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The Use of Scalp Cooling for Chemotherapy-Induced Alopecia

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Abstract

The side effect of hair loss impacts many patients undergoing chemotherapy around the world. Alopecia can impact a person's overall well-being and self-esteem. This thesis explores the use of scalp cooling in patients to reduce chemotherapy induced alopecia. Additionally, this thesis examines effectiveness, adverse effects, financial needs, treatment specifics, and age limits of these cooling treatments. The research consists of a literature review of qualitative and quantitative research databases to address unknown information. The scalp cooling treatments are seen to have a positive outcome on reducing hair loss due to chemotherapy with minimal side effects. This thesis also presents specific details about the treatments and important factors that affect the outcome for patients.

Keywords: Scalp cooling, effectiveness, side effects, financial costs, length, age limit

The Use of Scalp Cooling for Chemotherapy-Induced Alopecia

Background

One of the leading causes of death in the world is cancer. “In the United States alone there were estimated to be 2 million new cancer diagnoses in the year 2023, with over 600,000 deaths related to cancer” (Siegel, 2023). Almost everyone has been affected by cancer in some form. Whether that’s watching a family member, friend, colleague, or yourself struggle with this disease. Cancer can take a major toll on a person physiologically and psychologically.

To treat cancer the most used drug treatment is chemotherapy. This treatment has very powerful chemicals within it that will kill fast-growing cells within the body (Mayo Clinic, 2022). Cancer cells grow and multiply faster than most cells in the body, making chemotherapy the first line of treatment. Like most drugs, chemotherapy comes with a few side effects. These include nausea, vomiting, diarrhea, pain, easy bruising, fatigue, and alopecia (Mayo Clinic, 2022). The side effects of this treatment can be detrimental to a patient’s self-esteem. One side effect in particular that can harm the patient’s body image and overall disrupt the quality of life is chemotherapy-induced alopecia. Like cancer cells, the hair follicle cells are generated fast, making chemotherapy susceptible to killing them. There is a developing treatment for chemotherapy-induced alopecia, known as scalp cooling.

The scalp cooling treatment has been around since the 1970s but started as putting ice packs on patients’ scalps. It wasn’t until the 1990s when an oncology nurse in Sweden developed a system to reduce hair loss and be controlled in a medical setting (Dignitana, 2022). The system she created was named DiginiCap. The system included a cap that was attached to a cooling unit. The cap that is used can be molded to any type of head shape (Dignitana, 2022). The cooling treatment consists of wearing this cap which will cause vasoconstriction in the scalp. By

causing this vasoconstriction, it will help slow down the intrafollicular metabolism by reducing perfusion of the scalp. This will then lead to chemotherapy not being able to attack these healthy cells, resulting in a decreased amount of hair loss the patient will experience during treatments. The overall goal of scalp cooling is to reduce the amount of hair loss a typical patient experiences, which will then alleviate impaired body image and low self-esteem effects that the patient may experience.

Undetermined Information

Although we know that the scalp cooling caps are designed to decrease the alopecia patients experience during their chemotherapy treatment, the logisicts are still unknown. Previously it was discussed that the scalp cooling device is designed to constrict the blood vessels in the scalp, which will help slow down the intrafollicular metabolism. By the cooling device doing this, it should decrease the amount of hair loss that a patient experiences. The devices physiological function on the scalp is already known, but effectivness, side-effects, costs, length of treatments, availability, and age limits are still undetermined. This paper will discuss the unidentified aspects of scalp cooling treatment and how they may improve the quality of life for cancer patients.

Thesis

The use of scalp cooling is a fairly new treatment and is constantly changing and being improved. Due to the large population of people who suffer from cancer and receive chemotherapy, scalp cooling would be beneficial to many. Numerous cancer patients will express their concern about losing their hair when the discussion of chemotherapy arises. A better understanding of this developing treatment could help the millions of people who are

experiencing the effect that alopecia has on their physiological and emotional well-being. Although we know that scalp cooling treatments are used to help reduce the side effects of chemotherapy-induced alopecia, there are still many specifics of the treatment that have not been identified yet. Is scalp cooling effective in reducing chemotherapy-induced alopecia? What are the side effects of the scalp cooling treatments? What are the financial costs of going through the scalp cooling treatments? How many treatments does one need and how long are each of them? Are there any age limits for the scalp cooling treatment process?

