Digital Altitudes, LLC
© Copyright (c) 2015 Digital Altitudes, LLC. All rights reserved.
Rated 1.2+ for the following:
Infrequent/Mild
Medical/Treatment Information

iPhone Screenshot



Carrier	12:34 PM	Carrier	12:26 PM
< Records	Report	Show	Diabetes Pilot Tasks
Recent Glucose Averages			
June 19, 2013			
6:50 AM	Weight	187	lb
Unfiled			
7:00 AM	Medication	4.5	Humalog

Factory:

Digital Altitudes (USA)

Cost:

Version pro: free

Version classic: 25\$

Released:

Last version April 2014

Target:

Boy / Adult type 2.

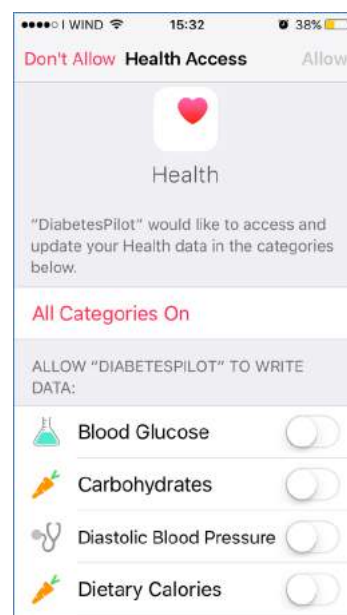
Technical features:

Profile setting:

It asks the possibility to synchronize the profile with the default app “Health”.

Data treatment:

- Blood glucose (mg / dl or mmol / l),
- Carbohydrates (grams or bred units)
- Blood pressure,
- Calories
- Cholesterol
- Sugar
- Fibre
- Proteins
- Saturated fat
- Sodium
- Body weight
- Heart rate
- Index of body fat
- Body weight

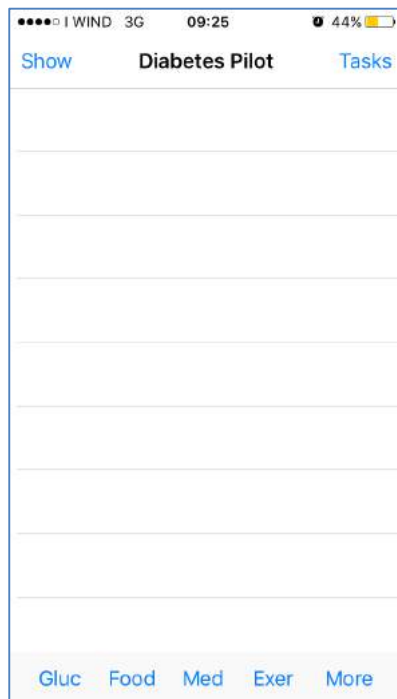


Functionalities:

After selecting which parameter to insert, the home page shows where to enter in your calendar the following activities:

- Blood Glucose Monitor: date / time, meal, values, notes
- Food: date / time, meal, carbohydrates, protein, fibre, fat, etc., (Would be possible to enter these data from the database or by scanning the QR code from the packaging, it's possible also to update and add to the database a personalized meals).
- Medications: date / time, meal, insulin values, notes. (it's possible to add more medicines)

- Exercise: date / time, meal, value, tasks, notes (it's not clear which unit of measure defines the activity)



Strengths:

- Scanning: the possibility to scan the barcode or QR Code of a food product to automatically add on the diary its nutritional values.
- Ability to customize their food database, adding specifications (carb, fibre, protein, calories, etc.)

Weaknesses:

- During the test, the scan didn't work properly with many bar codes.
- There is no any function like the monitoring by the physician and parents.
- The app does not provide information content / educational for diabetes.
- The database is too rich of detail and is not easy the browsing.

User Reviews:

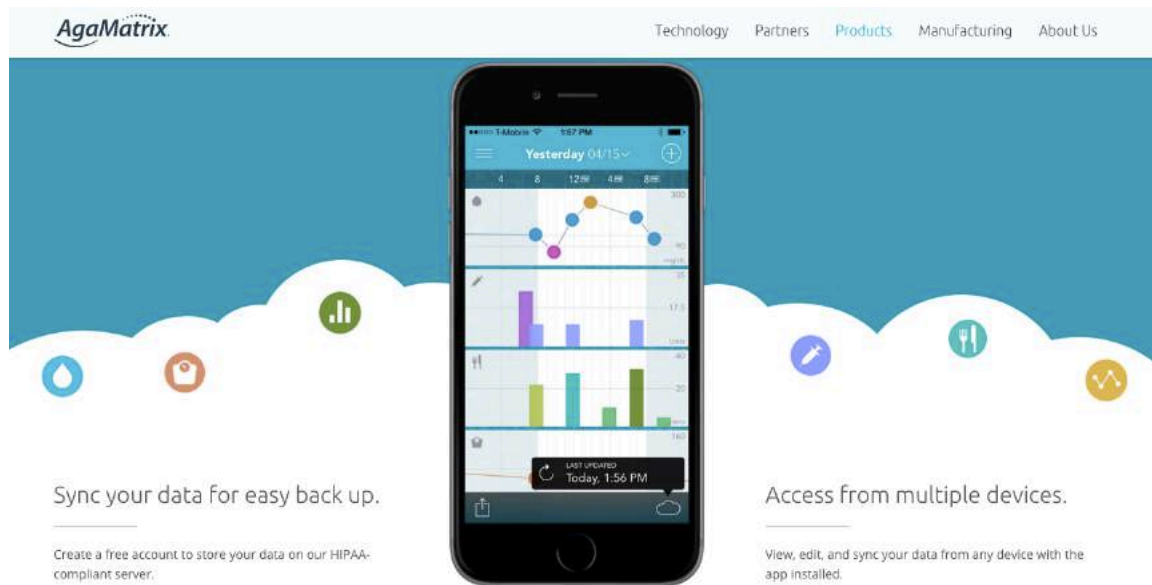
1. "The food database is massive and the app contains the most common data you'll need".
2. "Foods functionality is worth its weight in gold".
3. "Kept old version because old records did not go over to the new app".

3

Link: <http://agamatrix.com/products/agamatrix-diabetes-manager/>

Name:

Diabetes Manager - app iOS



Factory:

AgaMatrix (USA)

Cost:

free

Released:

last version Oct 16, 2015

Target:

Boy diabetes type 1.

Functionalities:

WaveSense Diabetes Manager allows to track:

- Glycaemia values
- Insulin doses
- Carbohydrate consumed

Strengths:

- Clear and easy interfaces.
- Recipes and tips on nutrition.
- It allows for the monitoring of values up to 90 days with the ability to view the data through graphs and statistics.
- The application includes a sharing feature that allows the user to exchange via e-mail the information with the doctor.
- Excellent video library with stories and interviews of celebrities with diabetes

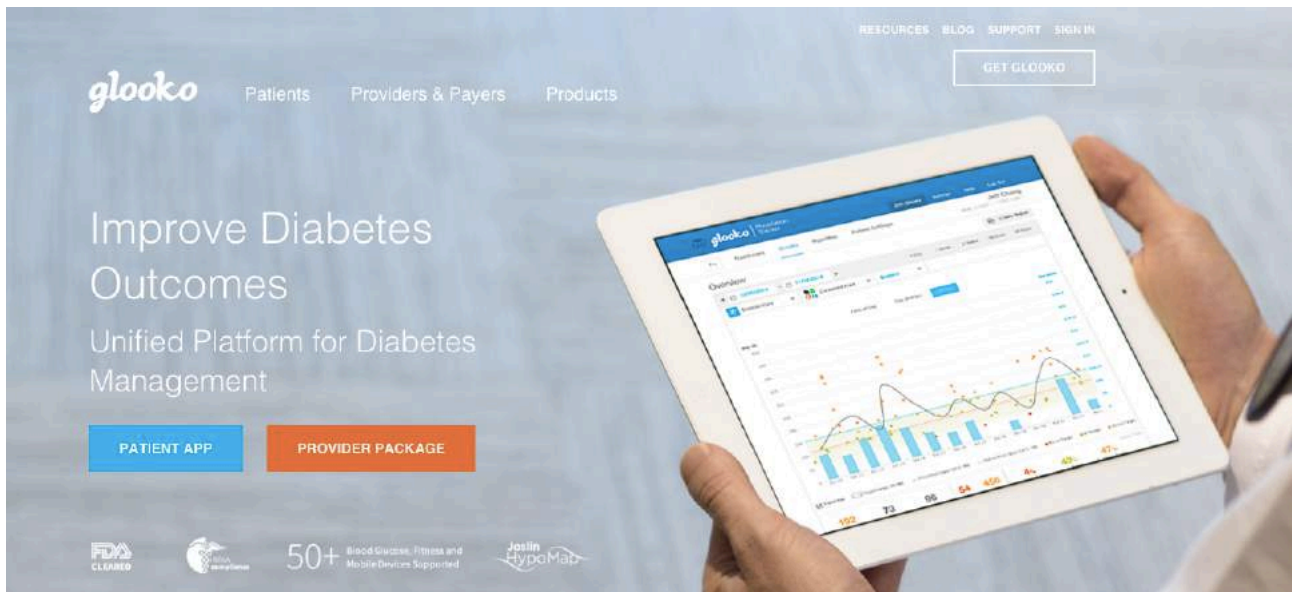
Weaknesses:

The app doesn't include any nutritional diary.

