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Minimal added value of wetting hair before scalp cooling to prevent chemotherapy-induced alopecia in cancer patients - Results from the Dutch Scalp Cooling Registry

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Abstract

Purpose

Preventing Chemotherapy-Induced Alopecia (CIA) is related to the degree of temperature reduction during scalp cooling. Wetting hair before scalp cooling reduces the scalp skin temperature. This observational study investigated the effects of wetting hair before scalp cooling on preventing CIA and on tolerance in cancer patients.

Methods

This Dutch multi-center cohort study comprised 1825 patients receiving ≥1 cycle of docetaxel (D), 5-fluorouracil-epirubicin-cyclophosphamide (FEC), 5-fluorouracil-epirubicin-cyclophosphamide-docetaxel (FECD), paclitaxel (P) or paclitaxel-carboplatin (PC). Patients underwent scalp cooling with wet or dry hair. Primary and secondary outcomes were the effects of wetting hair on head cover use and tolerance respectively.

Results

None of the associations between wetting hair and head cover use in patients on D, FEC, P or PC were significant, however results all tended to be in favor of wetting hair. For FECD, univariate (p=0.005; OR=1.6; CI=1.1-2.1) and multivariable associations (p=0.007; OR=1.8; CI=1.2-2.6) were significant. Scalp cooling discontinuation due to intolerance differed significantly between groups that wetted hair or not (3% and 1% respectively; p=0.034).

Conclusion

In a large patient group with mainly a European hair type and a high hair mass, no convincing evidence was found whether wetting hair prior to scalp cooling contributes to better prevention of CIA. Since it is argued that a higher reduction in scalp skin temperature by wetting hair contributes positively to scalp cooling efficacy, only a randomized controlled trial can provide an ultimate conclusion at the highest level of evidence. Until that time, healthcare professionals have to take into account that wetting hair may introduce lower compliance to the scalp cooling procedure.

Keywords

Scalp cooling, Chemotherapy, Alopecia, Wetting hair, Hair preservation, Tolerance

Abbreviations

CIA = Chemotherapy-Induced Alopecia

SOPs = Standard operating procedures

DSCR = Dutch Scalp Cooling Registry

D = Docetaxel

FEC = 5-Fluorouracil-Epirubicin-Cyclophosphamide

FECD = 5-Fluorouracil-Epirubicin-Cyclophosphamide-Docetaxel

P = Paclitaxel

PC = Paclitaxel-Carboplatin

Introduction

Approximately half of the patients undergoing chemotherapy are at risk for hair loss (1); a condition referred to as Chemotherapy-Induced Alopecia (CIA). CIA is considered one of the most distressing side effects of chemotherapy (2, 3). Although it is often temporary, permanent CIA has been observed in 30% of breast cancer patients on taxane-based regimens (4). Alopecia can affect the patients' self-esteem, body image, participation in daily activities and wellbeing in general (3, 5-7). Given this psychosocial impact, it is not surprising that CIA distress is also associated with depression (7). Fear of losing their hair has even caused patients to consider avoiding chemotherapy (8), thus risking suboptimal treatment of their cancer.

Scalp cooling is a widely used effective method to prevent CIA (9-13). Modern techniques of scalp cooling involve constant automated circulation of cold coolant liquid through a silicone cap (1). It is currently assumed that scalp cooling evokes vasoconstriction. Therefore, scalp blood flow containing the cytotoxic agents is reduced (14-17). In addition, scalp cooling affects drug uptake and metabolism in the scalp tissue, resulting in less damage to hair cells (14, 18). Side effects from scalp cooling are generally mild (e.g. experiencing chills, headaches, dizziness or nausea) (11, 13).

According to meta-analyses, scalp cooling can prevent CIA in 52% to 77% of patients (9, 13). Hair preservation, however, is related to the scalp skin temperature obtained during scalp cooling (14-22). It is suggested that for the hair preservative effect, subcutaneous scalp skin temperatures should be reduced to or below 22 °C (14, 19), while desired scalp surface temperatures of 18 °C (20) or even 14 °C have been reported (15). Yet, evidence on the optimal scalp cooling temperature remains inconclusive. It is however argued that lower scalp skin temperatures are more effective in preventing CIA. One aspect relevant in obtaining lower scalp skin temperatures is to ensure proper connection between the cap and scalp (1). A way to improve connection is by increasing thermal conductivity and minimizing the trapped air between the hair and the cap (23, 24). Some healthcare professionals therefore apply water or hair conditioner to the hair (23). Wetting hair before scalp cooling is thus expected to additionally lower the scalp skin temperature during the cooling procedure (23, 25), which may result in better

hair preservation. There is limited evidence on the effect of wetting hair on scalp skin temperature reduction. Muhanna et al. (unpublished) compared temperature differences between wet and dry hair groups of healthy volunteers (25). They found a mean temperature difference of 2.8ºC (95% C.I. 1.8-3.7, $p<0.001$) but concluded that the effect of wetting hair before scalp cooling remained to be studied in patients on preventing CIA.

