Design Criteria for Haemodialysis Patients Based on Self-Weight-Management Behaviour

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Abstract

Background Managing weight is very important for haemodialysis patients during the inter-dialysis period. However, many patients have difficulty managing their weight by themselves. The self-management of weight is left to the patients, and it is difficult for doctors or other specialists to intervene. User-centred design can help patients to self-manage their weight in everyday life. In this study, a behaviour process model suitable for self-management of weight of haemodialysis patients was developed based on user-centred design methodology and health behaviour theory. Possibilities for the design of further products and services are discussed.

Methods Interviews with haemodialysis patients were conducted in order to identify their current weight-management behaviours. The interview data were coded and analysed using a coding scheme based on the Health Action Process Approach (HAPA), a health behaviour theory.

Results First, the characteristics of the haemodialysis patients' weight-management behaviours were identified based on the HAPA. Second, a behaviour process model was built from the results of the empirical research. The model is deemed appropriate to explain the self-weight-management behaviours of haemodialysis patients. Third, the behaviour process model was used as the basis for further design directions regarding the self-management of weight for haemodialysis patients. The design directions were discussed in terms of the functions that would help achieve the desired behaviours.

Conclusions This study integrates behaviour theory into design research for understanding the behaviours and needs of haemodialysis patients with respect to the self-management of weight. The understanding is used as a basis for generating new design ideas. The results of the study can be used as a guide for designing new products or services for weight management of haemodialysis patients.

Keywords Self-management of Weight, Haemodialysis Patients, Health Behaviour Process, Behaviour-based Design

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1. Introduction

Haemodialysis is a treatment that removes excessive body fluid and waste through the blood vessels to prevent kidney deterioration. Haemodialysis patients must visit hospital three times a week to be dialysed, and each dialysis session takes about four hours. The accumulation of fluid in the body increases the amount of dialysis required, which may adversely affect patient health and post-dialysis prognosis. Since water accumulating in the body within a few days is considered equal to weight gain, it is very important for haemodialysis patients to manage their weight during the inter-dialysis period. However, many patients have a trouble doing so. According to Kim and Kim (2015), patients are aware of the importance of weight management, but 74.6% expressed facing difficulties with this task.

To help chronic patients manage weight, the medical community has attempted to develop various clinical programs. For example, there have been studies on exercise programs for haemodialysis patients (Painter, Carlson, Carey, Paul, & Myll, 2000; Parsons, Toffelmire, & King-VanVlack, 2006) and a study on a nurse-led management program for haemodialysis patients (Tao, Chow, & Wong, 2015). However, there still exists a limitation in that these approaches have focused more on how medical specialists could support patients rather than on how patients could care for themselves. Medical specialists cannot care for patients all day long. Therefore, self-management by patients is necessary for continuous management in daily life. Because self-management indicates that patients care for their own health in daily life (Clark et al., 1991), what really needs to be understood are the problems that patients face every day and the measures that put in place to help them overcome the problems themselves.

The approach to solve patients' problems from their point of view is similar to the user-centred approach in design. Patients' needs from their perspectives can be identified through design research using user-centred design methodology. Since haemodialysis patients remain in a particular environment for haemodialysis, a user-centred approach through design research will help deepen the understanding of their experience. The area of health behaviour, including weight management, has been well researched in psychology. Many kinds of theories, such as self-efficacy theory (Bandura, 1977), theory of planned behaviour (Ajzen, 1991), and the transtheoretical model (Prochaska & Velicer, 1997), have been previously suggested and validated. It has also been established that health behaviour programs and interventions based on health behaviour theories are effective in changing the health behaviours of subjects (Dunn & Elliott, 2009). Therefore, in the beginning of the design process, extracting user needs based on theories of health behaviour change as well as user-centred design methods will enable effective design, while satisfying the in-depth needs of haemodialysis patients.