Link: <https://www.glooko.com/>

Nome:

Glooko - iOS or Android



Factory:

Glooko (USA)

Cost:

free

Released:

22 October 2015.

Target:

Kid / Boy diabetic type 1.

Technical features:

It's necessary to buy a device to connect the own smartphone with the insulin pump and glucometer.

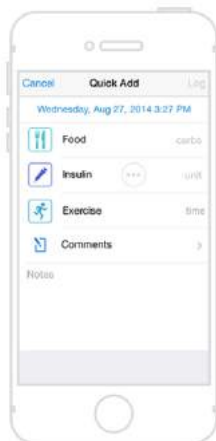


Profile setting:

- Name,
- Surname,
- address e-mail,
- Synchronization with the own device.

Therapy data:

- Glycaemia values
- Carbohydrates
- Insulin dose
- Physical activities



*It contains a database with over 200,000 foods, it can also automatically include carbohydrates of some meals of some restaurants in partnership.

Setting:

- Synchronization with other app related to the physical activities like: Fitbit, iHealth e Strava. It adds automatically the data.
- Reminder: it helps to remind when to measure glycaemia, to take insulin, correction, etc.



Data visualization:

Glooko provides an overview of all measured parameters, furthermore it displays the details that impacted "negatively" on blood sugar spikes in relation to: meals, events, activities, etc. Based on these data it is possible to "learn" to restrict certain effects and optimize the therapy. It can also monitor the operation of the device (insulin pump), possibly suggesting some tips to the proper maintenance.



Glooko has been designed basically to share the therapy values with the doctor.

From the medical staff point of view, would be possible:

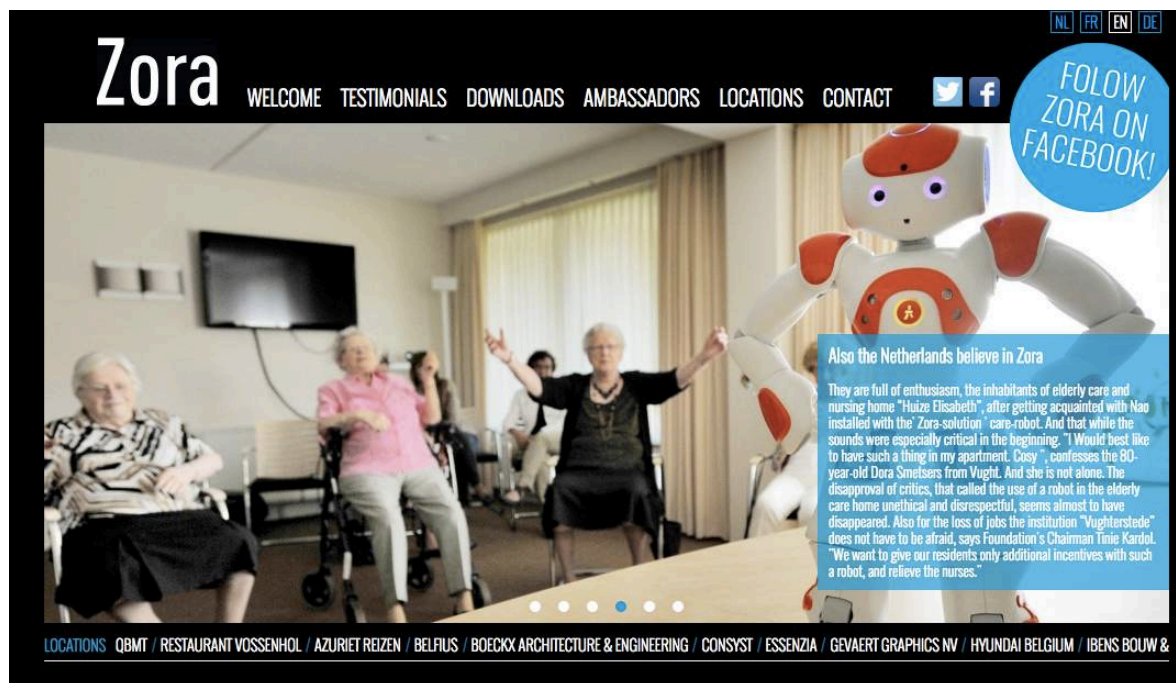
- Track the patient data,
- Compare the glycaemia trends,
- Intervene, optimizing and customizing insulin therapy,
- Activate the "spies" on some parameters for patients in particular need,
- Suggest practices and content for patients who are severely deficient

5

Link: <http://zorarobotics.be/?lg=en>

Name:

Zora qbmt – Nao Robot + Platform Zora e apps.



Factory:

QBMT (Belgium)

Target:

Elderly (nursing homes), children (schools, hospitals).

Functionalities:

In 2014, the NAO robot has been used in a study program in several nursing homes for the elderly. The goal of the experiment was aimed to evaluated the patient engagement with certain activities like physical exercises and gymnastics. The robot mimicked some of the movements that seniors patients had to follow and imitate.

According to their experiments, the robot is a medium that facilitates the work of doctors by imparting the practice of therapy, because it is considered as an "equal" to the elderly and children. Through a series of experiments using the technique of "wizard of oz" it was possible to interact with patients of nursing homes. They were open to dialogue with the robot and generally has been detected a decrease of the sense of loneliness. The same experiment was carried out in schools and in hospitals (paediatric wards).

The web platform has different types of dialogues "pre-set", through them the robot can interact with the target audience.

Fonte: <http://www.diabeticconnect.com/>

Name:

Diabetic Connect

Diabetic Connect

di Alliance Health Networks, Inc

Apri iTunes per acquistare e scaricare le app.

[Altre app da questo sviluppatore](#)



Visualizza in iTunes

Descrizione

Get connected with the largest community of diabetes patients on the Web. With Diabetic Connect mobile, you can follow discussions while on the go, ask your questions and add comments to interesting posts. It's the place to discuss treatments, start conversations, and learn from others. Diabetic Connect empowers people living with

[Sito web di Alliance Health Networks, Inc](#) [Supporto per Diabetic Connect](#)

[...Altro](#)

Novità nella versione 3.4.0

Log book - Easily enter your blood glucose numbers wherever you go, and discover trends that help you better manage diabetes

Factory:

Alliance Health Networks, Inc

Cost:

Free

Target:

Boys / Adults diabetics type 1 & 2

Functionalities:

Diabetic Connect is one of the main community of people with diabetes. Within this space the participant can follow threads, share his experiences and create new dynamics of support.

Technical features:

- Diary to track the glycaemia values,
- Chat to communicate directly with other community members,
- Find answers, topics, etc.
- Make questions, propose a topic for discussion, comment previous topics.
- Make new friends, by following specific community members.
- Follow the topic of interest.

7

Link: <http://www.lenny-diabetes.com/index.html>

Name:

Carb Counting with Lenny US app (android e ios) and Platform

App Store > Health & Fitness > Medtronic, Inc.



Get

Rating: 4+

LINKS

Developer Website

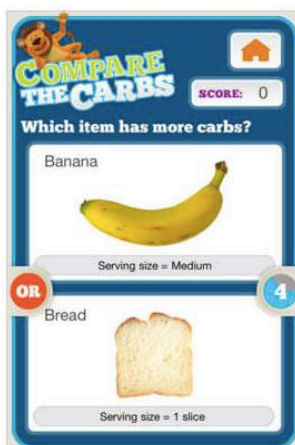
© 2012 Medtronic, Inc.

