

2.0 Research Summary

Key Research Areas/Approaches or Questions

These are the key questions that emerged early in the research process and drove the analysis:

- What is Diabetes?
- Why is it important to inject the right amount of insulin?
- What is InsuCalc and how does it work?
- What are the problems healthcare professionals are facing?
- Who are the users of InsuCalc?
- What are the problems?
- Why do patients need insulin dose calculator?

Summary of Methods Utilised

These are the methods that our group undertook in the research stage of the design process:

- Expert Interview
- Role Play
- Observation

Summary and Documentation of Research

As we are going to design a product service system for a medical device, it is essential to understand the background behind the product.

So what is diabetes?

Diabetes is having too much glucose (sugar) in the blood. This happens because the pancreas cannot make enough insulin. Insulin is a natural hormone that helps glucose enter the body's cell, where it is used for energy.

There are 3 types of diabetes:

Type 1, Type 2 and diabetes of pregnancy (Gestational Diabetes).

Glucose is an essential source of energy for the brain and is one of the sources of energy for the body. Glucose in the bloodstream comes from carbohydrate foods, which are changed into glucose after we have eaten them. Glucose also comes from liver, who converts fat and protein into glucose to make sure that there is a constant glucose supply even if we do not eat.

The normal level of glucose in the body should be between 4 and 8 mmol/L. (millimoles/liter)

All types of Diabetes is the result of the body not creating enough insulin to keep blood glucose level in the normal range. In this case we are going to focus on Type 1.

People with Type 1 who do not produce any insulin (or very little), because the immune system destroys the pancreas, stopping them from making insulin, therefore their body is unable to use glucose for energy

They need to inject insulin plus healthy eating to stay alive and maintain good health. They need to inject around 4 shots a day, 2 shots of basal injection (long acting insulin) in the morning and before bed, one shot of

bolus injection (short acting insulin) before each meals.

Diabetes affects more than 200,000 New Zealanders, individuals with Type 1 diabetes are required to inject a shot of short acting insulin before eating carbohydrate to maintain blood glucose level within the normal range to avoid developing vascular complications in the long term.

The amount of dosage depends upon current blood glucose, planned carbohydrate intake and physical activity (both recent past or near future). Furthermore, each individual's sensibility to insulin will influence the required dose, therefore the calculation of insulin dosage is variable.

If taking not enough of insulin, the blood glucose will become too high, which is a hyperglycaemia (hyper)and causes thirst, blurred vision, etc? However, if you are taking too much insulin, blood glucose will fall into hypoglycaemic (hypo) range which can result in tremor, sweating, seizures, goes into a coma and even death.

Therefore accurate dose calculations are facilitated by training in carbohydrate (carb) counting and structured diabetes education.

We did two interviews from the healthcare professionals one is our client, Dr. Steven Miller, who is a specialist on Diabetes, and Rachel, a dietician who works at the Diabetes Clinic. From both interview, we have gain more knowledge about diabetes and insulin injection. It is very important that the patients are counting their insulin and carb ratio.

Steven mentioned that he is actually not giving the insuCalc wheel out to his patients because the units they have on the wheels are different to the one that we use. So what they do is to have their own chart, and find out which range of insulin sensibility of the patient falls into (this usually take around one week to figure out), then from that, they know how many carb they take needs how much amount of insulin.

There is a course called DAFNE (Dose Adjustments For Normal Eating), this is a 5 day course for patients who is on insulin for a year to attend. We can't run before we learn to walk, by allowing patients to attend the course after a year of insulin injection, patients have a basic understanding with their sensibility. DAFNE is a course that helps patients counting their carb intake more efficiently and more accurate. However due to the intensity of the course, there are patients that choose not to attend.

It sounds simple and quite straight forward, but as mentioned previous, insulin dose is variable depends on what physical activity u did or going to do, how many carb the patient take, and what is the glucose level at that time. It is actually quite difficult.

