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Creating Adaptive Clothing for Dialysis Patients

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Abstract

In 2021, more than 1 in 7 Americans, or 37 million people, had chronic kidney disease. Chronic kidney disease is a progression of the loss of kidney function. As kidney disease progresses, the kidneys are no longer able to filter and clean the blood, which can lead to kidney failure. A failure of working kidneys can lead to accumulation of toxic waste, fluid volume excess, high blood pressure, heart disease, stroke, and early death (Centers for Disease Control and Prevention, 2021). If the disease progresses to a total kidney failure, it is fatal unless a kidney transplant or a dialysis treatment is implemented (Mayo Clinic Staff, 2021). Dialysis treatment is used to keep the body in balance by removing waste and keeping a balanced level of chemicals in the blood. One option for dialysis treatment is a hemodialysis procedure. Side effects of treatment include a drop in blood pressure and anemia. Both can cause patients to feel symptoms of coldness and tiredness or weakness.

Because of these symptoms, what a patient wears to treatment are important to their quality of life and treatment. There are very few manufacturers that have adaptive clothing designs for people with disabilities. Because the market for adaptive wear is so niche, the prices are set at whatever the designer and/or manufacturer wants, since the demand is so great. There are also limited apparel options that meet the aesthetical wants and functional needs of people with chronic kidney disease on dialysis, with some patients reporting feeling overlooked by the fashion industry (Kabel, 2017). The purpose of this study is to show how adaptive clothing for dialysis patients can be created to be affordable and stylish.

Introduction

Background and Need

In 2021, more than 1 in 7 Americans, or 37 million people – had chronic kidney disease (Centers for Disease Control and Prevention, 2021). Chronic kidney disease is a progression of the loss of kidney function. The kidneys filter waste and extra fluids from the blood (Mayo Clinic Staff, 2021). As kidney disease progresses, the kidneys are no longer able to filter and clean the blood, which can lead to kidney failure. A failure of working kidneys can lead to toxic waste, fluid volume excess, high blood pressure, heart disease, stroke, and early death (Centers for Disease Control and Prevention, 2021). Treatment is used to slow down the progression of the disease. However, kidney damage can still progress with treatment. If the disease progresses to total kidney failure, it is fatal unless a kidney transplant or a dialysis treatment is implemented (Mayo Clinic Staff, 2021). Dialysis treatment is used to keep the body in balance by removing waste and keeping a balanced level of chemicals in the blood. One option for dialysis treatment is a hemodialysis procedure (Mayo Clinic Staff, 2021).

Hemodialysis is performed with the use of a dialysis machine and a special filter. To access the blood, the doctor will perform minor surgery to get to the blood vessels. Some side effects of treatment include a drop in blood pressure and anemia. Both can cause patients to feel symptoms of coldness and tiredness or weakness (Mayo Clinic Staff, 2021). Because of these symptoms, what a patient wears to treatment are important to their quality of life and treatment. In addition to this, many patients can feel overexposed when having to remove clothing for treatment. Removal of clothing during treatment can be a nuisance, as well as also affect the quality of life during treatment.

Problem Statement

Currently there are very few adaptive clothing options on the market. Dialysis patients must factor in vascular accessibility, comfort, and cost when choosing what to wear to treatment. Choosing what to wear during treatment can affect the quality of the treatment, in terms of comfort. Due to the need for vascular access during the treatment, long-sleeve options are not ergonomic for patients. However, short-sleeved clothing can lead to discomfort due to the side effects of treatment. Finding adaptive clothing for these specific needs can be both difficult and expensive.

There are very few manufacturers who have adaptive clothing designs for people with disabilities. Because the market for adaptive wear is so niche, the prices are also essentially set at whatever the designer/manufacturer wants, since the demand is so great. In 2015, on average, Americans spent around $1,700 on clothes per year, which is about $142 per month, (Johnson, 2015). An example of adaptive clothing for this market is the brand HemoWear. They carry adaptive clothing for dialysis patients. On average, the price for a zip-up hoodie is around $60. For just one piece of clothing, that is almost half of what the average person would spend on clothing in a month. In addition to the steep price, the variety between styles is minimal. Many of the hoodies and shirts come in only solid colors and no prints. Fashion should be inclusive for everyone, and part of fashion is about expressing oneself.

Purpose of the Study

The purpose of this study is to show how adaptive clothing for dialysis patients can be created that is affordable and stylish. In addition, the adaptive clothing should be functional in thermal and stain-resistant properties and easy vascular access during treatment.