The aims of this research are, first, to identify the specific behaviours of haemodialysis patients regarding self-management of weight based on health behaviour theory; second, to establish a model which translates the psychological understandings about patients' behaviour into the design domain to lead to patient behaviour change; and finally, to propose

design strategies for inducing self-weight-management behaviours for haemodialysis patients based on the model.

For this study, first, the literature on behaviour theory was reviewed to select the appropriate theory for analysing data from this research. Subsequently, semi-structured in-depth interviews with new haemodialysis patients were carried out using a probe toolkit. Three coders coded the interview data according to the factors of the HAPA. The coded results were classified and reorganised as a health behaviour process model focusing on haemodialysis patients and self-weight-management behaviour. Finally, the design directions were discussed and extracted based on the major findings of the interviews.

2. The Health Action Process Approach for Analysis

In the field of design research, many researchers have tried to induce behaviour change in users based on behaviour theories. For example, De Vries, Truong, Kwint, Drossaert, and Evers (2016) developed a crowdsourcing message technology for provoking exercise based on the Transtheoretical Model (TTM, Prochaska & Velicer, 1997). He, Greenberg, and Huang (2010) developed an energy-feedback technology for inducing energy-saving behaviour based on the TTM. In addition, Consolvo, McDonald, and Landay (2009) proposed theory-driven design strategies for incorporating persuasive technologies (Fogg, 2002) into lifestyle behaviour change based on Presentation of Self (Goffman, 1959) and Cognitive Dissonance Theory (Festinger, 1962), and they developed the system UbiFit Garden using their strategies. However, many of these studies specifically focused on how to design interventions in a certain phase, especially the motivational phase, of the behaviour change process.

In this study, the understanding of users' weight-management behaviour as well as the application of design for behaviour change was studied based on behaviour theory. For the purpose of this study, a new type of theory, the HAPA (Schwarzer, 2008), was selected and used as a coding scheme for analysing the interview data. There were three criteria for selecting a behaviour model: 1) how appropriate the model is for finding the factors that affect the weight-management behaviour, 2) how appropriate the model is for finding new possibilities of design interventions in behaviour change process in this study, and 3) how appropriate the model is for understanding the target user's behaviour.

The HAPA model was deemed best for satisfying the selection criteria for three reasons. First, the HAPA has well-defined factors that are important in the overall process of behaviour change, compared to other behaviour theories which focus on a single factor, such as the theory of planned behaviour, self-efficacy theory, and protection motivation theory (Rogers, 1975). The well-defined factors of the HAPA are helpful in determining factors that should be considered when analysing interview data and designing products or services for haemodialysis patients. Second, the HAPA is useful for explaining haemodialysis patients' behaviour change in a step-by-step process, so that it can be possible to design better inducing behaviour change systematically. Last, the HAPA has been found to be useful

in studying the health actions of middle-aged and elderly patients suffering from chronic diseases (Schwarzer, Lippke, & Luszczynska, 2011). Haemodialysis patients are also classified as patients with chronic disorders, and they require correct behaviour with respect to weight control, diet, and exercise. These requirements are generally similar to those of people with other chronic diseases. Therefore, the HAPA was considered appropriate for haemodialysis patients.

The HAPA model can be interpreted as having three stages of behaviour based on intention and action (Schwarzer et al., 2011). People who have not yet formed an intention can be seen as preintenders, and people who have formed an intention without taking action can be seen as intenders. People who already have taken action can be seen as actors. Self-efficacy, outcome expectancies, risk perception, and other barriers and resources, such as social support, affect each stage.