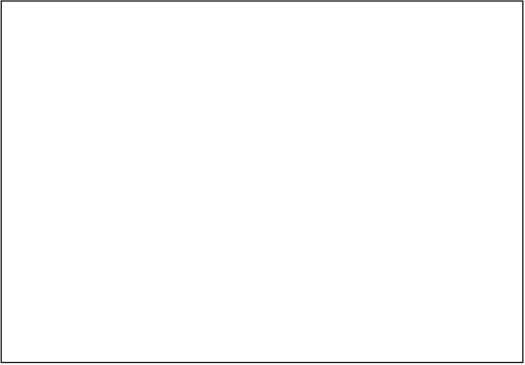
And here is the problem, patients often report difficulty with applying these principles with every single meal. Also lack of numeracy skill is a critical factor that insulin dose calculation occurs errors.

From the observation of Rachel's appointment with her patient, Brian, we realised even someone like Brian, who has Type 1 diabetes for more than a decade, still does not know the fundamental skills of handling diabetes and insulin. For example a needle need to be changed every day, but he doesn't change it for a month. Because the needle will be deformed within 5 times of use, it loses its usability. Additionally, insulin crystallises in the needle, blocking insulin to go through. This could be why he is back to the clinic because he glucose level is always high even he is taking the "right" amount.

However, we cannot blame on anyone, diabetes is complex, and until today, there is no explanation why insulin helps, but they know it works. Carb counting is difficult and keeping a habit that you do not which to have is hard, and patients need to do it every morning and night, every meal, every day of their lives.

Rachel also emphasised one point that it would be great if every diabetic attend the DAFNE course, this will help the patients understand more about the carb and insulin ratio and how to get it more accurate and how important it is. But again, there are people who do not care, and people that wanting to take care of themselves but not good with numeracy or having some kind of difficulty to learn all about this.

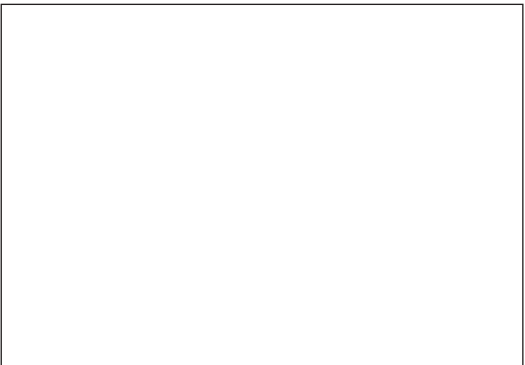
Therefore it is critical to come up with a device that allows patients and healthcare professionals to rely on. Something that can look after them and not make the patients guess or feel unsure if they are taking the right amount or not.



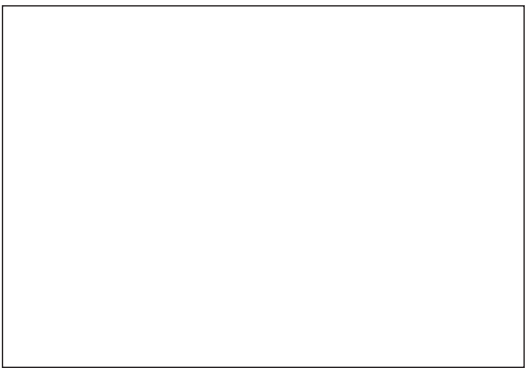
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Persona #1



Name: Kim Nukunuku
Age: 46

Gender: Male

Occupation: Truck Driver

Ethnicity: Maori

Education level: Primary

Interests & Hobbies: Spending time at home with his kids, watching TV at home when not working. Fishing by the dock during the weekend.

Description of persona:

Kim diagnosed Type 1 Diabetes two years ago. He tried to attend the DAFNE course, but the intensity of the course turned him down, he quit the course after the second day. He knows the basics of carb counting and his insulin to carbohydrate ratio. Kim quit school after when he was 10, therefore his literacy and numeracy skills are poor which affect his capability to do the calculation himself.

As he is a truck driver, he works different shifts, therefore he is taking basal and bolus injection to give himself more flexibility on what time he is going to have meals.

Therefore, he tried to keep his diet as same as possible so he does not need to worry about the insulin dose calculation for every single meal. He can just take the suggested amount of insulin dose from the dietician based on what he eats everyday. However, it gets hard when he is dining out.

Kim recently returned to the Diabetes Clinic, because he realised his blood glucose level is always high even though he is taking the "right" amount.