Research Questions

Is scalp cooling effective in reducing chemotherapy-induced alopecia?

The goal of scalp cooling is to reduce the side effect of hair loss that is caused by chemotherapy treatments. This preventative treatment has been used on multiple patients with many different types of cancer and different types of chemotherapy, but how effective is scalp cooling? Does this treatment only work well in patients with certain types of chemotherapy treatments or is it effective for multiple?

What are the side effects of the scalp cooling treatments?

Like many types of treatments in the medical field, there are side effects. These side effects need to be discussed with the patient before they consent to receiving these treatments. What are the adverse effects of scalp cooling and how severe are they? Are there any long-term side effects that the patient may experience after receiving the treatment?

What are the financial costs of going through the scalp cooling treatments?

When it comes to medical procedures many patients get nervous about the financial burden they may experience due to the cost. How much does scalp cooling cost for the patients? Is the cost of the treatments more or less expensive than buying wigs or head covers for the

patient? Are there any grants provided to the patients that can help cover the cost of the treatments?

How many treatments does one need and how long are each of them?

Like chemotherapy, a patient may need to get multiple treatments for the procedure to truly work. How many treatments does one need to reduce the alopecia side effect of the chemotherapy treatment? Is there a specific length of time the treatments need to be to work effectively? Does the length of each treatment vary depending on how many the patient has already gotten?

Are there any age limits for the scalp cooling treatment process?

Cancer is diagnosed not only in adults but also in pediatric and elderly patients. Chemotherapy is also given to these adults, pediatric, and elderly patients. Alopecia can affect the patient's physical and emotional well-being no matter their age. Is the scalp cooling treatment offered to all ages no matter how young or old they are? Are elderly patients suitable for this treatment or are the side effects of this treatment too harsh for this community?

Summary

The treatment for cancer can be harsh on a person's body and psychological wellbeing. By better understanding the use of scalp cooling to reduce chemotherapy induced alopecia, it can increase the overall quality of life for these patients. The unknown information about this treatment will be further discussed in detail because this treatment has the ability to improve the lives of many during their battle with cancer.

Main Research

For this research, qualitative and quantitative research databases will be used in the upcoming sections to provide information from studies that were done while exploring the use of

scalp cooling. After compiling data from these sources, it will address the unknown information that is being questioned.

Is scalp cooling effective in reducing chemotherapy-induced alopecia?

Overall Effectiveness

Use of scalp cooling device to prevent alopecia for early breast cancer patients receiving chemotherapy: A prospective study, was conducted to determine the effectivness of scalp cooling on 135 patients with breast cancer who were undergoing chemotherapy. These patients were all in early-stage breast cancer and received the scalp cooling treatments throughout their course of chemotherapy (Giarratano et al, 2019). The research team would evaluate the degree of alopecia each patient experienced by using the Deans alopecia scale for hair loss. This scale included 4 grades to determine if the patients' treatments were successful or unsuccessful. Grade 1 is considered excellent, with less than 25% hair loss. Grade 2 is considered good, with 25-50% hair loss for the patient. Grade 3 is considered moderate, with 50-75% hair loss. Lastly, Grade 4 was considered poor, with greater than 75% hair loss seen. For this experiment success was considered anything less that 50% hair loss, or a score of grade 1-2 on the Deans scale. An unsuccessful treatment was anything greater than 50% hair loss, or a score of grade 3-4 on the Dean's scale (Giarratano et al, 2019). The patients receiving the scalp cooling treatment were evaluated at the end of three weeks from the start and then reevaluated three weeks from the end of their treatments. At the end of three weeks from the start there was a success rate of 77% (Giarratano et al, 2019). Meaning 104 out of the 135 patients experienced no hair loss from the chemotherapy treatments. The patients were then reassessed three weeks prior to the end of treatment and showed a 60% success rate (Giarratano et al, 2019). When reevaluating the

success rate for the group of patients receiving the scalp cooling treatments, 81 of the 135 patients have had success in the reduction of alopecia experienced.