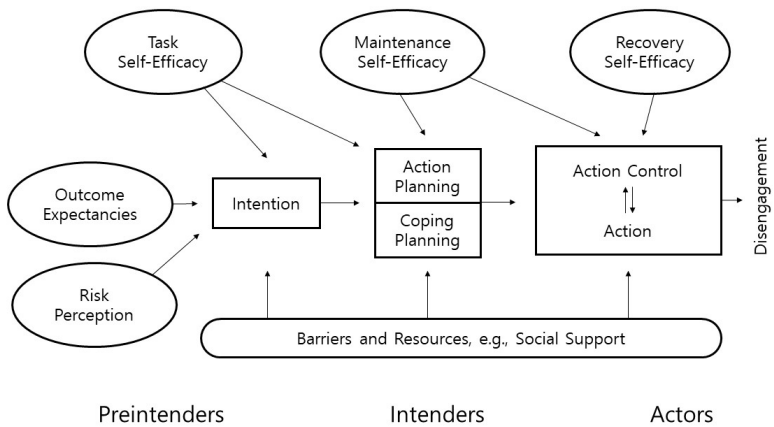

Figure 1 The health action process approach (HAPA) (Schwarzer et al., 2011)

Self-efficacy is people's confidence about their own ability, and it basically affects all three stages of behaviour process. It is classified into three types: task, maintenance, and recovery self-efficacy, depending on which challenges people face at each stage. Task self-efficacy is a personal belief that any task can be carried out on its own, even if it is difficult. Maintenance self-efficacy is related to a belief that one can continuously perform a task even if it is tiring. Recovery self-efficacy is the belief that one can try several times even if one cannot achieve a task.

The process of the health action is as follows. In the preintender stage, outcome expectancies and risk perception as well as task self-efficacy affect intention formation. Outcome expectancies are the predictions of the result of behaviours. Outcome expectancies, such as 'If I walk around for an hour, then I will be able to lose weight', are estimated based on an expectation of positive results for behaviours. Risk perception is a recognition about a risk situation, such as 'my kidney has a problem'. Outcome expectancies, risk perception, and task self-efficacy are compounded to form an intention, such as 'I should control weight by eating

less and exercising more'. After forming an intention, people enter the intender stage. They plan to turn their intention into action. People may plan actions, such as 'I will check my weight before and after I eat', but if they fail in taking action, then they can set up a new plan to overcome the failure. This is coping planning, which can be expressed in a statement, such as 'I often forget to check weight, so I'll set an alarm'. Task self-efficacy and maintenance self-efficacy also affect planning behaviour. After people carry out a planned action, they are in the actor stage, and it becomes important to control the action so that they can continue to take action for a long time or periodically. In this stage, maintenance self-efficacy and recovery self-efficacy affect their control ability. Depending on an individual's circumstance, the overall process can be influenced by other factors. The HAPA model suggests that social support like family is another major influence.

3. Weight-Management Behaviour and Needs of Haemodialysis Patients

To understand the self-weight-management behaviour of haemodialysis patients, semi-structured interviews were conducted with a probe toolkit. The data obtained through the interviews were coded using the HAPA model as a coding scheme, and user needs were identified through this analysis process.

3. 1. Participants

Our target subjects were new haemodialysis patients who had received haemodialysis for less than a year. Their life patterns and dietary habits should be changed a lot along with the changes from life without dialysis to life with dialysis. Therefore, they are most in need of changing their behaviour for weight management, and they will have their unique and typical behaviour that is different from other normal dieters.

We individually interviewed four participants in depth to explore and understand their unique and typical weight management behaviour. We determined that the number of four would be sufficient to extract insightful results. It is because the treatment of haemodialysis has a substantial impact on patients' overall lifestyle, which makes their weight management patterns typical. Basically, they are provided with the guidelines about their healthcare, including diet, based on identical medical knowledge. They also have to visit the hospital regularly about three times a week for dialysis and four hours for each visit, which also greatly affects their life patterns. Based on these points, it was presumed that they have their own unique behaviour features for self-weight-management in the sense of their motivation, the root of risk perception, the difficulties, and the solutions they have found. It is clearly distinguished from those of other dieters who don't have any serious problems. Due to the very typical nature of the patients' weight management patterns, four interviewees (two males and two females) were deemed sufficient to represent the patients' needs and reveal insights.

The four patients had received haemodialysis for three, five, six, and ten months, respectively.

