Reducing the dropout rate of a diabetes treatment through innovative design thinking and meanwhile standing in the spotlight

1. Introduction

Type 1 diabetes is a chronic metabolic disorder and one of the most underrated diseases in the world. It appears when the pancreas can no longer produce (enough) insulin. The function of insulin is to allow glucose to enter cells and to be used as energy. With type 1 diabetes the immune system attacks the beta-cells which produces insulin which leads to hyperglycaemia (Katsarou et al., 2017). According to the International Diabetes Federation, about 537 million adults globally will be living with diabetes in 2021 and in the upcoming years, this number will increase. About 10% of the diabetes population has type 1 (International Diabetes Federation, 2023).

Patients with type 1 diabetes are required to manage their blood glucose with life-long insulin therapy. When blood glucose levels are not well managed and a patient has recurrent hyperglycaemias it increases the risks of micro- and macrovascular complications (Bebu et al., 2020; Daneman, 2006; World Health Organization, 2016). The difficulty in treating diabetes is maintaining the blood glucose balance and avoiding hypo- and hyperglycaemia. Striving for a tight control is constrained by the increased potential for hypoglycaemia. Avoiding the possibility of hypoglycaemia comes often at the expense of hyperglycaemia and so the risk of complications and premature mortality increases (Peters & Haidar, 2018). The mortality risk of people with diabetes is about 3.5 times higher compared to the background population (Lind et al., 2014). And so the burden of type 1 diabetes and the obligation of a life-long strict insulin therapy leads to diabetes distress (Fisher et al., 2015).

Maintaining the balance of glucose levels is an everyday task which can result in diabetes distress. A study by Stanford University shows that people with diabetes make about 180 health decisions extra per day compared to a healthy person (Stanford Medicine, 2014). About one-third of the adults suffering from diabetes indicate high levels of diabetes distress which is translated to ‘diabetes burnout’ (van Duinkerken et al., 2020). The intrusion of hypoglycaemia in particular is experienced as disruptive and negatively impacts work performance, relationships and emotional health (Gonder-Frederick et al., 1997). In addition, the fear of hypoglycaemia influences greatly the normal functioning of people with diabetes and their family members (Martyn-Nemeth et al., 2016).

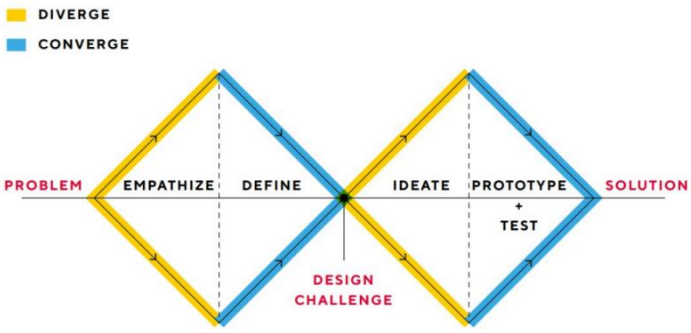
To treat and survive diabetes life-long insulin use is required and there are different options to administer insulin. Different producers try to make life with diabetes easier by inventing insulin injection systems which automatically deliver insulin into the body. Insulin can be injected in multiple ways and these different options can be categorized into three main groups. First, multiple daily injections where the user injects the insulin with a pen. Second, an insulin pump which infuses the insulin possibly used with a non-communicating sensor. Third, automated insulin delivery with a hybrid closed-loop system which communicates with a Continuous Glucose Monitoring (CGM) sensor. And since recent a fourth category can be added, a bi-hormonal fully closed loop treatment.