Carb Counting with Lenny US 4+

Medtronic, Inc. >

Details Ratings and Reviews Related

iPhone Screenshots



Factory:

Medtronic, Inc (USA)

Cost:

free

Realased:

2012

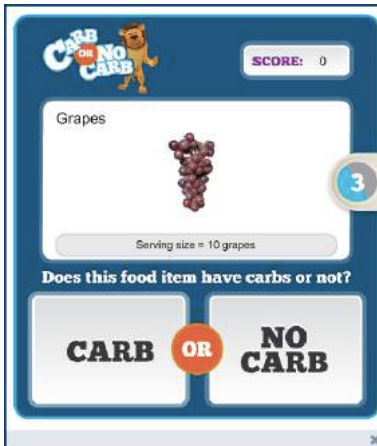
Target:

Kids diabetes type 1.

Technical features:

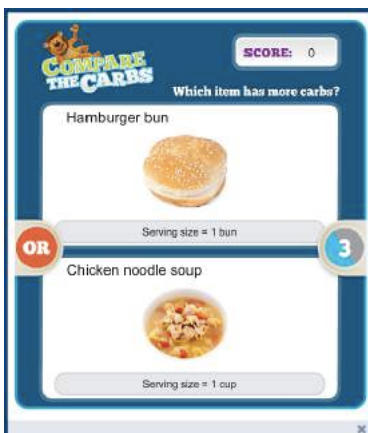
Carb or not carb:

The game asks to the child to answer if a determinate food item contains carb or not.



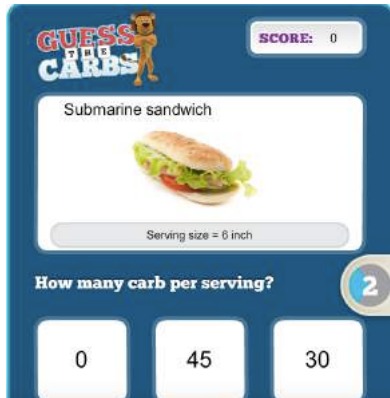
Compare the carbs:

The game provides a comparison between two different foods items, the child has to answer about which one contains more carbs.



Guess the carb:

This game aims to teach the average carb contained usually to a food item.



Build a meal:

This game displays several items food and a carb score to get, the child has to select the right food items in a way that the sum of the single carb of the food items reaches the score designated.



8

Link: <https://myglyc.com/it>

Name:

myGlyc – web platform, app (Android, Google Play).



Factory:

Alias srl (Italy)

Cost:

Free version (diary), Pro version 4,95€ (diary, therapy management, advanced statistics, sharing data)

Released:

2013.

Target:

Child / Boy diabetes type 1

Technical features:

My Glyc is a diabetes diary that allow to save the therapy data in order to create an historical record of the disease and treatments applied. It allows also to share the data diary with other devices, like for instance parents and close relatives. My Glyc also a dashboard visualization of the therapy management records like:

- glycaemic statistics trends,
- glycaemia average value,
- Number of the glycaemic measures,
- Graphics representing the absorption of insulin during the time,
- Duration of insulin peak effect and the initial time of effectiveness.

My Glyc can provide also some suggestions about corrections and therapy management, based on the data diary and settings, by a statistics that will support the user's decisions and control of therapy.

Strengths:

- My Glyc allows to works off-line.
- My Glyc allows to create a network with other devices in order to share the diary data.
- My Glyc take in account the insulin remaining, based on the setting / profile.

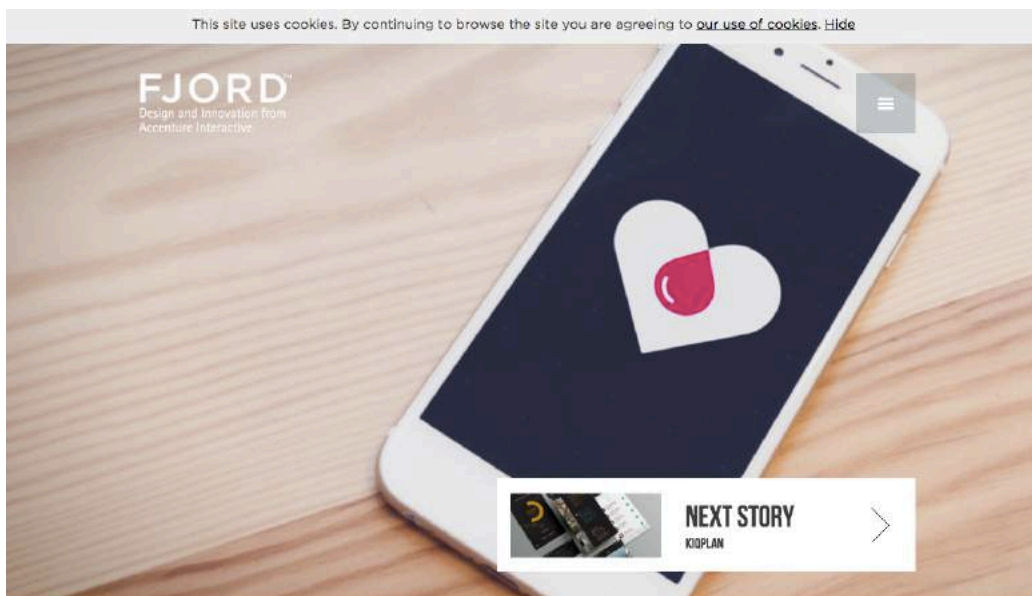
9

Link: <http://www.psfk.com/2015/10/diabetes-management-type-1-diabetes-platform-fjord-fido.html>

Video: <https://vimeo.com/140422986>

Name:

Fido, app and platform (living service) <https://livingservices.fjordnet.com/>



Factory:

Fjord (Norway)

Realised:

Prototype

Target:

Child / Boy diabetes type 1

Technical features:

Fido has been designed specially to use wearable devices in order to measure constantly all the data like exercise, food consumption, sleep habits and more. Those patterns can help manage uncertainty in the daily life of a diabetic person, for example, by predicting the need for less insulin on a day that historically has higher activity levels.

But the goal is not just to aid people on a personal basis. Instead, Fjord envisions Fido as a “Living Service” platform, sharing and aggregating data from everyone using the app to recognize patterns within communities. The more people use the platform, the more it learns from their experiences. The concept could then be translated to assist others suffering from chronic conditions.

The Fido concept will combine personal “thick data” and environmental “big data” with advanced analytics to create a Living Service platform. In other words, the more you use it the smarter it gets.

Three main features:

To Learn

The Fjord Fido concept’s goal is to help to manage uncertainty in a diabetic’s daily life. It will help see correlations between the cause (activity, meals, insulin etc) and the effect on blood glucose levels and identify historical patterns so you’re better prepared for the future.

To Act

Having quick access to the information you need at the right time is at the core of the Fjord Fido concept. The information needs to be relevant and meaningful for the user. You shouldn’t have to be a data scientist to understand how to make use of it.

To Predict

The Fjord Fido concept currently hopes to make use of all the historical data it captures to plan for future activities – like going on a bike ride, spending the day in the office or heading out for a meal. Not only this, but it is expected that it can feed in calendar events like birthday parties and environmental factors like air temperature so the users can better understand their own situation.

10

Link: <http://www.meteda.it/>

Name:

MyStar connect: (platform – medical health record – diabetes patient).

Currently used at OSR.