Rachel, the dietician said he is not taking the right amount of insulin. For example, he should add an extra unit when he is having an extra slice of bread. Kim is really confused, he is trying his best but there are many considerations.

Sometimes he wanted to give up, but thanks to his family for being very supportive, his family is the motivation for him to maintain his health.

Requirements:

Kim needs a tool that can help him to calculate insulin dose when he is not having something that he does not usually have.

Persona #2



Name: Sarah Barker
Age: 50

Gender: Female

Occupation: Sales Assistant

Ethnicity: European

Education level: Form 5

Interests & Hobbies: Listen to music, walk with her dog Bobby, eat chocolate cakes

Description of persona:

Sarah is a very happy obese person with Type 2 diabetes for more than 20 years. Life is too short to regret, so she does what she wants, eat what she wants. She has a fetish with chocolate cake, she cannot resist herself from it. She is controlling herself by just having one slice of chocolate cake a day, sometimes two.

A year ago, she became insulin independent. She was trained by the healthcare professional how to do carb counting and work out how much insulin does she need to inject every time. She knows she is not a very bright person but is trying very hard to cope with the calculation, however, she just can't cope with it. Therefore, she is injecting random amount every time before meal. This is why she always goes back to the clinic because she doesn't feel well. Healthcare professionals always need to keep an eye on her diet and suggest how much insulin dose she needs for each meal. This restricts Sarah to have whatever she likes.

She wanted to know more about insulin dose counting, she does not want to restrict herself to what she wants to do and eat, she wants more flexibility on her daily routine and diet, living like a normal person.

Therefore, Sarah took a week off work and went to the DAFNE course. Although she learnt a lot from the course, she still finds it hard to calculate insulin dose because she needs to do it in her mind.

Requirements:

Sarah wants a tool that can help her to do the insulin dose calculation, she is not very bright, she wants something that is straight forward. For her technology is like a stranger to her, she is still using her phone from ten years ago. She thinks learning how to text is the most challenging thing.

Summary of Key Insights

At the conclusion of the research phase our group identified these key insights in relation to the project brief:

- Diabetes team does not provide a device or tool to help Type 1 Diabetes for Insulin Dose Calculation (InsuCalc) as it is not functioning well due to lack of information given.
- Poor communication due to different standard is given on the calculator causes confusion.
- The appearance of InsuCalc is not appealing, images on the product are confusing as they have no relation to what is on the product.
- Information provided on the product is not suitable to New Zealand users as the measurement is different.
- Diabetic do not have the right tool to help them to do the insulin dose calculation.
- There are many variable that causes confusion for some people to do the calculation.
- Patients that are lack of literacy and numeracy skills are the group of patients that healthcare professionals find it difficult to train.
- Patients who did not take the DAFNE course are the one who are difficult to take care psychologically.

Objectives

After we have identified some key insights, these are the objectives in relation to the project brief:

- Provide an educational tool to the patients by the healthcare professionals. Improve diabetics lives because they become more independent and more responsible.
- Minimise the inaccuracy of insulin dose calculation by introducing a developed and highly reliable dosage tool. This new tool will help measuring the insulin dose based on different variables therefore avoid hypo or hyper to be occurred.
- Ease of use is one of the most important criteria for this product, as some patients' literacy and numeracy skills are poor.
- The appearance of the insulin dose calculator must be discreet, yet appealing and create an emotional attachment. Something that other people do not notice as a medical related product.

Reflections

Before starting this project, we thought diabetes is just an illness that you only need to inject insulin dose some time during the day. However, when we started research on diabetes, it is actually more serious than we thought. If we do not treat diabetes especially Type 1, we can go in a coma and die in a short period of time.

We understand that we must do an in depth research in order to come out an appropriate solution for our medical product. We have gained an incredible knowledge which help us to identify more opportunities.