Every patient can choose their treatment, some patients are satisfied, some are not and discontinue the treatment. A logical thought is that patients who are unsatisfied with the treatment or service feel the urge to stop the treatment and switch to another product. Because satisfaction (or dissatisfaction) results from the experienced service quality and comparing that encounter with what was expected (Nguyen & Nagase, 2021). Discontinuation in patient care could occur because of different reasons such as dissatisfaction, lack of improvement of the blood glucose or accomplishment of the treatment goals (Karekla et al., 2019). To understand the dissatisfaction of the people who discontinue and reduce this number the following question was central in this research: How can the dropout rate of a diabetes treatment be decreased? And this research is based on a bi-hormonal fully closed loop treatment.

2. Research design: Design Thinking

In researching and developing a solution to the dropout rate of a diabetes treatment a Design Thinking approach is used. Via this approach, the solution will be practical, but also theoretically grounded to address the problem statement (Devitt & Robbins, 2013). Design Thinking is essentially a problem-solving approach that has crystallized in the field of design to combine a holistic user-centred perspective with rational analytical research – all to create innovative solutions. Design Thinking is defined as grounded in optimism, constructive thinking, and hands-on experience, design thinking focuses on meeting the requirements of the consumers of the product or service as well as the supporting infrastructure (Brown & Wyatt, 2010; Dam & Siang, 2022). It integrates profound consumer or constituent insights and rapid prototyping, with the ultimate goal of surpassing the assumptions that block the development of effective solutions (Brown & Wyatt, 2010).

Design Thinking consists of different phases: Exploration, Define, Ideate, Prototype and Test, according to Standford d.school. These steps are summarized into a Double Diamond model (Design Council, n.d.) which is sketched out in Figure 2 (Van Zeeland, 2022). Every phase requires different ways of researching, but the whole process will be dynamic and interactive. With this model the research will be in-depth and focused, both diamonds start with a diverged broad view and close with a converged narrow-down view. The first diamond will focus on the problem, known as the problem space. The second diamond will focus on the solution, also known as the solution space (Design Council, n.d.).



Double Diamond (van Zeeland, 2022)

3. Problem Space

The problem space is divided into two phases, Exploration and Define. Both phases are discussed separately, including methods used and results.

3.1 Research Method Problem Space

The problem space consist out of three research methods, literature, industry analysis with the five forces of Porter and patient analysis with type 1 diabetes patients.

The literature is divided into three main topics: the customer/patient journey, satisfaction factors in the post-purchase phase of outpatient care, and reasons for discontinuing insulin pump therapy for diabetes. Besides the literature, the market is analysed based on the Five Forces of Porter. Michael Porter has introduced the Five Forces model (1980) and explains the position of the industry in a complex strategic environment. The model is used to evaluate the attractiveness of diabetes treatments in the market, therefore not all forces are discussed. Forces which are discussed to explain the dropout rate are the threat of substitutes, the bargaining power of the buyers, the threat of new entrants and the rivalry of the industry. The patient analysis is done with a total of 8 patients who discontinued (N=5) a diabetes treatment or doubted (N=3) about the treatment they were using.

3.2 Exploration

Literature

Since the goal is to decrease the dropout rate of a diabetes treatment some literature will be interesting to look into. To understand the patient and its motivations the customer journey and the post-purchase phase seem important. At some point the patient decides to stop the treatment, so what influences this decision? Also, the literature will show the differences between the customer journey for commercial and the patient journey for medical purposes. A certain event which is known within the post-purchase phase of medical treatments is response shift, maybe this phenomenon is involved as well.

The customer journey is a tool for structuring customers' emotional and cognitive responses to products, goods, or services (Crosier & Handford, 2012; Følstad & Kvale, 2018). A customer journey involves all activities and events related to service delivery from the customer's perspective, consisting of customer experience and

touchpoints. Customer experience is multidimensional, including cognitive, emotional, behavioural, sensorial, and social components, and evolves through the purchasing cycle (Lemon & Verhoef, 2016; Ponsignon et al., 2018). So, the interaction between the provider and the customer (patient) creates a certain experience.