Factory:

Meteda (Italy)

Target:

Doctors – Diabetologists / Patient

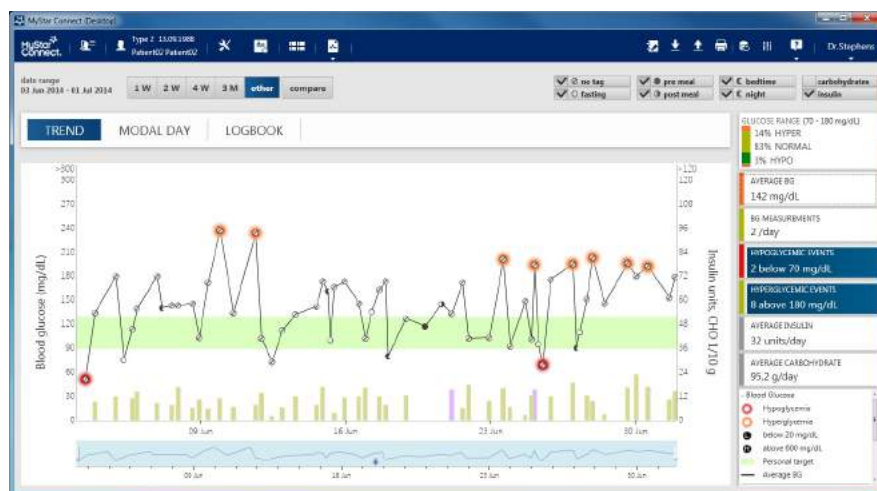
Technical features:

MyStar connect is a platform that monitors and displays the diabetes patient glycaemic trends. Doctors use it to store the patient data and consult it for the next visit.

Data visualisation focuses on key metrics, targets, and trends to support doctors in their clinical decision making to optimise diabetes therapy for each individual patient.

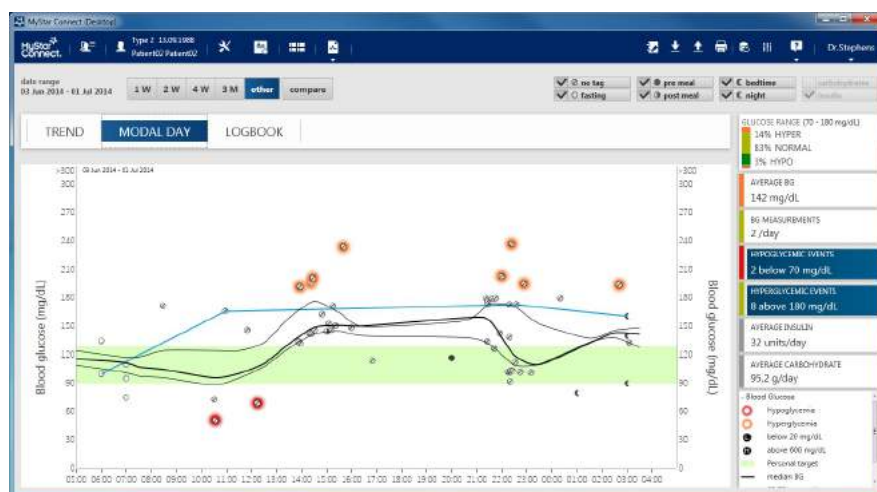
Monitoring Interface:

It shows the glycaemic trends diagram and insulin doses of patient, according to his last updates, it comprises a time ranging from **one week to three months**.



MyStar connect – Glycaemic General Trends Interface

- The green area identifies the personal glycaemic target.
- The orange spot identifies the hyperglycaemia
- The red spot identifies the hypoglycaemia.



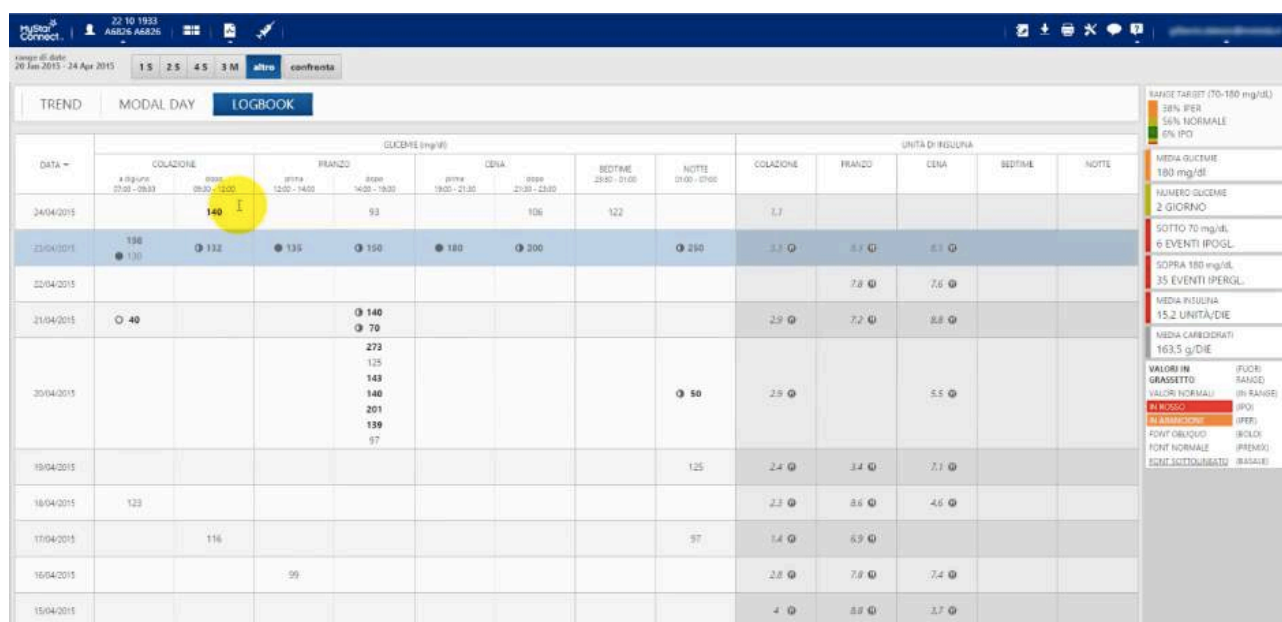
MyStar connect – Daily Glycaemic Trends Interface

Modal day is useful to highlight in which moment of the day the patient has difficulty to maintain a good glycaemic control.

Another way to visualize patient data is represented by **Log Book**:

The logbook shows in tabular form the blood glucose status before and after the meal (breakfast, lunch, dinner). For each one of these moments, it shows the dose of insulin and carbohydrate taken.

Through the menu is possible to highlight the hyper and hypoglycaemia, this information should enable the patient to understand how his daily behaviours affect the blood glucose levels.



MyStar connect – Log book interface

Data Input:

It allows the patient to update in remote his glycaemic trends to the platform. (It's compatible with some glucometer devices like Accu-Check).

The first access requires the registration with the e-mail and password.

The patient visualises the informed informed consent.

The patient selects the compatible glucometer device used and download data.

As alternative the patient can add manually his data through the icon (Log Book).

This functionality seems a basic diary where the patient can add three different activities:

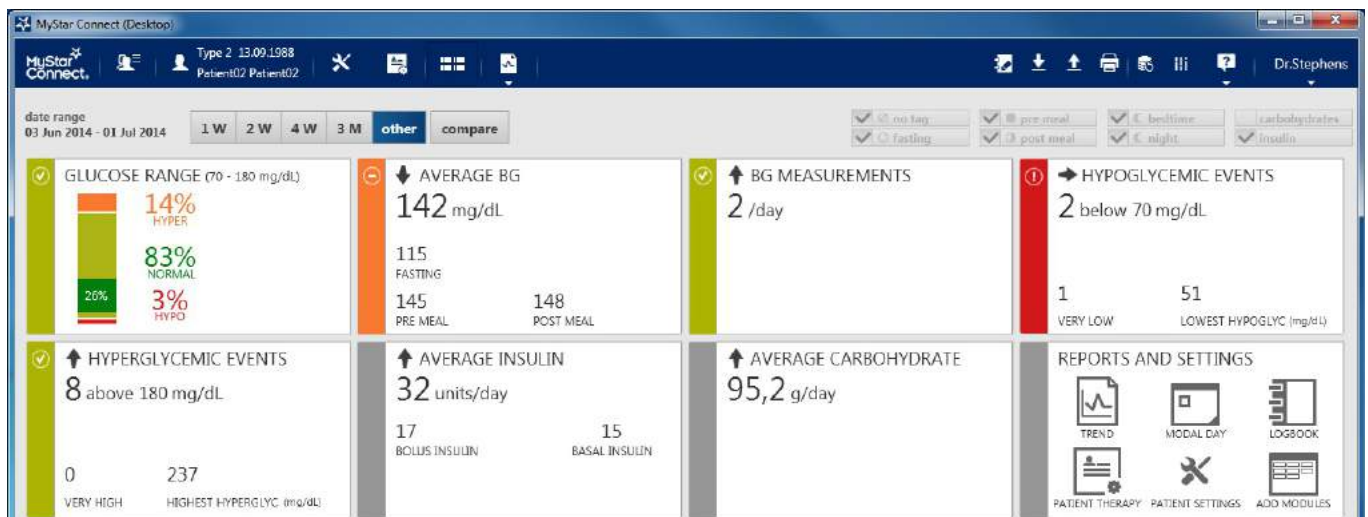
Insulin bolus, Glycaemic measurement, Carbs taken by specifying for each entry the time and value related.