Another study that researched the effectivness of the scalp cooling treatments conducted a systematic literature review of 12 studies that met specific criteria. These articles were selected due to the high level of evidence, inclusion criteria, and data saturation they possess (Ross & Fischer-Cartlidge, 2017). During the search process for these articles the publication date was not limited, but after the final review of the article's publications within the last 5 years were prioritized. When going through the study's there was a success rate of 34%-93% for the preservation of the patient's hair while receiving the treatments. Cohorts that did not partake in the scalp cooling treatments saw a success rate of hair prevention ranging from 0%-26%. The medium of these articles showed an overall success rate of 83% (Ross & Fischer-Cartlidge, 2017). One of the studies used in this literature review was a single-arm study. These types of studies don't typically have the same strength of evidence that comparative trails do, but this particular study had a large population. For this trial 1,411 patients were studied. Out of this large population, 50% of the patients did not use a head cover during their time of treatment. Meaning half of the population experienced minimal hair loss while taking part of the scalp cooling treatments (Ross & Fischer-Cartlidge, 2017). The other studies that were reviewed for the effectivness of scalp cooling has a successful rate between 10%-100% with most clustering around 50% successfulness (Ross & Fischer-Cartlidge, 2017). This study concluded that there was better hair preservation in patients who received the scalp cooling treatments than patients who did not undergo scalp cooling. The 12 different studies used within this systematic literature review supported the claim that the use of scalp cooling for prevention of chemotherapy induced alopecia is in fact effective.

Effectiveness in Different Types of Chemotherapy

Another study, *Sensor-controlled scalp cooling to prevent chemotherapy-induced alopecia in female cancer patients*, which was completed by another research team recruited 55 females with cancer. The population being studied included patients who were above the age of 18. Of these 55 women, 42 patients had breast cancer, 12 had ovarian cancer, and 1 had endometrial cancer (Fehr et al. 2016). From the 55 patients involved in the study, there were 7 diffrent chemotherapy regimens. These regimens include:

- Paclitaxel 175 mg/m2 and carboplatin 6 AUC for 6 weeks (12 patients)
- Doxorubicin 60 mg/m2 and cyclophosphamide 600 mg/ m2 for 4 three-week cycles, followed by docetaxel 100 mg/m2 for 4 three-week cycles(11 patients)
- Epirubicin 90 mg/m^2 and cyclophosphamide 600 mg/ m^2 for 4 three-week cycles, followed by paclitaxel 80 mg/m^2 weekly for 12 weeks (10 patients)
- Paclitaxel 80 mg/m^2 weekly for 16 weeks (8 patients)
- Docetaxel 75 mg/m^2 and cyclophosphamide 500 mg/ m^2 for 4 three-week cycles(6 patients)
- Docetaxel 75 mg/m^2, doxorubicin 50 mg/m^2, and cyclophosphamide 500 mg/m^2 for 6 three-week cycles (4 patients)
- Fluorouracil 500 mg/m^2, epirubicin 100 mg/m^2, and cyclophosphamide 500 mg/m^2 for 3 three-week cycles, followed by docetaxel 100 mg/m^2 for 3 three-week cycles (4 patients)

These women were asked to assess the degree of hair loss they experienced by using a grade scale. Grade 0 being no hair loss experienced, grade 1 minimal hair loss (0-25%), grade 2

moderate patchy alopecia (25-75%), grade 3 complete alopecia, but reversible (>75%), and grade 4 non-reversible alopecia. They were also asked to rate their satisfaction on a scale of 0-100, if they would recommend the treatment to others, and if they used head coverings when receiving treatment (Fehr et al. 2016). Out of the 55 women who initially started the treatments, 43 completed the treatments for the entirety of their chemotherapy regimen. The reason for the drop in participants was due to hair loss (7 patients), death (3 patients), change of treatment center (1 patient) and doubt (1 patient) (Fehr et al. 2016). At the end of the study, it was concluded that the overall effectiveness of scalp-cooling to prevent hair loss was 56%. This means that 28 of the 50 patients saw a decrease in hair loss. The effectivness per each chemotherapy regimen is showed in Figure 1. (Fehr et al. 2016) *Objective assessment of the effectiveness of scalp cooling at the end of chemotherapy or at cessation of cooling treatment*.