Research Objectives

The following research objectives guided this study:

- Identify the aesthetic and functional needs and wants of hemodialysis patients.
- Design and develop two sweatshirts with an adaptable and functional closure to be used during treatment.

Literature Review

There are limited apparel options that meet the needs and wants of people with chronic kidney disease on dialysis, with some of the patients reporting feeling overlooked by the fashion industry (Kabel, 2017). Many studies have found different needs for accommodations, which will affect the design of the overall garment (Carroll, 2010). This review of literature will discuss the most recent and relevant studies related to these areas: an overview of chronic kidney disease, hemodialysis accommodations, and the current market for adaptive clothing.

Chronic Kidney Disease

Chronic kidney disease affects nearly 1 in 7 Americans. Chronic kidney disease involves a loss of function of the kidneys and over time they can become damaged and can no longer clean the blood or filter out toxins. A lack of filtration can cause dangerous levels of fluid, electrolytes, and wastes to build up in the body (Mayo Clinic Staff 2021). Advanced chronic kidney disease can lead to total kidney failure chronic kidney disease is more common in people

ages 65 and older. It also has a slightly more chance of occurring in women (14%) than in men (12%). Chronic kidney disease is more common among non-Hispanic Black (16%) compared to Hispanic (14%), non-Hispanic White (13%) and non-Hispanic Asian (13%) adults. Treatment for chronic kidney disease can help control the progression of kidney damage, usually by controlling the cause of the damage. However, controlling the cause of the damage does not necessarily keep the damage from progressing. Chronic kidney disease can progress to total kidney failure, which is fatal unless a transplant or treatment is implemented (Mayo Clinic Staff, 2021).

Hemodialysis Procedures

Hemodialysis is the most common form of treatment for kidney disease, which involves diverting blood into an external machine, in which the blood is filtered and then returned to the body (U.S. National Library of Medicine, n.d.). However, many side effects and barriers can come with this treatment. Recent studies have found patients receiving hemodialysis have challenges in finding adaptable clothing. To access the blood, to be cleaned and filtered, there must be access to the veins. There are three types of procedures that doctors can perform. A physician will place either an arteriovenous (AV) fistula, AV graft, or a central venous catheter (U.S. National Library of Medicine, n.d.). A central venous catheter is either placed in the neck, chest, or upper leg. While the AV fistula or the AV graft is placed in the lower forearm (U.S. National Library of Medicine, 2019). At the start of treatment, a dialysis nurse or technician places two needles, each needle is then attached to a soft tube connected to the dialysis machine. The dialysis machine pumps blood through the filter and returns the filtered blood back into the body. Treatment lasts for around four hours, three times a week (U.S. Department of Health and Human Services, n.d.). To access the area where the needles are placed, patients must remove clothing from the area. Short-sleeved t-shirts, and sleeves that can be moved can be worn during

the procedure. However, if a catheter is placed, then a greater clothing accommodation may have to be made to access the area.

Hemodialysis Side Effects and Potential Clothing Accommodations

High blood pressure is a common complication for patients who have chronic kidney disease, and it is common that they need to be treated with antihypertensive medications. In general, people could feel colder when taking antihypertensives. A common side effect of hemodialysis is feeling cold at the time of the treatment. This happens because at any given time they have less blood circulating in their body since part of the blood will be going through the dialysis machine. This happens because a common side effect is low blood pressure (Hypotension) during the treatment. The blood pressure tends to go up once the treatment is completed. Medicine to treat high blood pressure can cause patients to feel cold. In addition to this, the blood circulating in and out of the body can cause the patient to feel cold, which can be uncomfortable for the patient (Mayo Clinic, 2021). Studies have also found that patients on dialysis for 5 years or more had significantly lower weight and skinfold thickness than those on dialysis for less than five years. Researchers also found that dialysis patients tended to be short, lighter, and have less adipose tissue than healthy people of their age (Chumlea, 2004).

Studies have examined clothing issues and physical limitations in the product development process. The findings in the study include consumers with limb/outer extremity problems who need enhanced dressing assistance built into their clothes. Dressing assistance was operationalized as fastenings and donning/doffing. New products that incorporate improved design, functionality, and materials performance would help meet the needs of all people with disabilities (Carroll & Gross, 2010).