They were between their 40s and 50s, and the sex ratio was half and half (Table 1). They were recruited through a domestic web site for kidney disorder patients. In the case of P4, the mother of P4 also participated in the interview. Interviews were conducted at a place where they felt comfortable, such as their houses or cafés or the restaurant run by one of them.

Table 1 Basic Information of Interviewees

Participants	Years	Gender	Age
P1	3 months	Female	51
P2	10 months	Male	43
P3	5 months	Male	45
P4	6 months	Female	41

3. 2. Interview Questions

Interviews were conducted to identify the hidden and underlying needs of the participants. In order to identify their deepest intrinsic needs, we used the 'five-whys' technique (Reid & Smyth-Renshaw, 2012). Further, a probe toolkit was used to allow them to be aware of and express their needs that are unmet, unarticulated or even unknown (Mootee, 2013). The kit was used to help invoke participants' memories and remind them of their specific behaviours at a certain time and space. The kit consisted of two tools, addressing 'time' and 'space'. The first tool was a timetable (Figure 2(a)) that reminded the participants of their personal experiences according to 'time'. The second tool reminded them of memories related to 'space' based on cards with general living products and specific places in the home, such as the living room and kitchen (Figure 2(b)). Participants looked back at their usual behavioural patterns by creating a timetable and explained in detail how their house structure looked, where a scale was placed, and when they measured their weight by using space-product cards.

Figure 2 Probe Toolkit: (a) Time table (first) (b) Space–product cards (second, third)

The questions were mainly about daily life patterns and how the participants manage their weight (weight measurement and behaviour management). First, to help participants actively think about their daily life and their behaviours, probe tools were shown to them. Next, specific questions were asked to understand their underlying needs in the weight

management process, how and when they measure their weight, and what they usually do to manage their behaviour.

3. 3. Analysis Method

The interview data were analysed to 1) identify the patients' behaviours and needs concerning self-management of weight and 2) build a new behaviour process model tailored to the identified behaviour and needs of haemodialysis patients. The analysis was processed in three steps: 1) Transcription, 2) Coding, and 3) Discussion. First, the recorded interviews were transcribed into a total of approx. 9,000 Korean words. After that, the interview transcript was coded using the factors from the stages of the HAPA model as a priori coding scheme (Table 2). There were a total of eight codes, risk perception, positive outcome expectancies, intention, action plan, coping plan, action & action control, self-efficacy, and other barriers and resources.

Table 2 Coding Scheme

Category	Codes
Pre-intenders	Risk Perception, Positive outcome expectancies, Intention
Intenders	Action plan, Coping plan
Actors	Action & Action Control
Others	Self-efficacy, Other Barriers and Resources

The interview data were coded by three design researchers with more than four years of experience in user-centred design research, skilled in qualitative content analysis. The coders categorised bundles of sentences with one meaning into each code. For instance, the following sentences are one bundle of semantic units: "I check my weight once before and after a meal. I compare the weights and I see how much my weight gained for each meal". After the data was coded individually, three coders discussed the parts that did not agree with each other to build final consensus for the final coding result and extract insights related to the health behaviour of haemodialysis patients. As a result of coding, the following numbers of semantic units composed of several sentences were collected for the total of eight codes: risk perception (17), positive outcome expectancies (1), intention (6), action plan (10), coping plan (8), action & action control (23), self-efficacy (8), and other barriers and supports (19) (table 3).

Table 3 Coding Result

Category	Codes	The number of semantic units composed of several sentences
Pre-intender	Risk perception	17
	Positive outcome expectancies	1
	Intention	6
Intender	Action plan	10
	Coping plan	8
Actor	Action & Action control	23
All categories	Self-efficacy	8
	Other barriers and supports	19

For inter-coder reliability, two Kappa coefficients between main coder and other coders were obtained. Nvivo11 was used to calculate Kappa coefficients. The average Kappa was 0.75, signifying substantial agreement (Viera & Garrett, 2005). Through the discussion among three coders, the major findings were extracted for each stage with a focus on developing a more practical and deeper understanding of the experiences of haemodialysis patients. For example, we found that the greatest motivation factor to the haemodialysis patients was risk perception rather than positive outcome expectancy. Patients' responses often refer to their own health risks that may be caused by their actions, rather than anticipating positive outcomes with their own actions. It was also found that the patients' goals were to maintain their current status quo, whereas the goal of normal health behaviour is to make the body better, such as to lose weight or to make a beautiful body. Subsequently, a behaviour change model tailored for haemodialysis patients was constructed, and possible design implications were discussed.