Chemotherapy regimen	Patients (*n*) by grade[a] of alopecia					Effectiveness (grades 0 and 1)
	0	1	2	3	Total	
FECx3→Dx3 or ACx4→Dx4 or ECx4→Px12	3	8	9	4	24	46%
Paclitaxel–carboplatinx6	3	5	1	2	11	73%
Weekly paclitaxelx16	2	2	1	0	5	80%
TCx4	2	2	1	1	6	67%
TACx6	0	1	0	3	4	25%
TOTAL	10	18	12	10	50	56%

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When the women who participated in this study were asked about their overall satisfaction score on a scale of 0-100, there was a score of 80% satisfaction from 64% of the women (Fehr et al. 2016). When they were then question about recommending this treatment to others going through chemotherapy treatments, 36 women said they would recommend scalp cooling to others, 10 said that they did not know, and 4 women would not recommend this treatment. There were 26 women who reported wearing a head cover or wig at some point during their treatment period (Fehr et al. 2016). The study concludes that multiple chemotherapy

regimens are compatible with the scalp cooling treatments. Within the seven different chemotherapy treatments patients saw the scalp cooling treatment to be effective in preventing chemotherapy induced alopecia. Data of overall satisfaction, recommendation, and patients who did not use a head cover or wig for the diffrent chemotherapy regimens is shown in Figure 2 (Fehr et al. 2016). *Subjective indicators of alopecia and patient satisfaction by chemotherapy regimen.*

Chemotherapy regimen	Pts (*n*)	Indicator [*n* (%)]		
		≥80 Satisfaction with cooling treatment	Recommend to others	No head scarf or wig used
FECx3→Dx3 or ACx4→Dx4 or ECx4→Px12	24	15 (63)	16 (67)	9 (38)
Paclitaxel–carboplatinx6	11	8 (73)	10 (91)	7 (64)
Weekly paclitaxelx16	5	4 (80)	3 (60)	4 (80)
TCx4	6	4 (67)	5 (83)	4 (67)
TACx6	4	1 (25)	2 (50)	0 (0)
TOTAL	50	32 (64)	36 (72)	24 (48)

What are the side effects of the scalp cooling treatments?

Adverse Effects and Severity

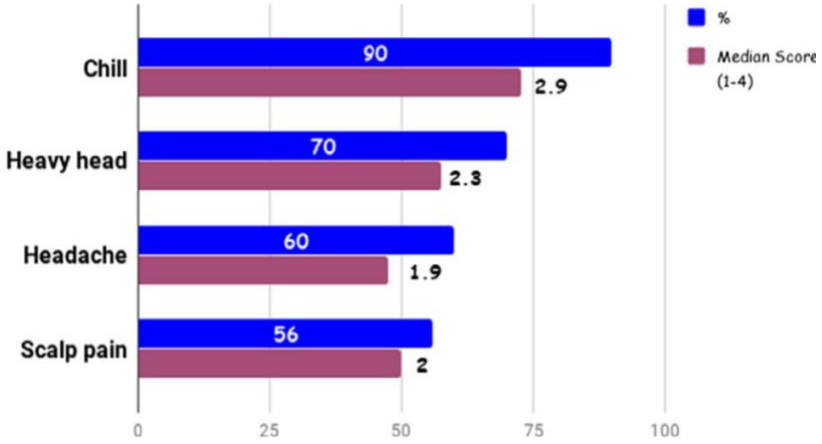
Understanding the side effects of a specific procedure before a patient decides to proceed is crucial in the medical field. like most procedures, scalp cooling does have side effects that may cause the patient to not want to go through with the treatment or even stop treatments when the patient is in the middle of a heir cycle, due to the side effects. The study, *Scalp Hypothermia (Penguin Cold Caps) in Preventing Alopecia in Cancer Patients*, goes into great detail about the scalp cooling treatments and what side effects are most seen in patients who receive the cooling treatments. The study states that the most frequently observed side effect of the procedure is a headache with a 78.5% of the 122 female participants experiencing this (Aygin & Gul, 2019). More unintended side effects observed are coldness, common cold, nausea, trypanophobia, claustrophobia, and increased distress. From the 122 patients who received scalp cooling

treatments 4 patients needed to stop due to the headache side effect and three patients quit treatment due to the common cold side effect (Aygin & Gul, 2019).