According to Lopes et al. (2014), when studying the correlation between depression symptoms and quality of life, they found that patients who needed more time to recover from hemodialysis, had a lower Health-Related Quality of Life score, and the probability of depression was higher. Results from the study also suggest that the possibility of symptoms that represent a great burden for hemodialysis patients contributes to the need for time to recover from the hemodialysis session.

Stain Resistant Textiles

During dialysis, patients experience staining on their clothing, either from the solution leaking or from bleeding from the IV being placed or taken out, "Ann explained that her late husband never wanted to wear anything nice during treatment because they used heavy-duty cleaners with his catheter, which caused bleach-like stains" (McAndrew, 2020, pp. 8). Many patients wear cheap clothing, dark colors, or clothing they did not care about, in case of bleeding. Studies have found that certain chemicals used as fabric finishes have prevented blood staining from happening. Often used in the medical field for hospital wear, research has found that "the fabric needs to have a lower surface tension than blood and body fluids whose surface tension ranges in between 42 dynes/cm and 60 dynes/cm to produce water repellency" (Bhargava, 2018, pp. 31). Bhargava found that various classes of chemicals have been used to impart blood-repellency to the fabrics, and fluorochemical polymers are most prominently used as blood and water-repellent finishing agents.

Patients' Experiences with Clothing and Hemodialysis

The current market lacks in providing adaptive clothing that meets the needs and wants of hemodialysis patients, according to recent studies. In exploring the experiences and feelings of people on dialysis, a better understanding of dialysis treatment was uncovered. McAndrew

(2020) found several clothing barriers, and discovered that many patients had their everyday clothes, and then their 'dialysis uniform'. Patients also described having trouble finding clothing that would keep them warm while also having easier vascular access for the dialysis procedure. In addition to this, studies found that there are limited apparel options that meet the needs and want of people on dialysis, with some of the patients feeling overlooked by the fashion industry (McAndrew, 2020). Being adaptable means being versatile. Current adaptable clothing should not be for treatment only, it should be versatile enough to allow patients to wear the garment during day-to-day activities. Adaptive clothing should be functional and meet the aesthetic wants of patients. Studies found that 64% of participants indicated that apparel issues have made them feel embarrassed or humiliated (McAndrew, 2020). One participant reported "Although my mother is [in] a nursing home where everything frankly has no style, this is not her norm. She always dressed very well until it was too difficult to find clothes that fit and are functional… Things tear so you don't want to spend lots of money for something to be ripped but all she can now wear are loose t-shirts and baggy pants which just make her feel worse" (McAndrew, 2020, pg. 166). Overall, the response to the study supports the argument that clothing is an important aspect of attaining the desired quality of life and level of social engagement for people living with disabilities (Kabel, 2017). Not only are functional aspects important, but aesthetic needs are also important for patients.

Comparing Adaptive Clothing Costs.

When designing apparel for hemodialysis patients, it is important to keep in mind financial needs as well. The Bureau of Labor Statistics found that on average Americans spend $1,700 on clothes annually. They also were able to compare data from the 1930s to now. They found that "In 1930, the average American woman owned nine outfits. Today, that figure is 30

outfits — one for every day of the month" (Johnson, 202, pg. 2). Figuring out how much Americans are willing to spend on clothing and what their clothing needs and wants are can help determine the price range for each garment. A current brand on the market, "HemoWear" promotes its mission to design, manufacture and deliver customized clothing for dialysis patients (HemoWear, 2021). Prices range from $27 for a T-shirt to $65 for a microfleece jacket. One jacket is nearly half of what Americans spend on average during a month on clothing.

Relationship between Clothing and Self-Concept or Identity.

In 1953, author Thorstein Veblen was one of the first writers to suggest that clothing did more than protect the body (Veblen, 1953). His early theory of fashion consumption suggests that clothing and fashion are often used to communicate social class or wealth. Veblen (1953) found that people often make judgments on other people's wealth or status based on what they are wearing. Clothing also serves to allow cultures to communicate with both members of the community and others. It is a social process that creates cultural meaning and is part of the basis of our social communication interactions. We communicate through our clothes. What we communicate through our clothes can help contribute to an individual's sense of who we are. Fashion can help communicate our internal feelings and our concept of ourselves.