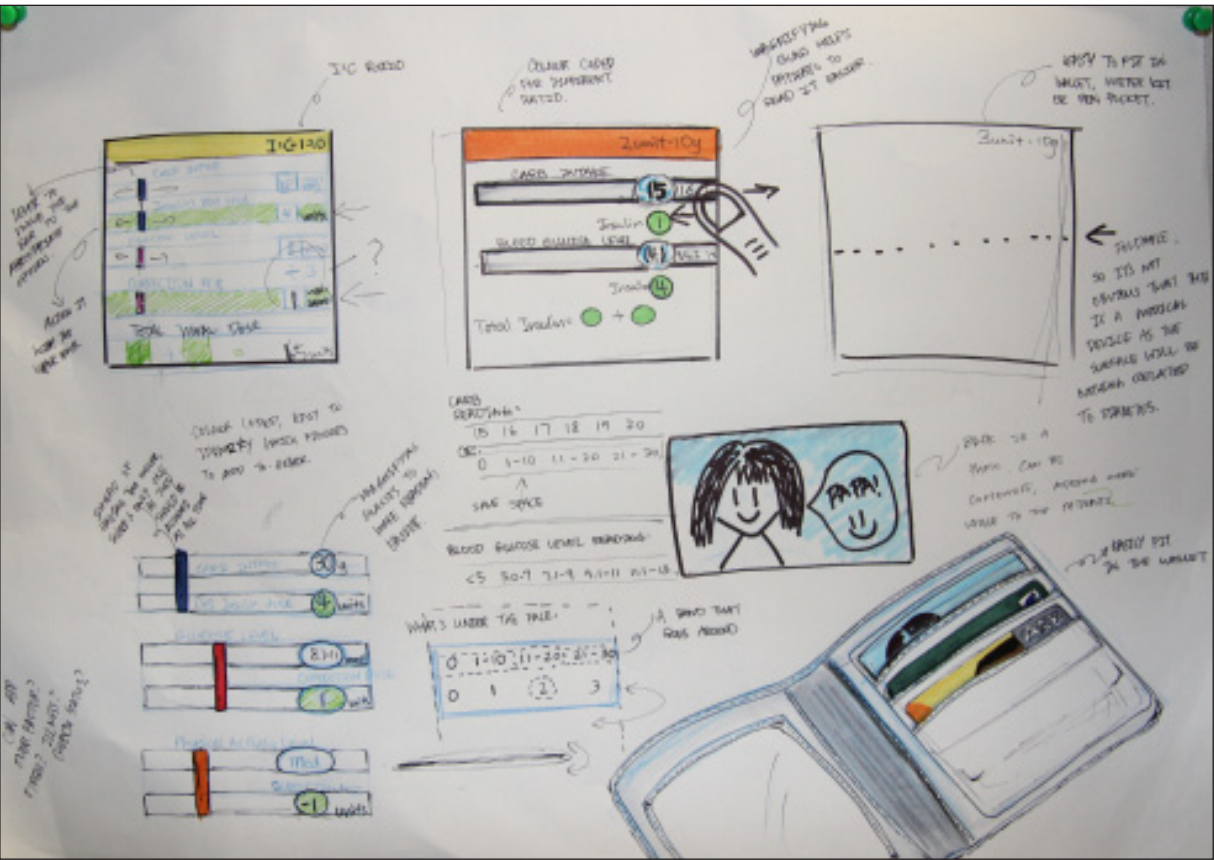
Observation is such a helpful research method tool to gain more information from a third person. However, being the actual user is very helpful too. We understand the user's needs, hence develop a suitable device for the users. Interview professionals is another way to gain more information from a different aspect. Role play is being the actual user, which our experience will be another useful information to come up with a human centred design product.