Touchpoints are individual interactions between the firm and the customer at distinct points, forming the journey's structure in three phases: pre-purchase, purchase, and post-purchase (Følstad & Kvale, 2018; Lemon & Verhoef, 2016). The customer journey perspective helps in managing and designing customer experiences, providing a systematic way to understand and anticipate customers' responses and needs throughout their interaction with a product or service.

But the patient journey is different from the regular customer journey as Lemon and Verhoef (2016) suggest. Ponsignon et al. (2018) did research on the journey of cancer patients. They suggested that there is evidence that patients' priorities change at different points in the healthcare journey and so the patient-centric experience quality dimensions should change over time. Within the different stages of the patient journey, there need to be different quality dimensions with a direct or indirect mode of communication. The patient journey starts with receiving a diagnosis, which relates to the interaction and activities leading to the assessment and communication of patients' condition. Then the treatment is determined, will it be inpatient or outpatient care. Treatment with inpatient care includes the patient's admission to the healthcare facility, treatment, overnight stay and discharge. Treatment with outpatient care includes patients who visit a healthcare facility for treatment and do not stay overnight. After treatment, the patients come into the phase of post-treatment care, including the experience of follow-up healthcare service including check-ups, aftercare, medical support, and complaint handling. When patients are terminally ill the phase of end-of-life care be identified to support the patient in the last phase of life (Ponsignon et al., 2018).

In the case of diabetes, it concerns outpatient care. In this phase, the most important dimensions are the direct dimensions of attitudes behaviour and communication. In the case of indirect dimensions timelines and accessibility are important (Ponsignon et al., 2018). Treating a patient with a chronic disease such as diabetes is an ongoing process, these patients receive continuous outpatient care. During the treatment, patients have regular contact and touch points with either the hospital or clinic of their choice. In the phase of outpatient care, the satisfaction and experience of the patients are influenced by expertise, communication connection and context (Philpot et al., 2019).

Whether the patient continues the treatment depends on the satisfaction and their experiences, this is comparable to the post-purchase phase in a customer journey. The post-purchase phase of the customer journey is characterised by different behaviours such as usage and consumption, post-purchase engagement and service requests. It covers the aspects of the customer's experience after purchase that relate in some way to the brand or product/service itself. The product itself becomes the critical factor in the touch points in this stage (Lemon & Verhoef, 2016). During the post-purchase phase, a trigger may occur that leads to customer loyalty which generates a repurchase order or other positive behavioural intentions but can also trigger a new beginning of the purchase process by re-entering the pre-purchase phase to consider alternatives (Court et al., 2009). According to Rust & Oliver customer satisfaction (1994) is defined as follows: ''…, customer satisfaction is a summary of cognitive and affective reaction to a service incident (or sometimes to a long-term service relationship). Satisfaction (or dissatisfaction) results from experiencing a service quality and comparing that encounter with what was expected.'' In a recent study, the relationship between patient satisfaction and loyalty was found significant (Nguyen & Nagase, 2021), so when patients are satisfied with the treatment, they will stay loyal to it.

In the healthcare setting a factor is added in case of the service quality and satisfaction, the extent to which customers perceive risk and the control over the process. Grewal et al. (2007) developed a theory that is useful for examining the influence of post-purchase perceived risk and behavioural intentions in the service setting of healthcare. This factor post-purchase perceived risk is the probability of uncertain outcomes after a purchase. To foster recurring engagements and collaboration, it is crucial to minimize the perceived risk after a purchase. The positive perspective about service quality is influenced by allowing them to join the decision-making process and offering the customer different choices (Grewal et al., 2007). Which is beneficial for the relationship of service quality and loyalty.