Clothing can play an important role in self-expression, communication, and quality of life. Patients are experiencing barriers to selecting clothing and report feeling overlooked by the fashion industry (McAndrew, 2020). For dialysis patients, many accommodations need to be made for apparel to be functional during treatment, which will affect the overall design of the garment. Adaptive clothing should be versatile and inclusive and should not only meet patients' functional needs but aesthetic needs as well. Creating a garment that can meet these needs may help improve treatment for a patient, and the quality of both the treatment and the life of a

patient. Addressing these needs is vital in the design and production process. Studies have found that adaptive clothing on the market right now has failed to meet a culturally defined threshold of acceptability, creating new obstacles for men and women facing headwinds of prejudice and ableism (Kabel, 2019). According to Kabel, some patients feel as though these specifically made adaptable garments draw attention, further leading to ableism. When designing the garments, it will be vital to keep a design in mind that can be worn for both treatment and everyday life.

Development Plan

Chronic kidney disease affects nearly 15% of adult Americans. Advanced chronic kidney disease can lead to total kidney failure. However, people with chronic kidney disease have different treatment options, although many patients experience limitations and side effects with the treatment. During hemodialysis, patients need adaptations to their normal daily garments to accommodate treatment side effects. During treatment, there needs to be vascular access, and normal clothes cannot accommodate this need.

Based on feedback from hemodialysis patients, an initial development plan was made for the design of the sweatshirts. The garments were made with the respondents' desires for accommodation during dialysis treatment. The prototype was created to test the closure method and aid in figuring out what alterations were necessary on the sweatshirt pattern. The final garment fit was designed with the creation of the garments that are most functional to meet aesthetic needs in the end results.

The adaptive garments created also needed to accommodate the ability to keep patients warm during treatment, while also meeting the aesthetic wants of patients. Testing of the garment fit helped understand what alterations were needed.

The following steps were created for the development plan to create two prototype sweatshirts.

1. Developed a survey to understand the aesthetical wants and functional needs of adaptive clothing.
    a. Developed questions that targeted what accommodations patients needed in their clothing for vascular access, the accessibility issues related to standard garments during dialysis treatment, and patients' feelings regarding the current market of dialysis clothing.
2. Development of the Design
    a. Closure Methods Research
        i. Identified which closure method is most applicable by testing different mock-ups.
    b. Determined necessary supplies and purchased fabrics, thread, etc. needed and selected from different closure methods, including zippers, magnets, snaps, hooks and eyes, Velcro, etc.
    c. Determined current fabric considerations including stain-resistant fleece, or flannel. The current market is made up of mostly solid-colored fabric (HemoWear, 2021).
    d. Drafted patterns, based on patient feedback, mock-ups, and closure and fabric research.
        i. Drafted patterns that included the selected closure method. Also, considered patient feedback on wants and needs during the design processes.

3. Construction of sweatshirt #1

    a. Created an opening in the sleeve for vascular access.

    b. Added an adaptable closure that patients can close on their own.

    c. Based on mock-ups, a closure method was chosen due to being the most efficient and effective. The chosen closure methods included an opening in the arm underarm seam and a chest port, closed by using an invisible zipper.

4. Construction of sweatshirt #2

    a. Created an opening in the sleeve for port access.

    b. Added an adaptable closure that patients can close on their own.

    c. Based on mock-ups, decided which closure method is the most efficient and effective. Opened the raglan sleeve front seam and inserted the specified closure.

5. Garment wear testing

    a. Solicited patients to wear test the garments.

    b. Analyzed the placement of each closure and fit of the garment.

    b. Altered the garment based on the feedback of patients.

    c. Patients were refitted with adjusted garments.

Content Analysis

The current market for adaptive clothing for dialysis patients is very limited. Hemodialysis Dialysis Central, a program operated by the nonprofit Medical Education Institute (MEI) features multiple brands that sell adaptive clothing for dialysis patients. Of the brands featured, three brands carry some version of a hoodie or jacket. As of February 25th, 2022, the brand, “RonWear”, is sold out of the jackets they sell (RonWear, 2022). “HemoWear”, one of the top brands when searching for “adaptive clothing for hemodialysis patients", sells adaptive

jackets and hoodies on their website (HemoWear, 2022). The hoodies featured are all solid colors and prices start at $50 and go up. Jackets are also all solid colors and are priced at $40 and up. Both their hoodies and jackets feature a zipper function in the arm. The brand, “Ivye”, sells an adaptive jacket for $44.95, and is sold in blue, gray, and pink (Ivye, 2022). In addition to these brands, there are also several sellers on Esty who sell adaptive hoodies and jackets.