Another study that dove into the adverse effects one may experience, *Factors Influencing the Effectiveness of Scalp Cooling in the Prevention of Chemotherapy-Induced Alopecia,* preformed a literature review on 32 studies. Of these 32 different studies performed the scalp cooling treatment was reported to be generally well tolerated, with the most common reported side effects being headaches, coldness, uncomfortable sensations, and claustrophobia (Komen et al. 2013). Overall, the patients who receive this treatment appear to indicate high levels of comfort and acceptability. Even though many patients may not be affected by the cooling treatment, it is contradicted for people who experience cold sensitivity, cold agglutinin disease, cryoglobulinemia, cryofibrinogenemia, and post-traumatic cold dystrophy (Komen et al. 2013). Meaning the people who experience these disorders are recommended to not pursue this treatment or not able to receive this. This treatment has few side effects, but by knowing what may happen will help prepare the patient for what to expect. When the patient better understands the risks of this specific treatment it may help persuade them to receive the scalp cooling treatment or decide to not go through with it.

An study previously used for the effectivness of the treatments also recorded the side effects each patient experienced. The study, *Use of scalp cooling device to prevent alopecia for early breast cancer patients receiving chemotherapy: A prospective study*, observed 135 female patients. out of the 135 patients 90% experienced chills, 70% experienced a heavy head, 60% experienced headaches, and 56% experienced scalp pain (Giarratano et al. 2019). The patients who experienced scalp pain did not require the use of any antalgic medication to reduce their pain. There were 13 patients who decided to quit the treatments due to not being able to tolerate

the discomfort they were experiencing (Giarratano et al. 2019). This shows that out of all the patients receiving the scalp cooling treatment, only 10% could not finish entirely. Although there are a few side effects, this low percentage of people having to stop the treatment shows that the adverse effects are tolerable for most. Data from this study is shown as a bar chart in Figure 3. *Cooling-related symptoms and the respective mean high scores* (Giarratano et al. 2019).



Long term side effects

It was previously discussed that the scalp cooling treatment does have a few commonly seen side effects. The side effects that the treatments have typically will go away within a few hours to days, but the study, *Scalp Cooling The prevention of chemotherapy-induced alopecia*, explains of one adverse effect that is long term. This long-term side effect is known as scalp metastases, which is cancer that has started in another organ and then the cancer spreads to other parts of the body, including the scalp (Katz, 2017). In this study 6 of 553 women who went through scalp cooling developed scalp metastases. The median follows up time for these patients was 5.8 years after their treatments (Katz, 2017). The study goes into detail about two specific women who experienced scalp metastases after their scalp cooling treatments. One of these patients was diagnosed nine years after treatment while the other patient was diagnosed 7 years after treatment (Katz, 2017). The study concluded that this incidence is low in patients after their

cooling treatments and that it can be provided without the risk due to it being a rare occurrence (Katz, 2017). There has been only one long term adverse effect reported after the scalp cooling treatments. This single long-term effect is rare in patients and is only seen in about 1.1% of the population that was being studied. By scalp metastases being this rare of a side effect there is no major risk of a patient developing it due to the scalp cooling treatment they receive. Although it is important for the patient to understand that it is always a possibility and should be discussed before the patient decides to continue with the procedure.

What are the financial costs of going through the scalp cooling treatments?

Cost for Each Patient

Cost of the treatments can be an important factor to wether a patient decides to undergo scalp cooling. The article, *Key Considerations for Implementing a Scalp Cooling Program*, explains the financial costs these treatments cost for patients. The treatments have an estimated cost between $1,500- $3,000 in total. The typical installment for scalp cooling is around $389- $799 per month and the estimated cost of the cooling machines is between $1,800- $2,200 per patient (Byrne, 2019). Most insurance companies will not pay for these treatments, meaning that a patient would have to pay out of pocket. Although scalp cooling would help improve the quality of life for the patient, the financial burden of these treatments may cause financial distress which may overtake their overall well-being.

Another study, *Scalp Cooling*, done about the effects of scalp cooling went into detail about the cost of these treatments. This article claims that the average out-of-pocket cost for each treatment regimen is $1,500- $4,800 (Heery et. al, 2019). This cost depends on the specific regimen a patient is receiving, as well as how many treatments one is receiving. The typical regimen consists of 6-16 treatments in total (Heery et. al, 2019). Many patients are not able to

afford this treatment out-of-pocket, this financial burden then decreases the chances of patients improving their quality of life during chemotherapy treatments.

