

# Efficacy of Scalp Cooling in the Prevention of Chemotherapy Induced Alopecia Among Breast Cancer Patients

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## SUMMARY

Patients undergoing chemotherapy treatment for cancer are known to develop alopecia. Alopecia is the loss of hair from different parts of the body depending on the type of alopecia. Chemotherapy-induced alopecia (CIA) results in the loss of hair from the entire scalp as a side-effect of the majority of the anti-cancer drugs provided under the chemotherapy treatment. These drugs disrupt the growth cycle of hair follicles, leading to alopecia. To prevent CIA, scalp cooling has been discovered as an effective procedure that preserves hair follicles. These initial findings sparked interest due to this method's safety and tolerance among patients. Results from clinical trials add to the evidence for scalp cooling's efficacy in hair preservation as well as hair regrowth following chemotherapy. As alopecia is known to influence body image perception negatively, investigating scalp cooling can aid in reducing stigmatization surrounding CIA and improve patient health outcomes.

## ABSTRACT

Alopecia refers to hair loss, which is a common side-effect of chemotherapy regimens for cancer. Anthracyclines and Taxanes are the common anticancer drugs prescribed within chemotherapy that result in significant alopecia. Scalp cooling is identified to be an effective method that prevents chemotherapy-induced alopecia (CIA) in patients. This method has been present since 1974; however, novel technologies have enhanced the efficacy via modern scalp-cooling devices. By maintaining a low scalp temperature, vasoconstriction aids in the reduced absorption of anticancer drugs into the bloodstream, which reduces intrafollicular metabolism. Randomized controlled trials conducted recently found statistically significant results, evidencing the hair preservation and hair regrowth abilities yielded via scalp cooling. These results attracted the attention of researchers due to the treatment success and the patient safety aspect of the process. Extensive scientific research reveals that alopecia affects the perceptions of patients regarding their body image and lowers their self-esteem significantly. Furthermore, the quality of life of alopecia patients is reduced due to public stigmatization. The effectiveness of scalp cooling in preventing CIA is of high significance as it can help improve patient outcomes of patients undergoing chemotherapy and their mental well-being.

**Keywords:** Scalp cooling, Alopecia, Hair loss, Chemotherapy, Quality of life

## 1.0 INTRODUCTION

Clinical literature defines alopecia as "hair loss" irrespective of its cause of onset. Alopecia can affect any body part and is not exclusive to the scalp.<sup>1</sup> There are many different types of alopecia, categorized by scientists based on their etiology.<sup>1</sup> One of the major causes

of alopecia in oncological patients that is underestimated by physicians is Chemotherapy-Induced Alopecia (CIA).<sup>9</sup> Following chemotherapy, a variety of treatment measures are pursued to combat the resulting hair loss, such as the commonly used micro-needling procedure.<sup>5</sup> Recently, the use of scalp cooling has been rigorously investigated as a potential therapeutic option for the prevention of CIA in patients undergoing chemotherapy.<sup>2</sup> The efficacy of scalp cooling in a

meaningful number of patients represents a promising step toward the prevention of alopecia in breast cancer patients undergoing treatment.<sup>10</sup> This paper will analyze the onset of CIA and the mode of action of scalp cooling in preventing the occurrence of hair loss.

## 2.0 CHEMOTHERAPY-INDUCED ALOPECIA

Alopecia is a non-life-threatening but disruptive side effect of the majority of the adjuvant chemotherapy regimens for breast cancer.<sup>7</sup> The severity of alopecia is determined by the nature of drugs used in chemotherapy treatment.<sup>7</sup> In particular, chemotherapeutic agents such as Anthracyclines and Taxanes are known to commonly result in significant alopecia.<sup>7</sup> These anti-cancer drugs are known to target the matrix keratinocytes present in the hair during the anagen phase, the state when hair cells are most proliferative.<sup>9</sup> Given their high sensitivity to anti-cancer drugs, rapid apoptosis occurs, leading to alopecia.<sup>9</sup> Research studies indicate that over 70% of the patients experiencing alopecia are undergoing chemotherapy involving one of the two drugs that were mentioned.<sup>7</sup> However, there are several risk factors known to exacerbate the chances of developing alopecia in cancer patients.<sup>9</sup> These are treatment-related aspects such as drug dose, administration regime, and exposure to risk rays.<sup>9</sup> Furthermore, patient-related risk factors include age, nutrition, and hormonal status.<sup>9</sup>