Methodology

The data collection for this study involved three stages 1) A pre-survey to understand the aesthetical wants and functional needs of adaptive clothing. 2) A mock-up was created based on the results of the pre-survey. 3) A garment fit test to understand what aspects of the adaptable clothing prototype the patients liked and disliked. The data collected was taken from an online survey consisting of questions that determined what patients wore to treatment, and how they felt about the current market for adaptable clothing. All participants were female and currently undergoing dialysis treatment. Questions included asked about demographics, garments currently worn during treatment, and concerns with the current market for adaptable garments. A total of 18 respondents filled out the survey, with 10 usable responses. In the second stage of this study, two prototypes were created based on the results of the pre-survey. For this study, two sweatshirts were created. Due to the availability of fabrics on the market, a normal non-stain-resistant fleece fabric was used to create the mockup in a size small/medium. The first sweatshirt included an invisible zipper in the underarm seam. The sleeves of the sweatshirt are a different color from the bodice of the sweatshirt, to add color blocking, created with a ribbed fabric. The second sweatshirt also included invisible zippers but for access to a port placed in the chest. This sweatshirt included a light blue fleece for the bodice and the sleeves and a dark blue ribbed knit to create some color contrast in the design. Both designs had raglan sleeves, rather than the

traditional inset sleeves. This design choice was made with the intention of creating an opening for those who use a port in their chest during treatment. Once the mock-ups were created, a garment try-on test was then completed. Participants who selected they would volunteer in a garment try-on test in the pre-survey were recruited to try on both mock-ups. All participants, female, were then asked what they liked and disliked about each of the mock-ups through an online post-survey. The age range of subjects that participated in the fit evaluation process was 25-70+ years. All 10 subjects that had usable responses were females. Eight subjects were white, one was Black/African American, and one selected "other". The entire data collection process was reviewed and approved by the IRB from the University of Arkansas.