Different scholars have discussed discontinuation for different diseases, such as diabetes. In general, the most known reasons for discontinuing medical treatment are lack of improvement or accomplishment of the goals,

dissatisfaction with the treatment, and environmental obstacles and constraints. Patients report also dropping out for reasons which are not related to the therapy itself, e.g. circumstantial problems and difficulties, illness, new responsibilities, improvement due to therapy, high treatment costs no need for services and need for independence. Three main categories for dropping out of diabetes treatment are recognized. 1) patient-oriented problems, 2) healthcare provider-oriented problems, and 3) physician-patient relationships (Masuda et al., 2006). More recent research about drops out from Dekker et al (2023) gives additional patient-oriented reasons. This research focuses on type 1 patients who used an automated insulin delivery system. All the discontinuation reasons regarding diabetes treatment are summarized in the table below. (Dekker et al., 2023; Karekla et al., 2019; Masuda et al., 2006).

PATIENT - ORIENTED PROBLEMS

	Discontinuation reason	%	Explanation
Patient profile	Gender	8.7%	Female tend to drop out sooner then male in a treatment, since female adolescents are more concerned about their body image and social acceptance with pump use. This is mostly shown from an age of 18 to 26 years old (de Vries et al., 2011; Dekker et al., 2023; Masuda et al., 2006; Wong et al., 2017)
	Age	10.7%	Patients within age group of teens and early adolescent seem to likely to discontinue the treatment, because the parental involvement in the diabetes management is decreasing and consequently treatment adherence too (de Vries et al., 2011; Dekker et al., 2023). Also Masuda (2006) found out that the drop out group is younger then the continuing group among adults.
	Education	4.9%	The educational level and education regarding the insulin delivery system do have a significant impact on discontinuation. High levels of education are less likely to discontinue insulin therapy, since they are more easy to motivate for behavioural changes, which is key to diabetes management. (de Vries et al., 2011; Dekker et al., 2023; Masuda et al., 2006)
	Economical status		Patients with lower economic status are more likely to discontinue the insulin therapy (Dekker et al., 2023; Masuda et al., 2006)
Treatment	Duration of disorder	1.9%	The duration of how long someone is suffering from type 1 diabetes (Dekker et al., 2023; Masuda et al., 2006)
	Glycaemic control	13.6%	Lack of improvement or even deterioration of the HbA1C is often related to discontinuation. Since the glycaemic control is not improved as expected (Dekker et al., 2023; Masuda et al., 2006)
	Technical control	7.1%	Problems with cannulas, connection problems, insertion problems, adhesion and faulty/broken equipment are playing parts in discontinuation.
	Wear-related issues	28.6%	Constantly having to wear a device attached to the body and interfering in daily activities, such as limitations in clothing and discomfort (Dekker et al., 2023).
	Discouragement issues	9.3%	Disliking the pump, suboptimal following of treatment instructions, too much freedom.
	Work load treatment	6.4%	Maintenance of the device. Switching ampoule with medication, new infusion sets or sensors etc.
	Side effects	5.7%	Side effects of medication, plasters, cannulas of the infusion set.
	Reliance	4.3%	The dependence of the device. If it not functions, there is not treatment.
	Pregnancy	0.7%	Not with every device or treatment can be used during a pregnancy or wish to be pregnant.
Psychological problems	Depression	*	(Dekker et al., 2023; Masuda et al., 2006)
	Life intrusions	8.6%	Visibility of the pump, affecting body image, more confrontations with your diabetes (Dekker et al., 2023; Masuda et al., 2006)

HEALTH CARE PROFESSIONAL - ORIENTED PROBLEM

Discontinuation reason	%	Explanation
Waiting times at the clinic or hospital	*	(Masuda et al., 2006)
Follow-up of treatment recommendations	13.6%	Problems with following treatment recommendations. When facing problems to follow the recommendations of the healthcare professionals patients are more likely to quit the treatment (Masuda et al., 2006)
Distance from residence of patient to clinic	*	When the distance from the residence of the patient to the clinic is relatively long, it is more likely to not return to follow-up appointments (Masuda et al., 2006)
Lack of knowledge	*	Healthcare professionals are playing a key part in the degree of success of the therapy. A healthcare professional needs to screen patients on suitability for the treatment. Since the technology development evolve quickly a mismatch can occur due to lack of knowledge (Dekker et al., 2023).