3. 4. Analysis Results: New Classification and User Needs Insights

It was found from the results of the coding analysis that each stage of the HAPA model (preintenders, intenders and actors) has a different function in the self-weight-management of haemodialysis patients: 1) motivation, 2) preparation and 3) action. The three functions could act as major criteria for designing an intervention in patients' behaviour change for. Therefore, the specific features of patient behaviour which need to be considered for fulfilling each function were identified. Finally, a model for identifying the self-weight-management behaviour of haemodialysis was developed. The model consists of three main stages and the key features to be considered in each stage (Figure 3).

3. 4. 1. Motivation Stage

In the motivation stage, users are aware of their health condition and realise that they need to practise healthy behaviour. Usually, a positive 'outcome expectancy' is a strong force in the motivation stage because this stage is about patients' expectancies of their health becoming better. For example, people might have a will to exercise to improve their physical condition. However, for the haemodialysis patients, 'risk perception' was found to be the most important and practical factor. This is because the risk of not managing their weight can lead to a severe deterioration of their health or even death. P3 said, "On the first day of dialysis, I vomited. I fainted on the third day. Such hard experiences forced me to control myself really hard on a diet." As seen from his case, risk perception becomes a strong motivation, a finding specific to haemodialysis patients' self-management of weight.

The factors that drove the haemodialysis patients to perceive risk were generally divided into internal and external factors. The internal drivers were from their own experiences. One type of internal driver was an accidental experience, such as fainting or sudden difficulty taking deep breaths. The other was daily signals from the body. Patients usually have their own way of perceiving risk, such as a swollen face from drinking lots of water or a weak voice. External drivers include indirect experiences of other patients, alerts and advice from experts, and the sense of a crisis from knowledge learned from the media (internet, books, etc.). The design implications of these findings will be discussed in the next section.