Figure 1 Original port placement

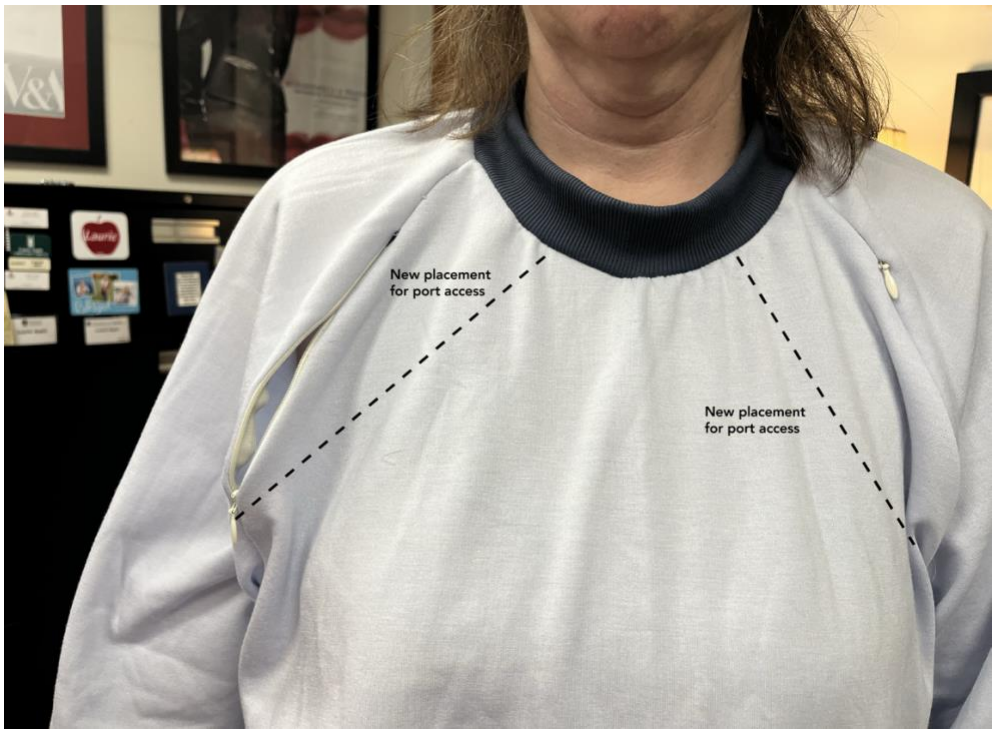

Figure 2 New placement for port access

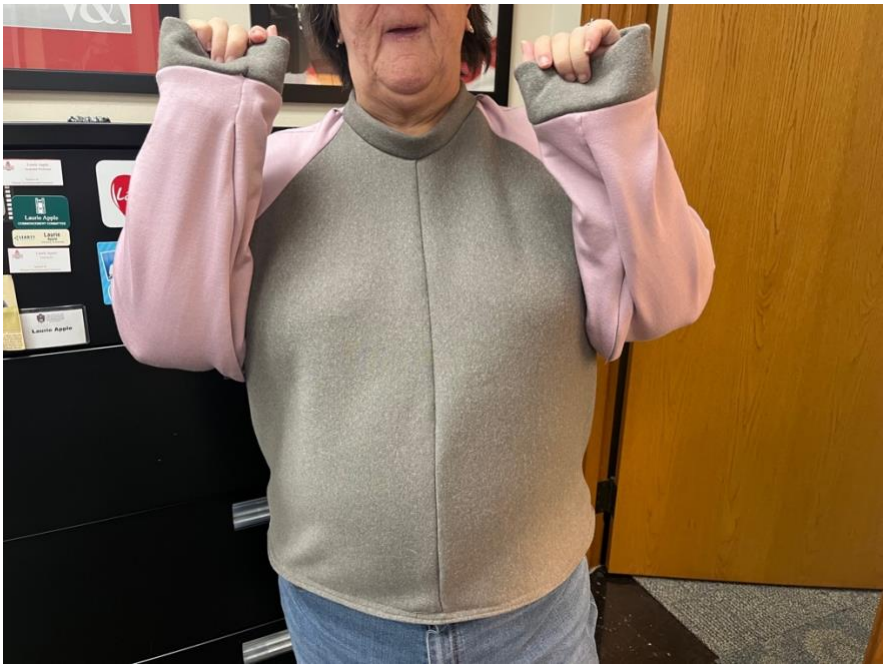

Figure 3 Sweatshirt with sleeve seam opening

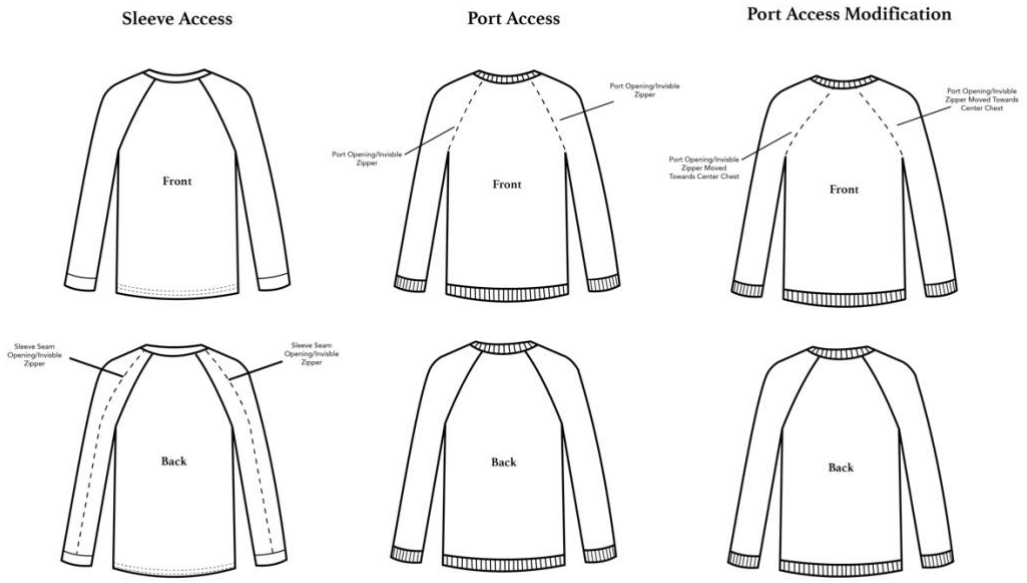

Figure 4 Flat Patterns of Sweatshirt and Modifications

Figure 5 Cut out fabric for garment construction.