PATIENT PROVIDER - ORIENTED PROBLEM

	Discontinuation reason	%	Explanation
Disrupted by psychological problems	Decreasing motivation	*	When patients are less motivated to adapt to the new management of diabetes and are less motivated, the relation between HCP and patient can be disrupted (Masuda et al., 2006)
	Mannerism and habits	*	When patients are not willing to adjust the management of their diabetes or the attitude and manners towards the HCP the relationship can be interrupted (Masuda et al., 2006)

Industry analysis

Another research method to dive deeper into the problem statement is the analysis of the five forces of Porter. The five forces of Porter are used to research the attractiveness of other systems and what the chances are of new entrants coming to the market (Porter, 1980). It can be concluded from this analysis that there are a few groups of substitutes for diabetes treatment. No matter what, insulin is needed to lower blood glucose, but the way to inject the insulin is more or less advanced. The decision on which treatment the patient will use depends on the personal preference of the patient self and must be in accordance with the healthcare professional. Besides the approval of the healthcare professional, the insurance company has to approve as well due to the indications and conditions. That is why the power of the buyer is rather complicated and makes it less easy for the patient to switch to another treatment. The rivalry is rather high since these systems are achieving good results within the patient group. Therefore these systems are attractive to switch to when choosing a new treatment. Also to develop a new system which is comparable to the results and systems now available in the market is quite difficult, a lot of resources are needed to enter the market as a new entrée. It is more likely that already established companies within the diabetes market, are developing a new generation and evolving the current available systems.

Patient analysis

The patient analysis consists of a ERP system analysis of the total population of patients who stopped the treatment. After the ERP analysis 5 patients who stopped were invited to participate with an interview in this research. Also 3 patients who have doubted to discontinue the treatment but continued were invited to participate with an interview.

From the ERP analysis and interviews the discontinuation reasons were compared to the available literature. The outcomes of the patient analysis were comparable to the found literature. Also in case of the bi-hormonal fully closed-loop glycaemic control, wear-related issues and life intrusions were mentioned as discontinuation reasons.

3.3 Define

All information gathered in the exploration phase is summarized and narrowed down to one paradox and design challenge. In the market, people are expecting a breakthrough in diabetes technology or even a cure to the disease and a very innovative product which fixes all the problems with type 1 diabetes. On the other hand, people decide to stop advanced diabetes treatment because of wear-related issues, the lack of glycaemic control and the experienced life intrusions.

So to reduce the dropout rate the next ‘’How might we… - question’’ is in order: How might we improve the available diabetes treatments to the wishes of the patients and during the development managing the expectations?

4. Solution Space

Based on the design challenge, improving diabetes treatments to the wishes of the patients and managing expectations in the meantime the solution space consists of two solution directions. First, product development is based on the requirements of the users. This solution direction is not shown in the abstract due to confidentiality. The second solution direction is related to expectation management and improving communication. During the product development the expectations of the (potential) patients can be more managed and will not be set too high.

4.1 Research Methods Solution Space

The research methods for the second diamond in this research method are literature studies and expert interviews. The literature is used to support the solution directions. The suggested improvements and changes based on the patient analysis should be tested and reviewed by the literature. Besides the support and review of the solution direction, it helps to understand coping mechanisms. Subjects discussed in the literature regarding product development are the importance of self-management, empowerment and personalisation of diabetes management. Based on the literature the solution directions can be optimized, but also with the support from the literature gives more certainty before implementing the changes.

Three experts are interviewed to ideate and give inspiration to the prototype, but also to support the found solution directions. One expert interview is used as validation of the final prototype regarding the solution directing expectation management and communication. The expert interview outcomes will not be discussed due to confidentiality.

4.2 Solution direction: Product development

In the patient analysis a lot of user requirements were collected. However because of confidentiality reasons these insights could not be shared.