*The patient can also go to an enabled pharmacy to update his glucometer device.

Data Dashboard:

The dashboard provides an area referring the therapy management data, with the following entries:

- Glucose range (percentage of hyperglycaemia, hypoglycaemia, normal status)
- Average blood glucose (pre meal / post meal)
- Blood glucose measurements (number of times for day)
- Hypoglycaemic events (number of events and value)
- Hyperglycaemic events (number of events and value)
- Average insulin (number of units for day – bolus insulin / basal insulin)
- Average Carbohydrate (grams for day)



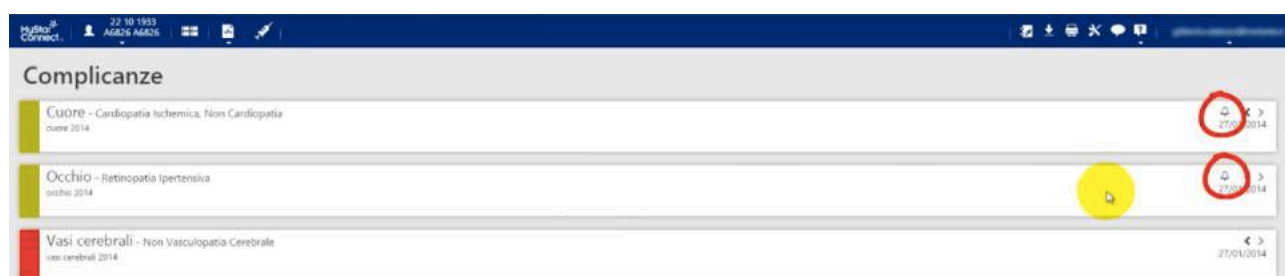
MyStar connect – Dashboard Monitoring Interface (Therapy management).

Another area of the dashboard refers to the “follow up visit data”, with the following entries:

- Cardiovascular complications, according patient’s parameters it shows the level of potential risks related to cardiovascular issues.
- Diabetes complications, according patient’s parameters it shows the level of potential risks that may affect: heart, peripheral nerves, eye, foot, kidney.

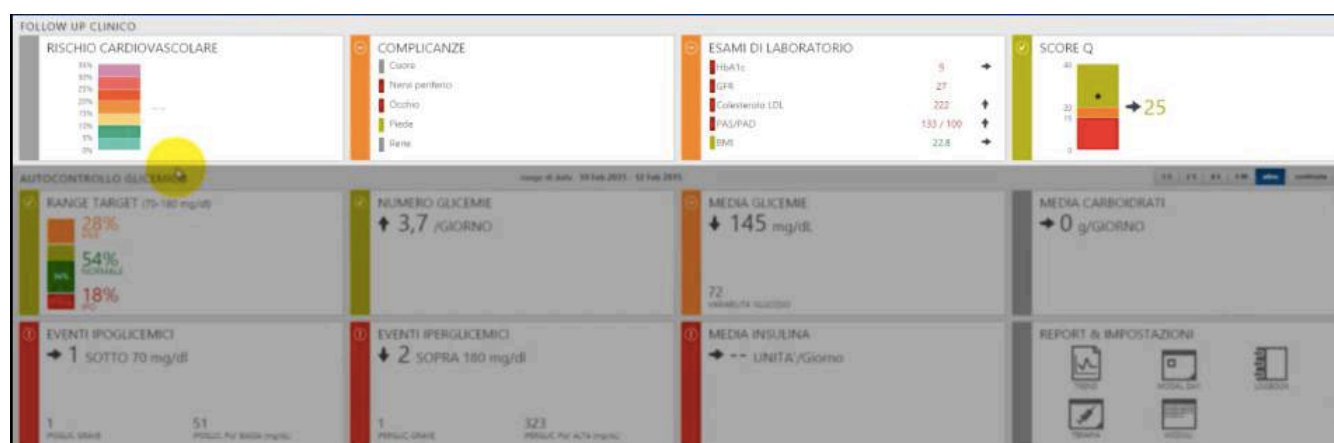
Colours represent the feedback, green means that the parameter is in compliance with the normal status, red represents a bad compliance.

The “bell icon” on the right represents a specialist visit already scheduled referring to the specific complication.



Diabetes complications - Interface

- Laboratory tests (shows the results of the medical examinations)
- Score Q, this entry shows the risk of developing within three years a cardio cerebral-vascular disease. The score is based on four parameters: glycosylated haemoglobin, blood pressure, LDL cholesterol and Albuminuria.



MyStar connect – Dashboard Follow up visit data

Therapy management:

The doctor can adjust the patient therapy by getting access to “Visualize therapy”.

This page shows the previous insulin therapy provided.

The doctor can change the current therapy by specifying the new insulin dosage according the specific time slot: breakfast, lunch, dinner, bed time, night.

In the same way, the doctor can specify also the quantity of carbohydrates suggested.

In additional, the doctor has the possibility to use the entry “Notes” for further details to communicate to his patient.

Data Report:

It allows the doctor to print out a personalized report for patients with graphical visualisations of the data to help patients’ understanding of their disease and therapy progress.



MyStar connect – Follow-up visit report

11

Link: <http://www.meteda.it/en/product/did-diario-interattivo-del-diabete/>

Name:

DID – Diabetes Interactive Diary:

DID – Diabetes Interactive Diary



Factory:

Meteda (Italy)

Target:

Patient

Technical features:

DID – Diabetes Interactive Diary allows to store all information relating to diabetes management, including blood glucose level, food choices, physical activity of choice, intercurrent illnesses, and insulin boluses. The photographic database of foods, in different serving sizes, allows to memorize the patient's preferred meals, and to receive in real time information relating to each meal's nutritional value and carbohydrate counting.

Data Input

As first tasks, the DID diary home page requires to insert the glycaemia value.

Subsequently, it provides a second page referring to the photographic database of foods.



DID – Food Database

In this case, the user selects the type of food and can easily customize the serving sizes. It allows to simplify the daily management of insulin therapy and makes carbohydrate counting easier. User also receives information about the nutritional values and carbohydrate count of their foods of choice.

With the finger is possible to interact with the photo of the meal and "erase" part of it in order to simulate the actual amount that will be eaten, like the following example:



DID – Food Database / Customize serving size.

Moreover, DID provides an additional feature: the insulin bolus calculator that automatically calculates the insulin bolus based upon customized factors set up by their Diabetologists.

This functionality should be considered like an advice or tip, the user can decide to follow or not. In order to access these advanced DID functions, it is necessary to promptly activate the

app start up procedure, which can only be completed by a Diabetologists through the MyStar Connect diabetes electronic medical record.

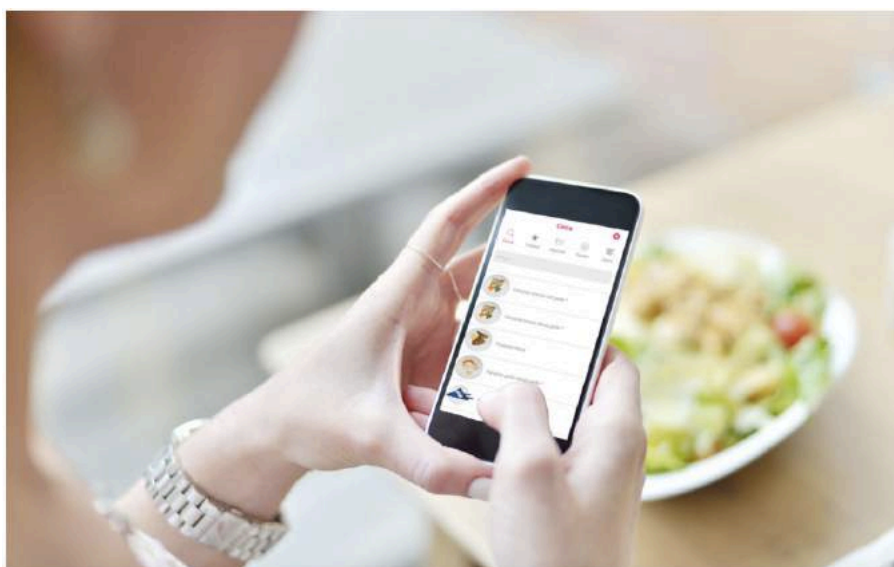
Finally, DID allows patients to communicate remotely with their Diabetologists. With the support of telemedicine, patients can send with a simple touch their system-stored data, which will be received by the physician directly on the patient's electronic medical record (MyStar Connect). The Diabetologists will have the opportunity to assess the efficacy of the patient's therapy and, if necessary, modify it. A Push notification will alert the patient that new settings have been saved.