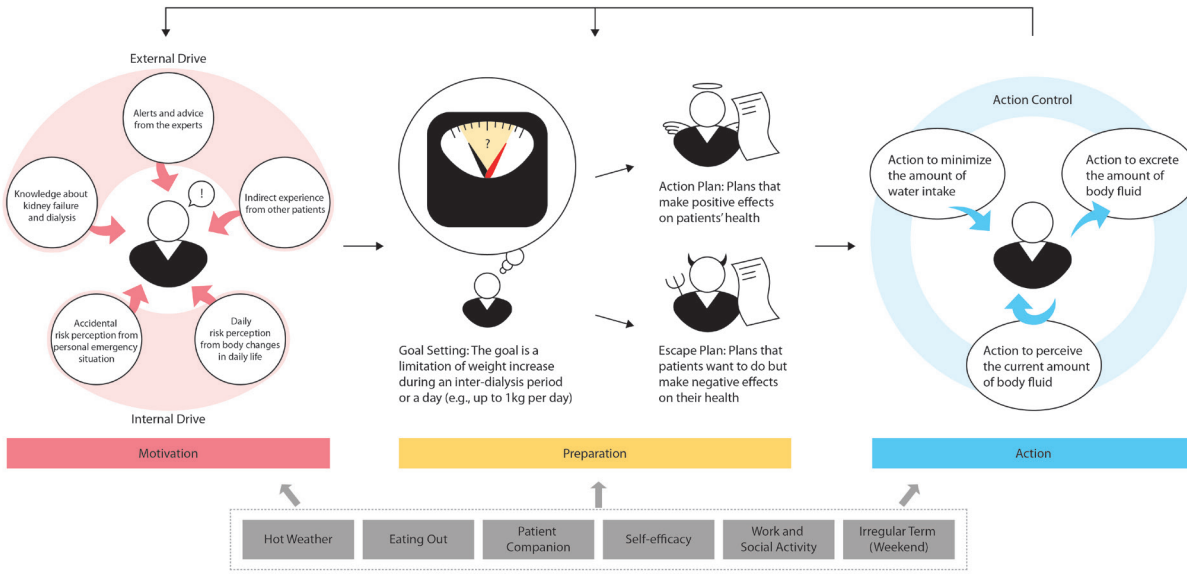

Figure 3 Model of the self–weight–management behavior process

3. 4. 2. Preparation Stage

In the preparation stage, users consider behavioural goals and plan to engage in healthy behaviour. The patients naturally set goals regarding limited of weight gain during the inter-dialysis periods or during a given day. Normal people usually set a goal to move to a healthier state, such as 'I will lose 2kg in a month' or 'I will increase my muscle to lift a 10kg bar'. However, the patients' goals focused on not getting worse than their current state. They expressed goals, such as 'I try not to go over 2kg until the next dialysis' and 'I try to keep my weight gain under 2kg until the next dialysis'.

In this stage, weight measurement is a crucial behaviour for planning action. By measuring weight, the patients could calculate their weight change and infer the relationships between their actions and weight change. For instance, if they repeatedly checked their weight after they eat breakfast, then they could deduce the type and amount of food that affects their weight change. By recognising their behaviours and changes in their weight, they were naturally going through the process of action planning.

The participants were planning action not only for their health, but also for what they wanted to do, even if it had a bad influence on their health. In this sense, plans for negative action were called escape plans. For example, an escape plan could be to drink a bottle of beer, while an action plan would be to take an hour-long walk to get rid of the excess water from the beer. This type of plan is made because the participant wants to achieve both drinking beer and not taking the health risk from it.

3. 4. 3. Action Stage

In the action stage, users put a health plan into action and control the action to complete the goal. Three types of weight-management behaviours were observed in the action stage: 1) behaviour to minimise the amount of water intake (e.g. having ice instead of a cup of water

and low-sodium meals), 2) behaviour to reduce fluid amount (e.g. walking) and 3) behaviour that perceives the current fluid amount (e.g. measuring weight, and observing swelling of the body). The most important behaviours that the patients had practised were those to minimise water intake. This type of behaviour must be constantly practised in everyday life, so patients have to overcome thirst and the desire for delicious food at all times. Therefore, the ability to continuously control their behaviours was an important factor for the patients.

3. 4. 4. Other Factors

Through the whole process, haemodialysis patients were sensitively affected by social activity, medical staff and fellow patients, weather, and their knowledge of the disease.

- Social activity: To maintain social activity, they needed to face some social events, such as dinners with work colleagues, friends' weddings, or eating out with family. Many social events are related to eating something, and this makes it difficult for patients to keep control.

- Medical staff and fellow patients: They also responded more sensitively to warnings from medical staff than social support from family, co-workers or fellow sufferers.

- Weather: The season or weather also directly affects the excretion of fluid because of sweat.

- Knowledge of the disease: Participants' knowledge of the disease also had a significant impact on the overall process. For example, a patient who knows that the more dialysed he or she becomes, the worse his or her kidney will be, may behave differently from a person who depends entirely on hospital treatments.

4. Design Implication

Based on the results of this study, specific weight-management behaviours can be applied to designing an intervention for haemodialysis patients. The research clarified the main factors affecting the behaviours at each stage of the self-weight-management behaviour process. These key factors can be used as key resources for 'behaviour-based design strategies'.