Results

Questions from the pre-survey asked subjects questions related to functional needs and aesthetic preferences for adaptive clothing and current clothing worn to treatment. When asked how often they deal with staining, 40% indicated “sometimes”, 9% selected “most of the time”, 20% selected “often”, 10% selected “always”, and 30% selected “never”. When asked if they do deal with staining, and how they treat stains, several answers were recorded. One participant said, “Rinse in cold water then apply stain remover, wash in cold water.” Another said, “Presoak”, one said, “Water and stain stick”, and another person said, “Soak in detergent water. Peroxide.” and the last person said, “I use Shout®”. When asked if they wear print or solid clothing, 64% of participants indicated they wear “mostly solids” and 36% said they wear “both”. Subjects were also asked about the fit of the clothing they wear and 74% said they wear baggy clothes, and 27% selected “other”. When selecting “other”, participants said their clothes were, “not tight, but not baggy” and “somewhere between tight and baggy”. When asked about the color of clothing, 81% said they do not wear a particular color to treatment, while one person indicated they wore dark colors and one person said they wore orange.

Subjects were also asked, “Have you found difficulty in finding appropriately sized clothing for yourself, specifically adaptable garments?” Responses included eight subjects saying no, and one person saying, “I’m just a petite so it’s a weird in-between”, one person saying, “Plus size-seems to be too generic, and baggy in wrong areas”, and the last person saying “Adaptative clothing and warm and weather appropriate”. Patients were then asked about adaptive clothing. When asked, if they would be willing to pay more for a garment that allows access to the IV opening//infusion site, 46% said yes, 36% said maybe, and 18% said no. Patients were also asked if the clothing they wear to treatment ever causes them embarrassment or

humiliation, eight subjects said no, one person indicated they “muffin top hanging over” and another said, “I had to cut my shirts”.

Participants were asked if they had any other concerns related to apparel needs for dialysis treatment. One subject responded “Need long sleeves that can access AV Fistula in the left arm but not cover the arm so much that the staff can't see the arm. Patients get very cold during dialysis. Maybe sleeves with zippers from shoulder to wrist.” Three subjects indicated that they needed the ability to stay warm without having to remove garments if they overheated, or without having~~2w3~~ to wear t-shirts in the winter. At the end of the pre-survey participants were asked if they would participate in a garment try-on test and 6 people said yes and 3 people said no.

After the pre-survey responses were collected, a garment wear test was conducted. We had two participants take part in the test, and each subject wore either the sleeve access mock-up or the port-access mock-up. When asked if the garments met expectations, both subjects said yes. They were also asked if they liked the color and fit of the garment, and both said yes. When asked if the sizing was correct, one subject indicated no, but then both said yes when asked if the fit was correct. Both subjects indicated that the opening was large enough for IV access and said they would pay $30-$35. The idea of moving the port access more toward the chest was also suggested.

A final wear test was also conducted to make sure the angle of the port access was correct. The final garment included a sweatshirt that had both arm and port access, with the results from the pre and post surveys in mind.

Conclusions and Discussions

Chronic kidney disease occurred in more than 1 in 7 Americans, or 37 million people in 2021(Centers for Disease Control and Prevention, 2021). As kidney disease progresses, the kidneys are no longer able to filter and clean the blood, which can lead to kidney failure. A failure of working kidneys can lead to toxic waste, excessive fluid volume, high blood pressure, heart disease, stroke, and early death (Centers for Disease Control and Prevention, 2021). If the disease progresses to total kidney failure, it is fatal unless a kidney transplant or a dialysis treatment is implemented. (Mayo Clinic Staff, 2021). Patient undergoing hemodialysis treatment may benefit from wearing cost-effective clothing that provides comfort and easy access to the vascular site. The current market for adaptive clothing for dialysis patients is slim and selective.

The results of this study present two sweatshirts that are made adaptable for those who are going through dialysis treatment. Both sweatshirts offer both the functional needs and aesthetic preferences patients indicated they had regarding the clothing worn during treatment. These sweatshirts provide options for dialysis patients that are not currently available on the market. Given the lack of adaptive clothing on the market for dialysis patients, it is critical that steps are taken to make adaptable clothing more accessible and more functional for wearers.

Limitations and Future Research

For this study, the research was limited to the number of participants who completed the survey. Out of 18 participants, only 10 of the responses were reusable. Furthermore, only two people were able to participate in both wear tests. In addition to this, during the design stage, the fabric chosen for the mock-ups was limited. Due to the lack of availability of stain-resistant fabric on the market, the mock-ups were created with normal fleece and ribbed fabric. For future

research, it is recommended to create more garments. It is also recommended that more subjects participate in the wear test and that it is worn and tested during treatment.

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