4.3 Solution direction: Expectation management and communication

To address the paradox and design challenge one could think about a solution contradiction, but instead abduction strategy is used: thinking from consequences back to the causes and working principles of how things work. (Dorst, 2015a). The solution often does not lay within the centre of the problem but within the context of the situation. Expectation management is limited to the understanding of the expectations and the requirements of the public so a strategic approach can be accommodated (Olkkonen & Luoma-aho, 2014). A new approach to a problem is called a ‘’frame’’ (Dorst, 2015b). Frame innovation, in the context of expectation management, offers a strategic approach to reframing situations, challenges, or problems to better meet expectations or to shift those expectations altogether. In the case of this challenge frame innovation is suitable because of its flexibility with a broad perspective and focus on innovation processes. But also frame innovation easily allows looking for the frames in the future (Dorst, 2015b, 2015a). It is essentially about altering the way we perceive, understand, and communicate about a particular issue to bring about more effective solutions or outcomes for now and in the future. Based on the available information and the new frames modelled it seems to be important to create a platform or opportunity for patients to communicate in a safe and transparent environment. Users of a treatment need to feel connected, engaged and captivated in order to continue a treatment. Also, other literature supports the found implementation suggests from the frame innovation model. Loyalty to treatment is based on the engagement and captivation of the patients in the process and development. Philpot et al (2019) confirmed the importance of communication and context concerning satisfaction and experience which is greatly influenced by it. Therefore managing the expectation before even using a specific diabetes treatment and continuously clearly communicating about it is important.

The public audience, all future users of a diabetes treatment need to be informed realistically about what to expect. The public needs to be informed via a website and its content, direct mailing, social media, education platforms or external independent platforms.

Besides the publicly available communication the current users and so the ambassadors of the treatment need to be informed with more detailed and exclusive information to keep them captivated and engaged. The current users, the community, need to be informed via an exclusive platform. When looking at the different branches, but also within the diabetes sector communities have the goal to associate people together. The literature describes four characteristics concerning a community (Rademakers, 2020; Rosenbaum et al., 2005):

- Feeling of belonging;
- Having influence and a sense of mattering;
- Being rewarded for participation in the community;
- Sharing memories and experiences.

Several prototypes were shown to an expert in the field concerning a community platform. Different practical concerns came forward, such as management of a community, the responsibilities as the manufacturer in the community and the duty to care. But also the prototypes should be tested within the field with diverse patients to test the urge for a community as suggested.

5. Conclusion and discussion

To conclude the thesis and this research: How can the dropout rate of a diabetes treatment be decreased? Managing blood glucose levels is a daily task which always requires consideration and attention (Clinical Diabetes, 2018; Stanford Medicine, 2014). Different treatment methods are possible and every treatment knows a certain dropout rate. The most common reasons to stop the insulin pump therapy are related to problems wearing the device constantly, lack of improvement regarding glycaemic control, and also difficulties with

following up the treatment recommendations (Dekker et al., 2023; Masuda et al., 2006). Switching to an alternative is lurking around the corner, since extreme rivalry between the treatment options. Solutions to prevent the dropout is further developing the related diabetes treatment according to the patient's requirements and wishes. Besides the product development improving the communication to manage the expectations is necessary to keep the patient satisfied and loyal to the treatment, which can be done with the introduction of a community platform.

However this research is a good starting point for reducing the dropout rate for diabetes treatments, but this research has a few limitations. First, the sample joining the research is rather small compared to the total diabetes population. So, no conclusion could be generalized. For future studies, the healthcare professional perspective on discontinuation reasons could be included. Another future study opportunity came forward in this research, the relationships between a healthcare professional, patient and manufacturer can be more highlighted. Lastly, to prevent and respond to dropout, risk profiles could be identified to predict the patient who potentially drop out of the treatment. But for now, the advice is to focus on the development of diabetes technology and improve communication towards a realistic message to future and current users.

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