12

Link: <http://www.meteda.it/prodotto/insulinfood/>

Name:

Insulin & Food (Carbs counting).



Factory:

Meteda (Italy)

Target:

Patient

Technical features:

Insulin&Food allows to associates to each food, and different serving sizes thereof, the insulin amount needed for its metabolization. This value originates both by calculating the I:C ratio and leveraging the diabetic patients' experience concerning a specific food.

By relying upon a photographic archive, Insulin&Food assists diabetic patients in recognizing and quantifying the carbohydrate intake of each food. By looking at a piece of bread, an expert diabetic patient can already "sees" the insulin units required for metabolization, without any need to estimate the bread's weight or carbohydrate count.

Data Input

The first task requires to setup the *Insulin / Carbs ratio* determined by dieticians and Diabetologists, the menu offers three different entries to use as parameter of reference:

- Carbs for each unit of insulin
- Insulin for 10g of Carbs
- Insulin for 1g of Carbs

By relying upon a photographic archive, Insulin&Food assists diabetic patients in recognizing and quantifying the carbohydrate intake of each food. This functionality uses the same system of DID (Diabetes Interactive Diary).

- Select the type of food
- Define the quantitative
- Get insulin bolus result (the dosage is based on the number of carbohydrates multiplied to the Insulin / Carbs ratio).

*The user can also update the database with his own recipes and define its parameters.

User Reviews:

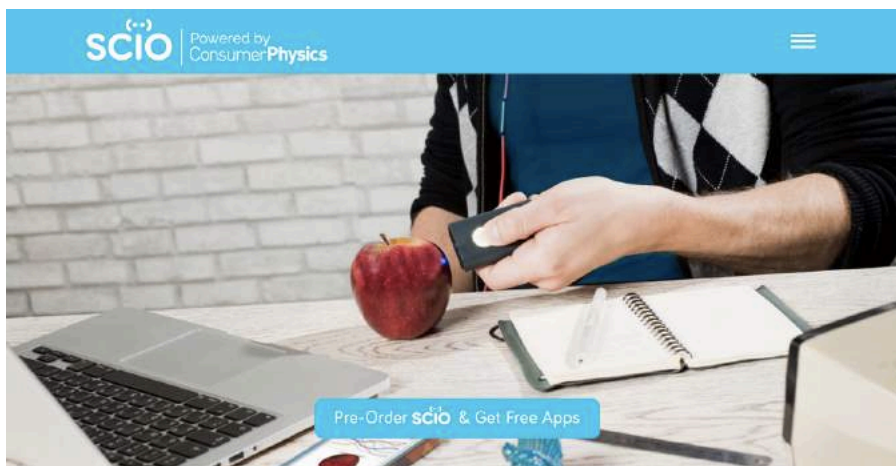
Users complain about an excessive price.

13

Link: <https://www.consumerphysics.com/myscio/>

Name:

SCiO: Molecular Scanner



Factory:

Consumer Physics (Israel)

Cost:

250\$

Released:

It is scheduled for the end of 2016.

Target:

Patient

Technical features:

SCiO is based on the proven near-IR spectroscopy technology. It is a device that works as molecular sensor, basically reads the chemical make-up of materials like: food, plants, medication, oil and fuels, plastics.

SCiO communicates the spectrum of the sample to a smartphone wirelessly.

Advanced algorithms utilize an updatable database to analyze the spectrum within milliseconds and deliver information about the analyzed sample back to the user's smartphone in real time.

Referring to the diabetes patient, this device can be used to scan the meal in order to receive the exact quantitative of carbs and in addition also fat and proteins.

Features Matrix:

	Diary	Educational Contents	Reminder	Gamification	Avatar	Dashboard Visualization Data mining	Evaluation test	Monitoring	Contents Reliability	Emotional Feelings tracking	Communication channel	Good habits disclosure	Device Synchronization Data import	CHO counting	Motivational Hints / Suggestions
MySugr	X	X	X	X	X	X	X			X			X		X
Diabetes Pilot	X					X								X	
Diabetes Manager	X (only glycaemic)	X (nutrition)				X		X							
Glooko	X		X			X		X				X	X		X
Zora qbmt					X				X	X	X				X
Diabetic Connect	X	X									X				X
Carb Counting Lenny US app		X			X		X							X	
myGlyc	X		X			X		X				X			X
Fido	X		X			X		X		X		X			X

References:

<http://www.healthline.com/health/diabetes/top-iphone-android-apps#2>

<http://www.ispazio.net/411445/mysugr-una-nuovissima-applicazione-per-gestire-il-diabete-senza-stress-ispazio-review>

<http://www.diabetespilot.com/iphone>

<https://community.aldebaran.com/en/news/my-adventure-aldebaran-project-zora-qbmt>

Article:

The Best Diabetes iPhone and Android Apps of 2015

Written by Elea Carey and Kristeen Cherney | Published on 29 July 2015

Medically Reviewed by George Krucik, MD, MBA on 29 July 2015

Smartphone-Based Glucose Monitors and Applications in the Management of Diabetes: An Overview of 10 Salient “Apps” and a Novel Smartphone-Connected Blood Glucose Monitor

Written by Joseph Tran, BS, Rosanna Tran, BS and John R. White Jr., PA, PharmD |

Published on October 2012, American Diabetes Association(R) Inc., 201

PAL HOSPITAL SCENARIO
FLOWCHART

ACCESS

The hospitalization can be activated by two different paths:

- EMERGENCY ER
- PEDIATRICIAN VISIT

Both this cases allow to get access to the hospitalization at the Pediatric Unit , where the child will stay at least 7 days and will receive the diabetes treatments.

THERAPY

The Insulin Pump will be insert during the preliminary stage of hospitalization (2 / 3 days) in order to balance the glycemia.

PRACTICAL TRAINING

In this stage of the hospitalization is expected the glucometer usage in order to monitor the glycaemia values.

NURSE SHOWS THE MODE OF OPERATION TO THE PARENTS AND CHILD.

Few days later, during this stage of hospitalization the insulin pen replaces the insulin pump.

DIABETOLOGIST AND NURSE SHOW HOW TO CALCULATE THE INSULIN DOSAGE TO THE PARENTS AND CHILD

THEORETICAL TRAINING

The child and his parents attend to the diabetes lessons, where they receive all the information about how manage their daily life tasks.

DOCTOR, NUTRITIONIST TEACH TO THE CHILD AND PARENTS

ASSISTANCE & SUPPORT

During the hospitalization the child and his parents receive support related with their emotional aspects.

PSYCHOLOGIST

The association SOS 70 provides to the parents a general diabetes framework like information, activities and bureaucracy aspects.