4. 1. Design Strategy 1: Use risk perception as a powerful motivator

In the motivation stage of the self-weight-management behaviour process, risk perception is much more effective for motivating the patient for weight management than positive outcome expectancy, since risks can lead to grave consequences. Factors that raise patients' awareness can be used to lead patients to healthy behaviours. More detail design directions for this strategy are as follows:

- *Design for users to easily recognise the danger signals of the body in daily life.*

Daily body signals like a feeling of heaviness or swollen face give patients risk perception. Therefore, it would be helpful to let patients perceive their own risks with design features that would make them more sensitive to body signals in daily life. To do that, multiple body data sensing techniques could be used to detect small changes, or small changes could be visualised to make them more noticeable. One of the most basic body data sensing tools is a scale. However, the current scale only guides the weight in numbers. Patients must be aware of trivial changes in their body with a very small number of changes of less than 1 kilogram, and always have to do an additional calculation to recognise their weight changes. By simply changing the function and user interface of this scale, patients will be able to more easily recognise their body weight changes. For example, design a scale that calculates and shows the weight differences between a patient's dry weight and his/her current weight. At the same time, it would be helpful to add visual indicators so that patients can notice their changes more easily and intuitively. The solution can be approached in a more persuasive way. In this case, the weight data also can be designed to be shown along with the patient's behaviour pattern. For example, if the weight data can be measured and shown in front of the refrigerator or in the bathroom just before patients eat or after patients go to the bathroom, the data could have a more positive impact when patients take actions or plan next actions.

- *Design features that send a warning signal if the user is negligent in weight management or weight has changed excessively over a long period of time.*

Although it is possible to manage weight temporarily from risk perception, risk perception and motivation would be reduced due to the repetition of behaviour patterns over a longer period of time. Therefore, it is possible to design functionalities which alert patients to be careful if they do not measure their weight for many hours or if the weight data change excessively. A mobile application could be developed to record and track patients' body data changes and give alarms through their mobiles. There are some mobile applications for dialysis patients, but there is still lack of specific applications for self-weight-management of haemodialysis. The mobile applications also should be friendly and easy-to-use to keep them engaged.

- *Design to motivate patients to manage their weight using risk experiences from other patients.*

Risk can also be perceived externally through indirect experience from fellow patients or advice from physicians or the media. In particular, patients are susceptible to a great deal of influence from other patients through short conversations at a hospital, hearing other patients in conversation with medical staff, and experiences from other patients shown in the media, including websites. All interviewees mentioned their fellow patients who did not manage their weight well and stated that they received indirect risk perception from them. Therefore, it would be good if a service were designed in such a way that it could raise patients' risk perception by providing other patients' risk experiences. There are many ways to see and share other patients' experience. One of the possible ways is to utilise the web community site for the dialysis patients. Although it is currently used well for sharing information and personal experience, it would be good to be utilised more actively for risk perception and behaviour change for dialysis patients.

4. 2. Design Strategy 2: Enable a reliable and flexible action plan for successful action

At the preparation stage, all haemodialysis patients had a goal of limited weight gain during the inter-dialysis period or a given day. Their goal was to focus on maintaining their current weight so as not to become worse. This goal was expressed in the form of setting a weight gain threshold. The resulting actions were usually diet or exercise according to the patients' conditions and goals. However, patients sometimes planned for unhealthy but desired behaviour, such as drinking. More detailed directions for Design Strategy 2 include:

- *Design for the patients to have a good action plan for achieving their goal by reflecting their current weight status accurately.*

Patients had their own ways of taking action to keep their goal of limited weight gain. They tended to take immediate actions in response to their weight status at a given time rather than establishing a long-term and continuous plan. They checked their weight by measuring weight using a scale or checking for facial swelling, hence the design examples given above. One possible way is to provide various recommended action lists based on the measured weight data, letting the user know how much they should exercise or how much food intake they can have for achieving their goal. In detail, a mobile application can be designed to continuously record patient behaviour and subsequent weight change data. In other words, when patients take a walk, the application keeps track of how much their weight is losing and can provide a personalised action guide based cumulated data.