3.0 Creativity and Exploration

Introduction

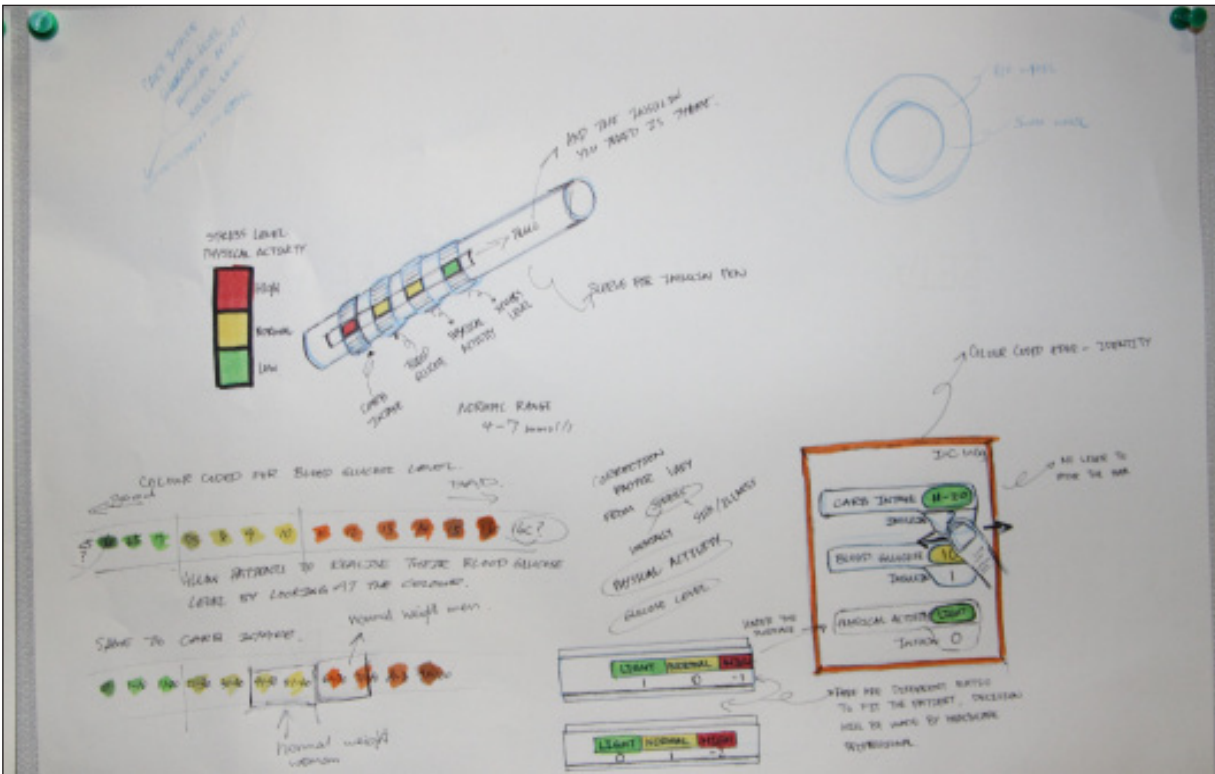
After we have summarised our research, we have identified some key insights and objectives, and these are the direction we need to go for. Every concept should be a reflection of our objectives.

Documentation of Key Work



From our research, we are acknowledged that the calculator should be portable, small enough to carry around, for example, in a pocket, in a meter kit, wallet, etc. Therefore the size for this concept is small enough to fit in the wallet.

Despite the chart that our client has provided us, we have found out how to calculate insulin for carb and insulin for blood glucose, this is to avoid so many numbers on one surface. Also providing a more simple interface.