The Cost Compared to Buying wigs or Head Covers

As discussed above the cost of scalp cooling treatments is expensive, but would the cost of wigs and head cover for a patient be more or less than these treatments? The study, *Cost-effectiveness analysis of scalp cooling to reduce chemotherapy-induced alopecia*, compares the costs of scalp cooling treatments and the cost of wigs or head covers. This study was conducted in the Netherlands, meaning the currency that is used is Euros. One Euro amounts to 1.08 United States Dollar. This study shows that patients who did not receive scalp cooling treatments spent more money on wigs than on hairdressers. The mean amount of money for patients who did not receive the treatments was 534 euros for wigs and head covers, while the mean amount that was spent on hairdressers was 82 euros (Van Den Hurk et. al, 2014). The number of patients who purchased a wig was significantly greater in patients who did not receive scalp cooling treatments. In patients who did not receive the treatments it was seen that 77% purchased wigs, while 52% of patients who did receive treatment bought wigs (Van Den Hurk et. al, 2014). Many patients who did not receive treatment had bought more than one wig during their chemotherapy treatments, meaning the mean cost of the non-scalp cooling patients could be higher. The overall mean cost of non-scalp cooling patients was 946 euros for wigs, 97 euros for head covers, and 109 euros for hairdressers. For the patients who had received scalp cooling, the mean cost was 460 euros for wigs, 49 euros for head covers, and 191 euros for hairdressers (Van Den Hurk et. al, 2014). Patients who did not receive scalp cooling treatments did not pay for the costs of these treatments, while patients who did undergo the treatments spend a total of 183 euros on scalp cooling treatments (Van Den Hurk et. al, 2014). The study concluded with the

total of all the costs in patients who received the treatments were 883 euros and the total costs in patients who did not receive any scalp cooling treatments was 1152 euros (Van Den Hurk et. al, 2014). This study shows that when looking at the cost efficiency of receiving these treatments versus not receiving any treatments, the cost effectiveness is in favor of scalp cooling treatments.

Grants for Treatments

The costs of scalp cooling can cause a financial burden of the patients who are receiving them, but also can affect a person's decision on whether they are able to receive them or not. The study, *Scalp Cooling: A Patient's Experience*, follows a patient who received the scalp cooling treatments. In this article, it explains that scalp cooling can be expensive for many patients and that financial assistance may be needed. The study provides resources for patients who may seek the financial assistance. One of the resources include HairtoStay. This resource is a nonprofit organization that need-based grants to help patients in need. They also provide education to the patients about scalp cooling (Weatherby et. al, 2019). Another resource this study includes is The Rapunzel Project, which provides need-based grants to help cover costs of these treatments. This website not only provides educations to patients who are interested in scalp cooling treatments, but also offers information about brands of scalp cooling that are available. The Rapunzel Project lists locations across the country that offer scalp cooling so the patient would be able to find the closest location to them. This site provides links to studies, FDA approvals, and funding for scalp cooling (Weatherby et. al, 2019). The last resource discussed is Breastcancer.org. Although this resource does not provide grants to patients, it gives the patients the ability to contact cancer survivors who went through the scalp cooling treatments (Weatherby et. al, 2019). The resources that were discussed in this study can not only provide grants to patients in need, but also give them incite on how scalp cooling can improve their quality of life.

How many treatments does one need and how long are each of them?

Number of Treatments

It is important to know how many treatments one will receive when undergoing scalp cooling. The amount of cooling treatments a patient will receive is determined by how many chemotherapy treatments they have. One study, *Scalp cooling to prevent chemotherapy-induced alopecia,* explains that the scalp cooling treatment is initiated prior to the chemotherapy treatment. Scalp cooling is also then maintained throughout the chemotherapy treatment and also kept on after it is completed (De Barros Silva et. al, 2020). Due to the number of chemotherapy treatments being the deciding factor for how many scalp cooling treatments one will receive, there is no set number of treatments. The drug a patient is receiving can affect the length of the patient's cycle. On average a person who is receive chemotherapy will usually have around 4 to 8 cycles of treatment. One cycle typically lasts around 2 to 6 weeks, meaning one full course of chemotherapy could last between 3 to 6 months (Cancer Research UK, 2023). By having the scalp cooling treatments with every chemotherapy treatment means that the patients would have around 4 to 8 cycles of the scalp cooling depending on what their chemotherapy regimen is. Some patients may have more or less scalp cooling procedures done than others depending on their specific drug regimen.