VOLUNTEERS

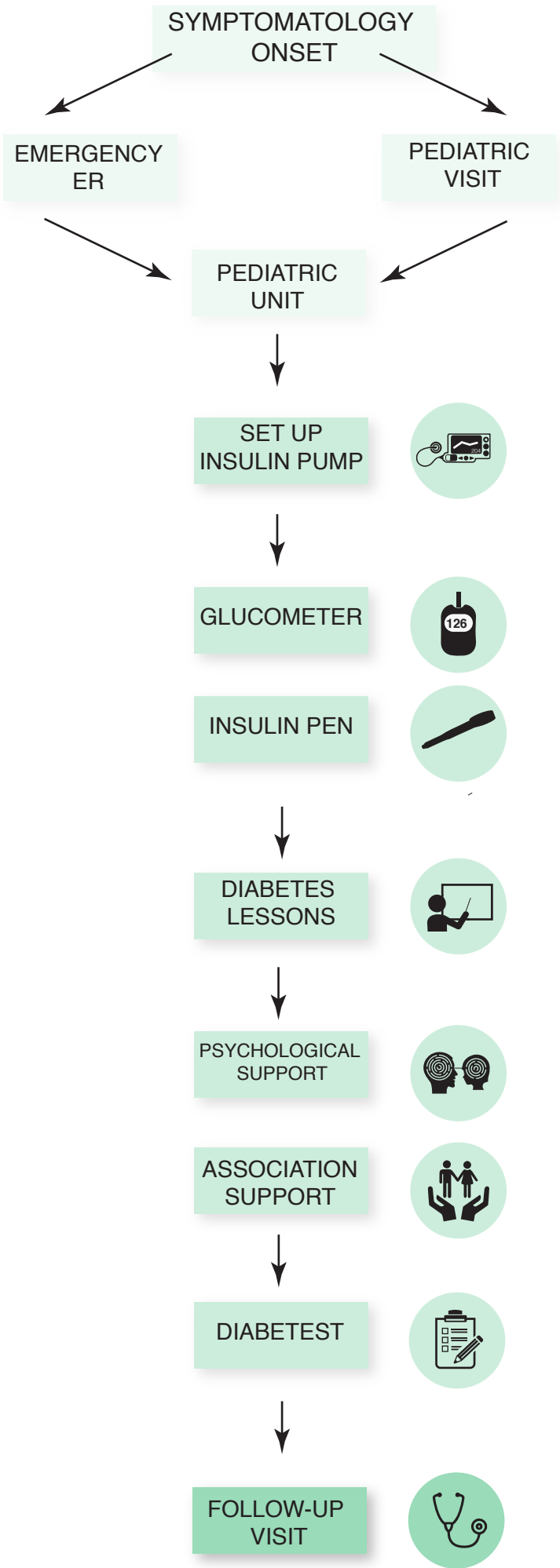
DISEASE MANAGEMENT EVALUATION

At the end of the hospitalization, the child and his parents need to pass a test that evaluates their diabetes management skills.
A good score allows the hospital discharge.

MONITORING

After the hospitalization the child needs to have several check up:

- Periodic control every 3-6 months
- A day hospital control once at year



1

Request

The request can be activated from the family or directly from the diabetologist.

2

Behavior Assessment

The diabetologist indicates the procedure to follow:

- Calculate the carbohydrates with the dietitian
- Evaluate the level of motivation and maturity of the child with the psychologist

3

Communication

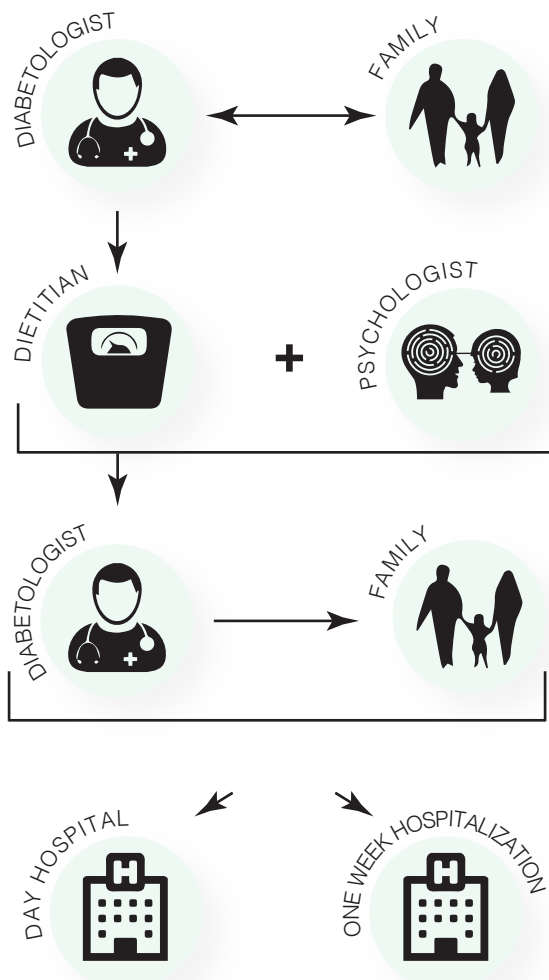
After the positive evaluation of the dietitian and psychologist, the diabetologist decides to inform the family about the possibility of using the insulin pump.

4

Hospitalization

In order to insert the insulin pump the child needs another hospitalization:

- 1 week of hospitalization
- Day hospital (mon, wed, fri)



DISCHARGE

6

Warm Up

One week later the child needs a new medical visit in order to check if everything it's right with the insulin pump setting.

7

Last Check

Three months later the child has the last check in order to confirm the proper usage of the insulin pump.