### 2.1 Impact on Patient's Lives

Alopecia after chemotherapy treatments is known to affect the quality of life of patients and the most notable public stigma of this treatment.<sup>7</sup> Research indicates that the CIA negatively influences the body image, sexuality, and self-esteem of patients.<sup>9,10</sup> Statistics show that approximately 8% of patients decide to opt out of receiving chemotherapy due to the risk of hair loss.<sup>9</sup>

## 3.0 SCALP COOLING

Utilizing scalp cooling devices was documented in the 1970s as a method to potentially reduce CIA.<sup>10</sup> Its efficacy data were unknown; therefore, recently, randomized control trials have provided insight into statistically significant data providing evidence for its efficacy.<sup>10</sup> There are different types of devices that utilize the scalp cooling procedure for the prevention of CIA.<sup>7</sup> The newer self-contained technologies use a machine to cool and circulate fluid in channels within a cap.<sup>7</sup> These channels contain glycol-based fluid and allow the scalp temperature to be maintained throughout

the duration of the treatment.<sup>7</sup>

According to scientific research, the cap placed on the patient's head during scalp cooling is silicone based.<sup>7</sup> Once placed, the desired temperature for treatment is between 3 °C and 5 °C.<sup>7</sup> The cap comprises two sensors, one located at the front and one at the back of the cap.<sup>7</sup> These sensors are used to monitor the temperature to ensure it is within the desired limits.<sup>7</sup> An additional sensor is present to ensure the temperature does not drop below the freezing point.<sup>7</sup> Novel scalp cooling devices include the DigniCap® Scalp Cooling System, a popular device capable of providing continuous scalp cooling during chemotherapy infusion.<sup>7</sup> Despite its benefits, systemic recurrences of diminishing hair follicles continues to remain an unanswered question.<sup>2</sup>

### 3.1 Mechanism of Action

Scalp cooling directly causes scalp vasoconstriction, which results in a reduction of blood flow to the area.<sup>2,3</sup> As blood perfusion is reduced, the cellular drug uptake is diminished.<sup>2</sup> Hence, the anti-cancer chemotherapy drugs that are known to cause alopecia cannot be delivered to the scalp, which reduces intrafollicular metabolism.<sup>7</sup> The low temperature of the cap placed on the patients' heads leads to a reduction in the scalp temperature and consequent altering of exposure and metabolism of cytotoxic agents within their hair follicles.<sup>4</sup> For the cap to reduce the scalp's temperature significantly to cause vasoconstriction, a pre-cooling time of around 30 minutes is required.<sup>4</sup> It is articulated that a time of greater than 30 minutes does not result in further cooling of the scalp via the device.<sup>4</sup> Scalp cooling as a treatment method for preventing CIA deems safe and well-tolerated.<sup>6</sup>

### 3.2 Results

Preliminary analysis of data using a randomized controlled trial (RCT) by a group of researchers showcases the successful results of scalp cooling in breast cancer patients. After following the chemotherapy regime, patients were randomly assigned to two groups.<sup>2</sup> One group underwent scalp cooling (SC), whereas the other group was a control and did not receive scalp cooling treatment. 56.3% of the patients in the SC group had successful hair preservation.<sup>2</sup> Conversely, all patients in the control group faced hair loss due to alopecia.<sup>2</sup> The results were statistically significant, with a vast difference in the hair re-growth rate.<sup>2</sup> The SC group demonstrated hair re-growth in 89% of the patients.<sup>2</sup>

Another clinical trial study alludes to the success of SC by completely preventing hair loss in 43% of the total evaluated patients.<sup>7</sup> 32% remaining discontinued the SC treatment, while the remaining experienced failure in the complete prevention of hair loss.<sup>7</sup> Furthermore, an RCT conducted in breast cancer patients undergo-

ing chemotherapy showcases the efficacy of SC in reducing CIA. Researchers observed successful hair preservation in 50.5% of patients that received SC treatment compared to 0% in the control group that did not receive the treatment.<sup>8</sup> A 95% confidence interval was obtained, which ensures that the results are statistically significant.<sup>8</sup>

## 4.0 CONCLUSION

Although scientists discovered scalp cooling in the 1970s, innovative technologies have bolstered its ability to prevent CIA in breast cancer patients undergoing chemotherapy. Since the SC treatment is documented to be safe and tolerated, it represents an effective method for improving patient outcomes by preventing alopecia development following chemotherapy. Due to the adverse effects of alopecia on body image, further research should focus on evolving the SC treatment process to maximize the chances of success.

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