Length of treatments

The length of a procedure is important to understand when receiving any medical procedure. It was previously discussed that the scalp cooling procedure is given prior to and after chemotherapy treatments. The study, *Association Between Use of a Scalp Cooling Device and Alopecia After Chemotherapy for Breast Cancer*, collected data over the course of patient's chemotherapy treatments and explains how long the scalp should be cooled before and after a

chemotherapy treatment. During this study, the patients' heads were placed in a fitted silicone cap, followed by application of an insulating neoprene cap 30 minutes before their chemotherapy treatment. The cap was then gradually cooled until it was maintained at 3 degrees Celsius. The cap stayed this temperature during the whole chemotherapy treatment. At the end of the chemotherapy treatment the cap was then reduced to a temperature of 15 degrees Celsius for 90 to 120 minutes (Rugo et. al, 2017). One course of chemotherapy can take anywhere from a few minutes to a few hours depending on the chemotherapy treatment. The full scalp cooling process can vary depending on what chemotherapy regimen the patient is receiving.

One study that was previously discussed reviewed 32 studies conducted over scalp cooling. During these studies, the scalp cooling treatment had a precooling time that ranged from 5 to 30 minutes. When the temperature reached around 18 degrees Celsius in the studies it remained the same temperature throughout the course of the chemotherapy treatment. After the chemotherapy treatment was over, the post cooling time ranged from 15 minutes to 4 hours (Komen et al. 2013). The study also investigated whether there was a better outcome when the post cooling time was longer or not. There were better results when the post cooling time averaged around 150 minutes (Komen et al. 2013). The study concluded that having a longer time of scalp cooling after the chemotherapy treatment concluded was beneficial.

An article, *Scalp Cooling*, explains important information regarding the cooling process. One of the key points it explained was the length of precooling and post cooling for two different types of chemotherapy regimens. One of the regimens is weekly Taxol. For this chemotherapy treatment the patient will receive 30 minutes of precooling. The patient will then receive one hour of chemotherapy infusion while still receiving the scalp cooling treatment. After the infusion has stopped, the patient will have 60 minutes of post cooling (The Clatterbridge Cancer

Centre NHS Foundation Trust, 2022). The other chemotherapy regimen discussed is Docetaxel. For this chemotherapy treatment to patient will receive 30 minutes of precooling. Then the patient will have an infusion of the chemotherapy for 60 minutes. After the 60-minute infusion, the patient will receive 20 minutes of post cooling (The Clatterbridge Cancer Centre NHS Foundation Trust, 2022). Concluding that the length of scalp cooling treatments vary depending on what chemotherapy regimen a patient is receiving.

Are there any age limits for the scalp cooling treatment process?

Age limits

Cancer is a disease that can be seen in every stage of life, it doesn't matter what age a person is. The article, *Scalp Cooling for the Prevention of Chemotherapy-Induced Alopecia,* discusses the contradictions of this treatments. One of the main contradictions that the article states is that the scalp cooling device is contradicted for all pediatric patients (Medical Coverage Database, 2023). Thus, making the minimum age able to receive these treatments 18. The pediatric population is contradicted from this treatment due to the side effects one may experience.

Another study, *Safety and efficacy of scalp cooling system in preventing chemotherapy induced alopecia - A single center prospective study*, was done to evaluate the effectivness of scalp cooling. During the experiment, the researchers also assessed if age was a factor to whether the treatments were successful or not. The population of the patients consisted of a total of 100 patients who were 18 years of age and older. The mean age for the group was 53.5 years of age (Kate et al. 2020). After the scalp cooling treatments were concluded, it was seen that the age of a patient does not show any contrasting outcomes. The importance of this study explains that the age of a patient does not determine the results of the cooling treatments.