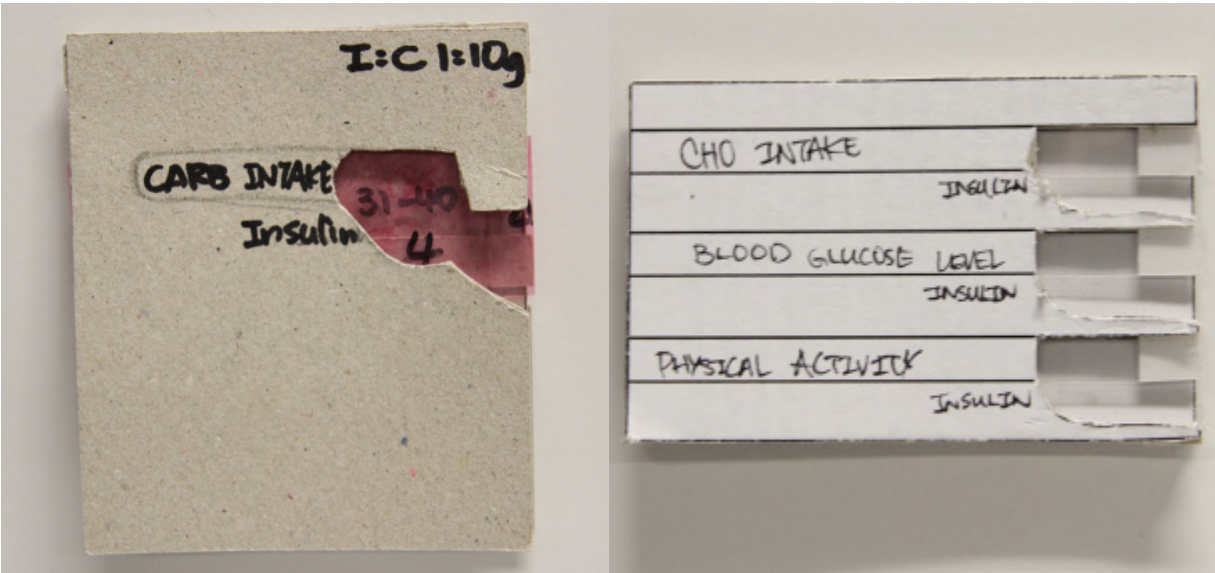


Colour coding is one of the features from this concept. The colour coding does not just represent the range of Carb or blood glucose level, but also indicate if they are doing well.

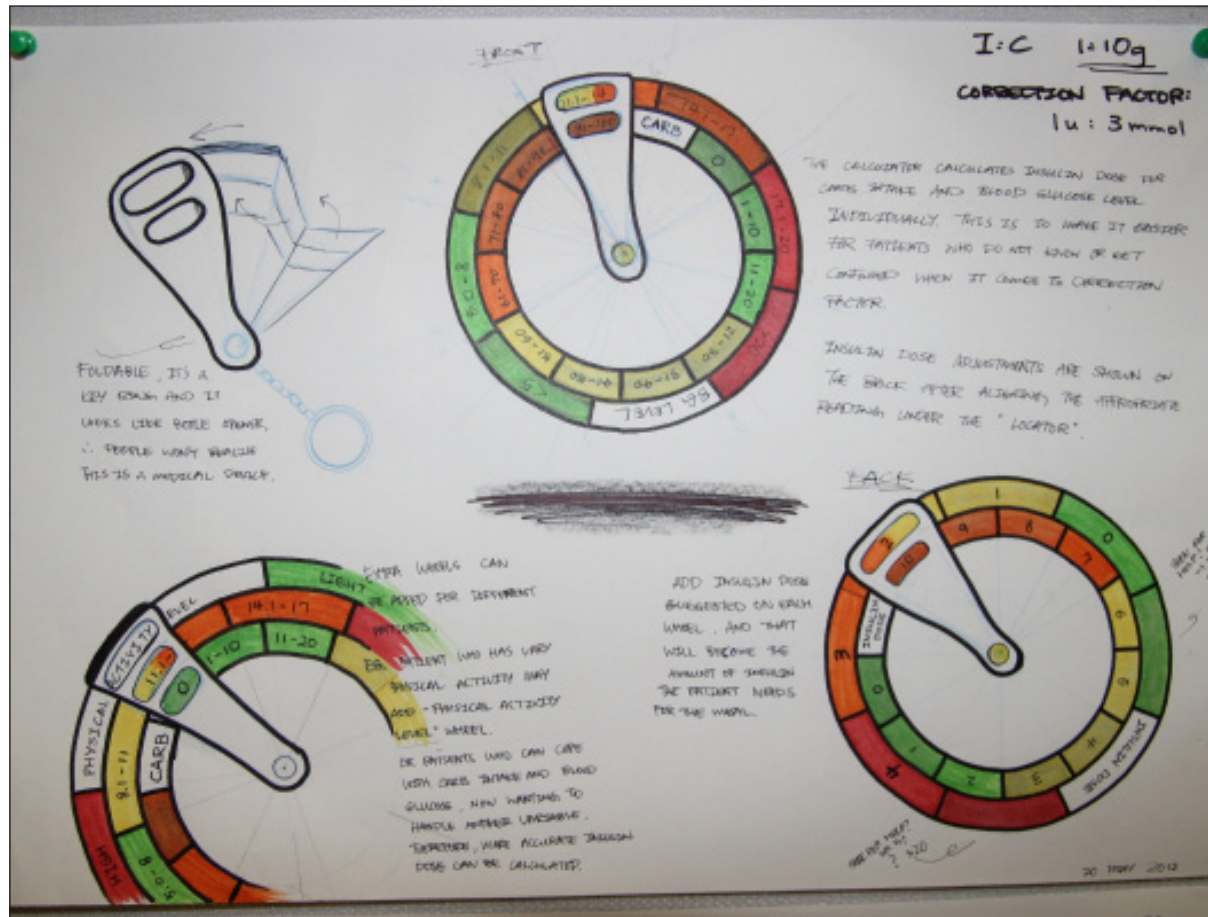
For example-Blood glucose level, green means good, yellow means okay, orange and darker means the patients need some medical attention.