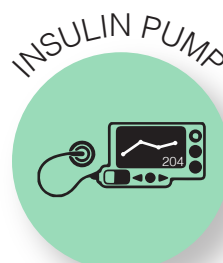


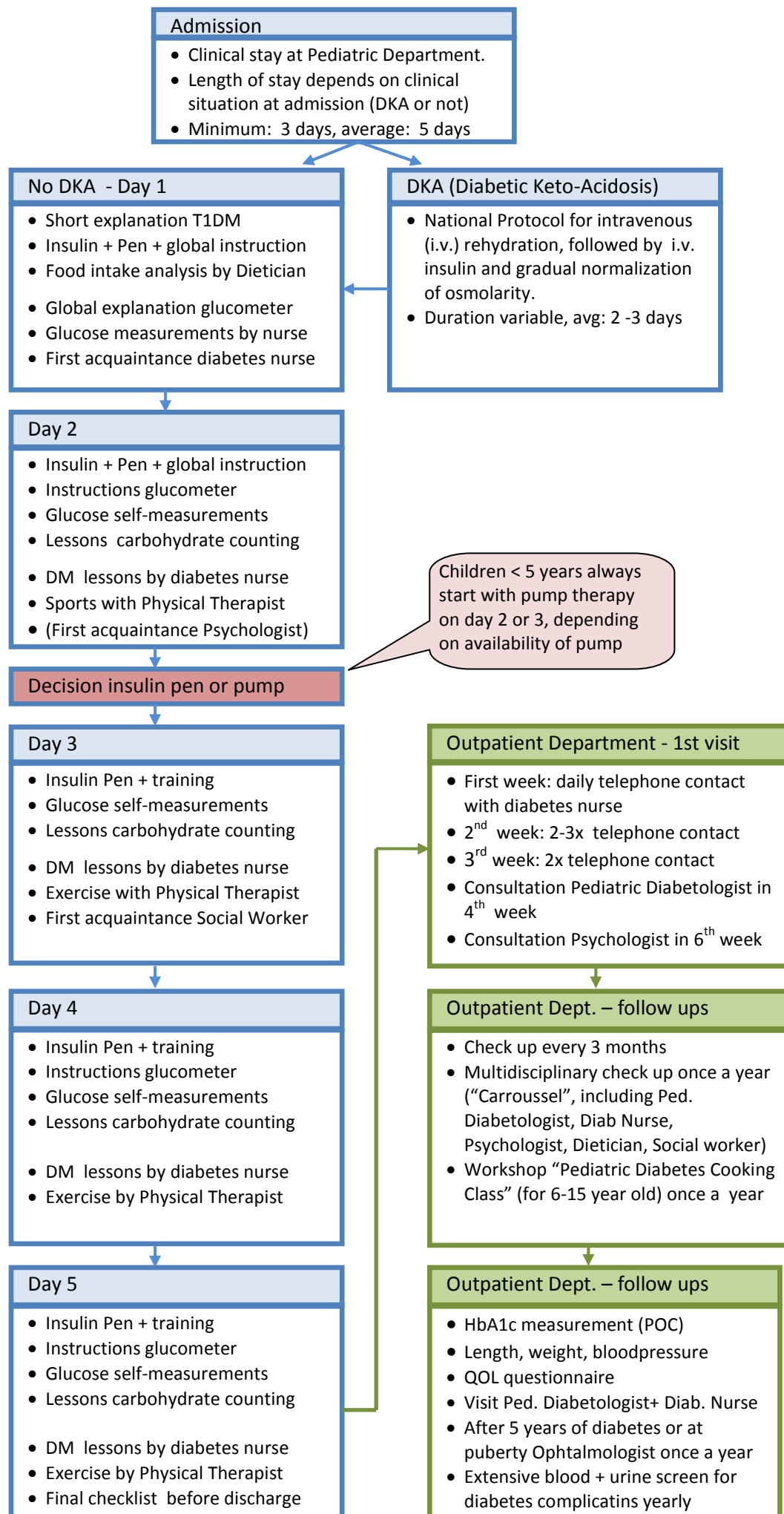
FINAL DECISION

8

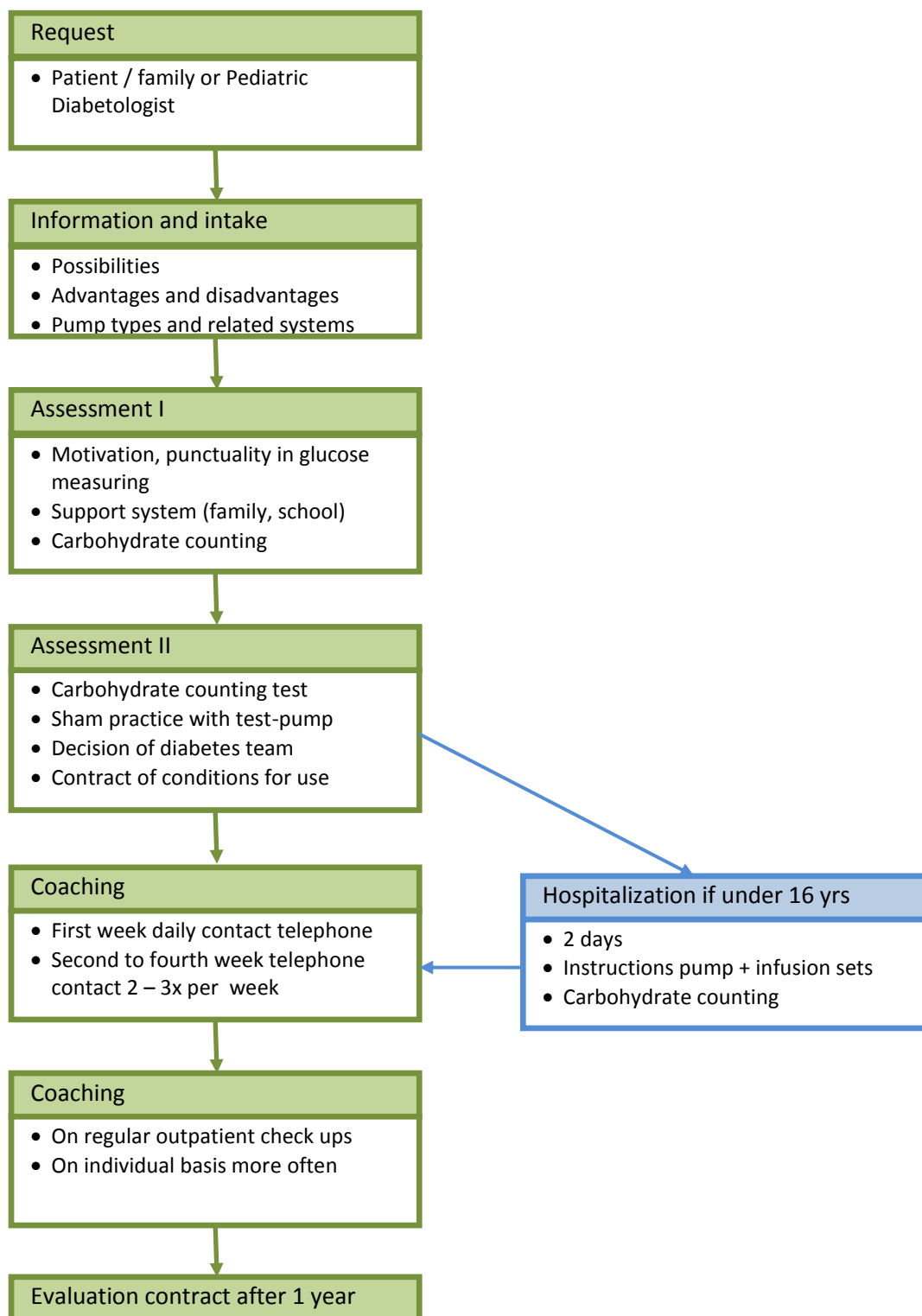
Insulin Pump Insertion

If everything it's ok, the child will start to use the insulin pump permanently.





Flowchart Insulin Pump



Flowchart instellen insulinepomp	
Start pomptherapie in het meander mc (en vele andere ziekenhuizen in nederland)	Start pump therapy in Meander MC (similar to various hospital in NL)
Geldre vallei?	
Indicatie is medisch, dus symptomatisch maar ook en vooral verbetering van kwaliteit van leven, beter kunnen anticiperen op het dagelijks leven.	Indication is medical, thus symptomatic, but also related to improving quality of life and coping with daily life
De start is in het meander en nederland totaal anders	Initiation of pump treatment is different (from IT?)
Kinderen onder de 4-6 jaar krijgen meestal bij diagnose DM meteen de insulinepomp. Dit traject gebeurt klinisch	Children diagnosed with T1DM younger than 4-6 years old are generally prescribed a pump. This takes place in the clinic
Voor alle andere kinderen geldt het volgende traject	Older children follow the following trajectory
1. Poliklinische fase van ongeveer 2 maanden	1. Polyclinical phase (children are at home and visit the clinic) for a period of 2 months
a. Voor en nadelen pomp, oriënterend gesprek	a. Orientation meeting, discussion of benefits and downsides pump
b. 1 week proefpomp met zoutoplossing, daarna beslissing	b. 1 week try out pump with salt solution, then final decision
c. Educatietraject bij diabetesverpl, kinderarts, diëtist, industrie. Praktische en theoretische training	c. Education course with diabetes nurse, paediatrician, dietician and industry (internist?). Theoretical and practical training
d. Huiswerk thuis oefenen	d. Perform home work
e. Recept en materialen bestellen	d. Order prescription and materials
f. Nieuwe glucometer die linkt naar pomp	e. New glucometer that connects to pump
g. 2 diabetes testen	f. 2 diabetes tests
h. Insuline omrekenen van pen naar pomptherapie	h. Recalculating insulin quantity from pen to pump therapy
i. 2 dagen voor start afbouwen langwerkende insuline	i. 2 days before start pump phasing out long working insulin
2. Dagopname pompstart, door diabetesverpleegkundige	2. Hospital admission for a day to start with pump, supervision diabetes nurse
a. Inbrengen van infusie set (kind, ouders hebben dit al	a. Inserting infusion (child and parents have practiced this before)

geleerd)	
b. Gebruik nieuwe glucose meter en ketonenmeter	b. Use of new glucometer and ketones-meter
c. Afronden educatie	c. Complete education
d. Eind van de dag handvatten voor de avond, nacht en naar huis	d. At the end of the day at hospital, child and parents receive guidelines for evening and night at home
e. Kind, ouders moeten thuis de pomp uit kunnen lezen	e. Child and parents need to be able to read out pump at home
3. 2 ^e dag poliklinische afspraak, vragen, pomp aanpassen, katheter wisselen, dvk	3. 2 nd day of hospital admission: Q&A, refining pump, switching catheter, supervised by diabetes nurse
4. 3 ^e dag tel of poliklinische afspr, pomp laten uitlezen, evt katheterwissel, dvk	4. 3 rd day of hospital admission: Q&A, refining pump, switching catheter, supervised by diabetes nurse
5. 4 ^e dag idem, dvk	5. 4 th day of hospital admission: Q&A, refining pump, switching catheter, supervised by diabetes nurse
6. Week 2 tel afspraak pomp uitlezen en afspr kinderarts, dietist	6. 2 nd week: telephone appointment with nurse to read out pump and make appointment with paediatrician, dietician
7. Week 3 poli afspraak dvk	7. 3 rd week: appointment at the clinic with diabetes nurse
8. Week 4 idem	8. 4 th week: appointment at the clinic with diabetes nurse
9. Week 5 tel afspr, pomp uitlezen, dvk	9. 5 th week: telephone appointment with nurse to read out pump
10. Week 6 poli afspr kinderarts, dietist	10. 6 th week: appointment at the clinic with paediatrician, dietician
Daarna reguliere afspraken en regelmatig tel, mail contact met dvk na pomp uitlezen	Then, regular periodic appointment face-to-face and on the phone with nurse after reading out pump
Gedurende het hele proces zn psycholoog	Throughout the full trajectorie meetings with psychologist