Elderly Population

It was previously discussed that pediatric patients are not able to receive this type of treatment due to the side effects. The elderly population may experience the same side effects and not be able to sustain the cooling treatments. The study, *Effectiveness of the MSC Cold Cap System in the Prevention of Chemotherapy-Induced Alopecia*, conducted an experiment with a population of 83 cancer patients. The age range is 26- 75 years of age with the mean age being 49.8 (Christodoulou et. al, 2002). As the experiment was taking place 7 out of the 83 patients decided to quit due to not being able to tolerate the scalp cooling procedure. The 7 patients were above the age 67 years old (Christodoulou et. al, 2002). The patients not only quit due to the side effects they were experiencing, but also stated that they were no longer motivated for their hair preservation (Christodoulou et. al, 2002). The study reveals that the older a patient who receives scalp cooling treatments are, the more likely it is that the patient may not be able to tolerate the side effects. By the treatments side effects being too harsh for some members of the elderly community, it may influence the patients to stop their treatments, or even drive away elderly patients from wanting to go through with scalp cooling altogether.

Conclusion

Alopecia caused by treatments of chemotherapy effects a patients physical and mental well-being. Many patients will express their concern about losing their hair in the process of the cancer treatments. Scalp cooling was designed to alleviate this concern. The scalp is cooled throughout the chemotherapy treatments, with the purpose of causing vasoconstriction within the scalp. By causing the blood vessels to constrict during the treatments, it will cause the chemotherapy to not attack these healthy hair follicles. Resulting in the preservation of the

patient's hair. By decreasing the risk of chemotherapy induced alopecia, it will improve the overall quality of life and increase self-esteem for these patients.

By having a better understanding about these scalp cooling treatments, it can help determine if this is something that is of interest for patients. Regarding the effectiveness of the treatments, it was concluded through multiple study's that these treatments are in fact effective in preventing hair loss. The specific type of chemotherapy regimen a patient was receiving did not affect the outcome of the cooling treatments. Almost all the studies expressed a high success rate after receiving their course of treatments and over 50% of patients in these study's saw a decrease in hair loss. There were few side effects seen in the patients, but the most frequently seen included headaches, coldness, uncomfortable sensations, scalp pain, chills, and claustrophobia. With no major risks of a long-term adverse effect. Making this treatment safe to undergo if the patient does not experience any type of cold sensitivity or claustrophobia.

As discussed, financial costs of the treatments could determine whether a patient would receive these treatments or not. The average scalp cooling treatment regimens cost anywhere between $1,500- $4,800 with no insurance coverage. This can be difficult to afford, which is why many resources can be found that offer grants to patients in need. By having these resources available it can help decrease the financial burden of these treatments for many patients. The cost of the treatments compared to buying wigs and head covers concluded in multiple studies to be less costly. Making scalp cooling treatments favorable when discussing the cost between the two.

The number of treatments a patient will receive is determined by the chemotherapy regimen they are receiving. The scalp cooling treatments are given with every chemotherapy treatment. A full course of chemotherapy could last anywhere between 3-6 months, meaning a patient can receive around 4-8 cycles of scalp cooling. There is no set number of treatments one

will receive, the deciding factor of the number of treatments is determined by the patient's specific drug treatment. The length of each treatment is also determined by what regimen they are receiving. Many studies showed effectiveness when doing 30 minutes of precooling, a consistent temperature during the infusion of chemotherapy, and then 15-30 minutes of post cooling. There is no set length for the scalp cooling treatments, due to the type of drug treatment they are receiving being the deciding factor.

In regard to the age of patients who are eligible to receive these treatments, it has been contradicted in the pediatric patient population. Meaning the minimum age a patient can be to receive the cooling treatments is 18 years. There is no cut off you're the elderly population, but it has been seen that they are more likely to discontinue due to not being able to tolerate the side effects they may experience.

In conclusion, scalp cooling has been seen to improve quality of life of cancer patients when they are undergoing treatment. Both qualitative and quantitative research databases helped determine the unknown information about the specifics of these treatments. Scalp cooling can improve the patient's self-esteem and decrease the negative view of one's body image. By providing these treatments to patients who are about to undergo chemotherapy, it can decrease the fear they may have about losing their hair. Thus, making the course of the patient's chemotherapy cycle less detrimental to their psychological well-being.

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