For carb intake, green means less then yellow is normal, orange and darker means too much.

However, these are not the final colours but only showing the concepts of colour coding.



These are the prototypes of the credit card idea. Simply slide each variables to the range the patient falls in to and the suggested dosage is shown below. After the patient has slided all the variables, what the patient needs to do is to add three suggested insulin dose together, and that will be the total unit of insulin the patient needs to inject for the meal.



This is the wheel theme. Same as the credit card idea, the one that slides, to avoid confusion, chart is not used to count the insulin dose but count by individual variable.

The "bottle opener" helps patients to identify their range clearly, reduce confusion.

As this should be small enough to carry around, the wheel could possibly be folded into the "bottle opener". Then the patients can carry it around like a key ring. Even if the patients do not want to carry it as a key ring, this product is compact enough to fit in the meter kit or the insulin pen kit.

The idea behind the bottle opener is to hide away the fact that this is a medical device, as from our research, some diabetes do not want to be recognised as ill people.

One of the features of this concept is that it is a modular, healthcare professionals can add another variable(s) if the patients is capable to do that. Making the calculation more accurate. Because is modular, the bottle opener can be changed, too.

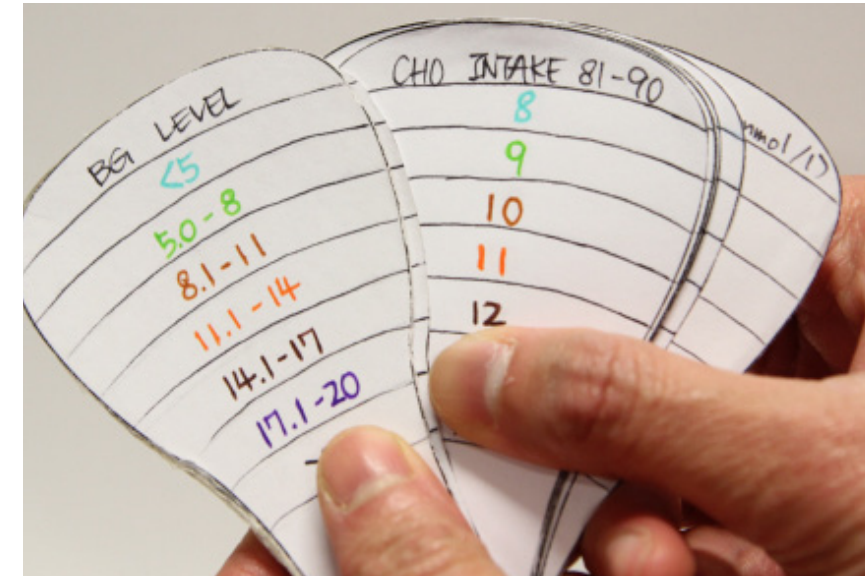