- *Design features enabling the patients to have flexible action plans considering variables such as weather and eating out.*

The personal intention is important to weight management. However, the weight-management behaviour is influenced by external factors and circumstances in reality. This is because weight management is directly related to food and water intake that are easy to be influenced externally. For example, patients may drink more water when the weather is hot or eat more food when eating out with friends, which prevents them from self-regulating their desire or overcoming social pressure. Therefore, it is necessary to take into account such barriers in the design of products or services for weight-management in haemodialysis patients, with the ultimate aim of achieving the goal rather than allowing the patients to fail. The design should address recording and managing weight by including not only obvious variables, such as the amount of food and water intake, but also external factors that influence weight, such as the weather and social gatherings. A diary or a calendar can be designed for patients to record their external circumstances or their personal plans. It can help patients to remind their plans and help to plan their meals. If the diary or calendar is in web-based or mobile-based application, then it can actively interpret patients' schedules and suggests their meal plans. If patients have a plan of having dinner out, then reducing the amount of food in advance can be encouraged.

5. Conclusion

This study focused on haemodialysis patients with their own life patterns and unique user needs, which can be a special user group in designing a solution for them. Self-weight-management is a very important and problematic issue for them, but there are not many examples of systematic understanding of their behaviour and analysis of design possibilities from their point of view in the field of design. This study focused on identifying their unique behaviours in order to contribute to design possibilities for behaviour changes in self-weight-management of haemodialysis patients. It is a meaningful research contribution to have highlighted that there is great potential for tackling this problem effectively with a design approach.

Other design studies about user behaviour change mainly focus on new concepts of products or systems for behaviour changes such as 'mobile text messages' (Fjeldsoe, Marshall, & Miller, 2009) and 'social media' (Lee, 2015) as interventions. There are also many studies that try to apply penetrating technologies as a solution to assist in users' behaviour change (Consolvo, McDonald, & Landay, 2009., Fogg, 2002). These design studies are generally included in a later stage of the 'double diamond design process' (Council, 2005). In other words, there are few studies that focus on understanding the behaviour of target users who need to show behavioural change which is a front stage in the 'double diamond design process'. There is lack of understanding of the unique needs of haemodialysis patients in current studies. If some solutions are tried to be developed in a later stage of the 'double diamond design process', patients' behaviour could be simply guessed or user research is likely to be poor. Therefore, this study aimed to build understanding firmly on self-weight-management behaviours of haemodialysis patients.

This paper carried out analysing and understanding the users' behaviours in the user-centred viewpoint. Then, the self-weight-management behaviour model for haemodialysis patients was built based on the understanding. In the model, the specific contents that is related to patients' actual behaviour as well as general behaviour change process were described. Further, the design possibilities of new products and/or services with desirable features for haemodialysis patients were also discussed based on the behaviour model. For example, in the motivation stage, utilising the fact that the risk perception has occurred from an indirect experience of other patients, the purpose of the online community for dialysis patients is to be more actively used to help self-weight management.

For further design studies, two different directions are recommended. First is to study other stakeholders related to haemodialysis patients. This study focused on the perspective of the target user, haemodialysis patients. The study shows that patients are more likely to be influenced by their nurses or doctors, fellow patients, and even work colleagues. Therefore, it is necessary to have an understanding of other stakeholders' perspectives and their situations. By doing so, a holistic view for understanding haemodialysis patients would be achieved, and solutions of a total weight management system for haemodialysis patients could be established based on the understanding. Second is to utilise psychological behaviour

change model for other design methodologies. In the process of this study, user data were analysed based on the HAPA model. The research has demonstrated that using a theory of behaviour change in psychology is appropriate and helpful for systematic design research on medical topics, such as chronic patients' self-health-management. Likewise, psychological behaviour change models can be used in a similar manner in other design studies for an in-depth understanding of user behaviour. For example, the health behaviour process model can be used to analyse the data of other design methodologies, such as diary study or ethnography study (Hanington & Martin, 2012) as well as interview.

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