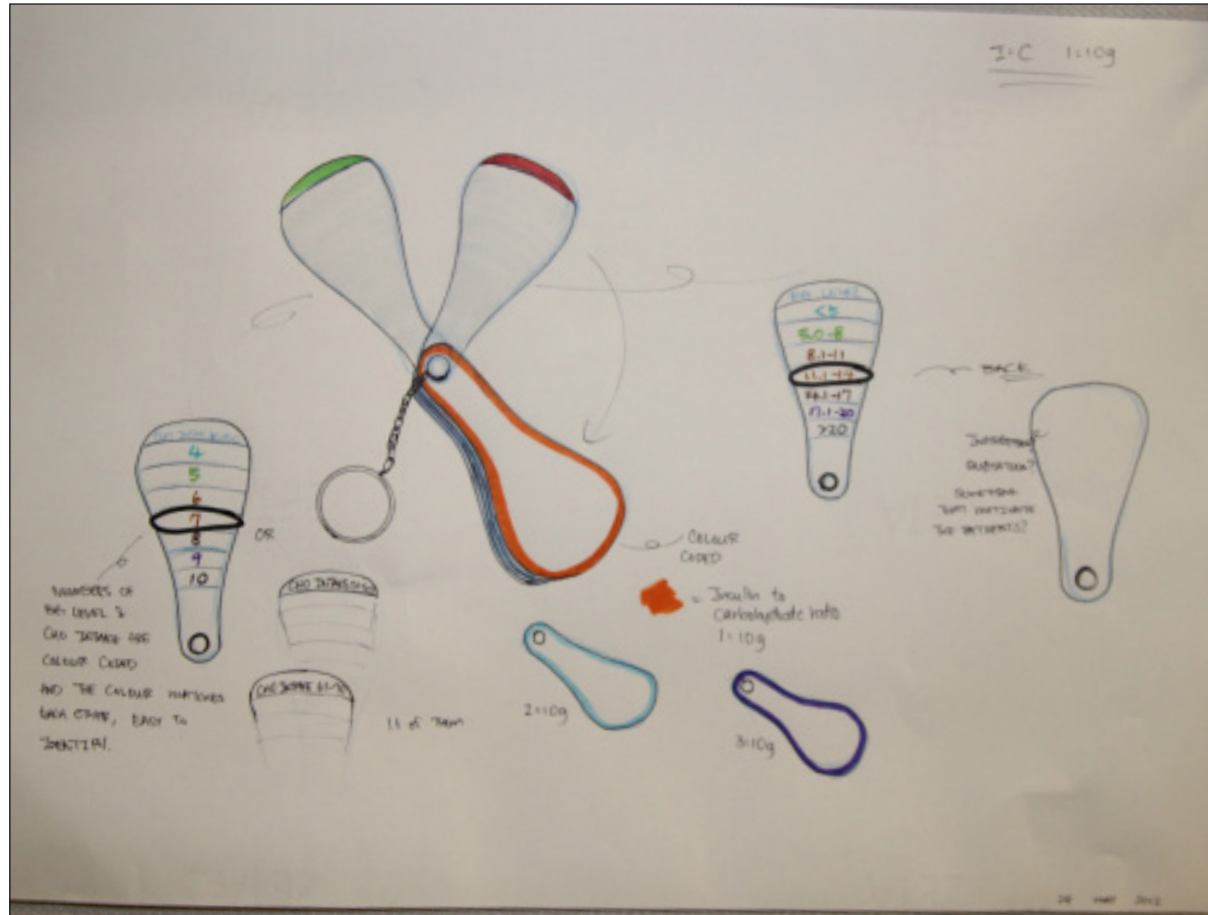


First, the patient needs to align the carb and blood glucose variables, then dial the "bottle opener"



When everything is aligned, turn the wheel around to the other side. What is bracketed in the "bottle opener" is how much insulin the patient needs to inject for the meal.

In this case, 7 units of insulin are required.



As explained before, the wheel could possibly be folded into the bottle opener. However, considering this object is going to be used at least three times a day, seven days a week for the rest of the patients' lives, durability is a very important element on this. Therefore, folding is not an ideal option as it could easily ribbed or teared after countless time of use.

Here, breaking each range into one leaf, and what the patients need to do is to align the blood glucose (BG) variable and the carb intake range that the patient falls into. Then the insulin dose suggestion can be easily identified.

Because each leaf is separated with each other, so there is no confusion as patient is only looking at the blood glucose level and the carb intake.

Again, colour coding plays a big role here. Colour coding the carb intake range helps patients to identify the range faster, as people recognise colour better than number. Colour coding the insulin to carb ratio, therefore they know which one is 1:1, which one is 2:1, etc, as some patients need more than one ratio to work on. For alignment of BG level and carb intake, colour coded the numbers helps the patients to identify the right insulin dose amount if they find it difficult to align them.