Currently, standard operating procedures (SOPs) on wetting hair before scalp cooling vary across Dutch hospitals. This is mainly due to the limited evidence on the effects of wetting hair on hair preservation, but also because colder scalp temperatures may burden the patient (26) and subsequently reduce compliance. Few studies have investigated whether wet hair is associated with more effective scalp cooling than dry hair. A study by van den Hurk et al. (2012) showed insignificant results of wetting hair before scalp cooling on preventing CIA in patients receiving various chemotherapy regimens (n=1411; 13% wetted; OR=1.0-1.2; p=0.4) (27). A few years later, an association between wet hair and better prevention of CIA was found for Anthracycline-Cyclophosphamide (n=1408; 50% wetted; OR=2.3; $p<0.0001$), but not for irinotecan (n=189; 30% wetted; OR=0.8; p=0.6) (28). Results from the latter study, however, have not yet been peer-reviewed for publication. Given the limited evidence on the added value of wetting hair and thus the inconsistency in SOPs, there is a need for clarification. Therefore, the aim of this study was to inform scalp cooling SOPs regarding wetting hair, by investigating the effects of wetting hair before scalp cooling on preventing CIA in cancer patients. Considering temperature has proven to be of significant relevance in optimal hair preservation, it was hypothesized that wetting hair would be associated with better prevention of CIA.

Methods

Study design and setting

In this study, we analyzed prospectively collected data from a large Dutch database: the Dutch Scalp Cooling Registry (DSCR). The DSCR contained observational data that were prospectively obtained from cancer patients receiving treatment in one of the 64 participating academic- and community hospital locations across the Netherlands.

Study population

The study comprised 1825 cancer patients receiving ≥1 cycle of one of the following chemotherapy regimens: D (docetaxel 100 mg/m^2 – 3-weekly), FEC (5-fluorouracil 500 mg/m^2, epirubicin 100 mg/m^2 and cyclophosphamide 500 mg/m^2 – 3-weekly), FECD (5-fluorouracil 500 mg/m^2, epirubicin 100 mg/m^2, cyclophosphamide 500 mg/m^2 – 3-weekly and docetaxel 100 mg/m^2 – 3-weekly), P (paclitaxel 80 mg/m^2 – weekly) or PC (paclitaxel 175 mg/m^2 and carboplatin with an area under the curve of 6 – 3-weekly). Patients that wetted hair in at least 3:1 scalp cooling sessions were assigned to the wet hair group. Patients that wetted hair in 1:3 or fewer sessions were assigned to the dry hair group. Patients wetting hair in 1:1 sessions were assigned to the wetting sometimes group and were excluded from the analyses. Other exclusion criteria were contra-indications for scalp cooling: hematological malignancies, cold sensitivity disorder, cold post-traumatic dystrophy, cold agglutinin disease, cryofibrinogenemia and cryoglobulinemia.

Data collection

Data was prospectively collected from 2013 to 2018 from all participating hospital locations and consistently entered into the DSCR. Depending on the year of inclusion and the associated legal regulation at that time, patients either provided verbal or digital consent. At the start of treatment, data on demographic characteristics (age, gender, ethnic hair type and hair mass) were reported by patients and data on chemotherapy characteristics (infusion time) were reported by healthcare professionals. Scalp cooling characteristics (number of sessions, whether hair was wet or dry) were reported by the patient at each session. All data were retrieved through case report forms and entered anonymously into the DSCR by data managers.

Scalp cooling procedure

Most hospital locations (n=63) used the Paxman system for scalp cooling. Only a few (n=3) used the DigniCap system. Both systems involve a corresponding automated cooling method and differences in outcomes between the machines have not been observed in practice (1). If hair of the patient was wetted before scalp cooling, this was done by healthcare professionals using a spray bottle of water. After fitting and assembling the right silicone cap size for the patient, a covering cap was used to secure that the cap remained in the right position. Coolant liquid was pumped automatically through the device and cap to extract heat from the scalp. Duration of cooling varied according to local protocols and depended on the type of chemotherapy, dose and local infusion times.

Outcomes

The primary outcome was the association between wetting hair and hair preservation. Hair preservation was assessed by the patients' self-reported need for a head cover (e.g. wig, hat or scarf) at the last session. Patients also reported whether a head cover was worn for religious reasons (if answered 'yes' and they reported no severe CIA, it was coded as 'no head cover') or if patients did not feel the need to wear a head cover despite CIA (coded as 'head cover'). The secondary outcome was the effect of wetting hair on scalp cooling tolerance determined by comparing reasons to discontinue scalp cooling between patients with wet and dry hair. These reasons were reported by the patient and/or healthcare professionals and included intolerance, end of treatment/progression of disease, severe hair loss and other reasons for discontinuing scalp cooling.

Statistics

All data were analyzed using IBM SPSS Statistics version 24 for Windows. The primary outcome was investigated using univariate and multivariable logistic regression analyses. As a previous non-peer-reviewed study showed considerable differences in the effect of wetting hair per type of chemotherapy (28), results were a priori stratified for type of chemotherapy. Additionally, given their purported impact on scalp cooling success (16, 27-30), the following characteristics were checked for being effect modifying or confounding factors in the associations: age (≤44, 45-54, 55-64 or ≥65), gender (male or female), ethnic hair type (European, Asian or African), hair mass (high or low), chemotherapy infusion time (in minutes) and the number of scalp cooling sessions (≤5 or ≥6). Effect modification was determined by interpreting significance of the interaction term between the independent variable and the assumed effect modifier. Confounders were selected through a forward stepwise procedure in which each variable was added independently to the crude association. Confounding was considered relevant if the effect change (in B-coefficient) compared to the crude association was greater than 10%. Stepwise, the strongest

confounders were added to the crude analysis until the final adjusted association was established. The secondary outcome was investigated using a Chi square test. In all analyses, statistical significance was determined by $p<0.05$.

Results

No significant differences were observed between the groups regarding the collected patient- and clinical characteristics, except for age and stage of treatment (table 1). 55% of the patients got their hair wetted. The study population comprised mainly females (96%). The median age was 53 years (ranging from 22 to 86 years). Asian (3%) and African (2%) hair types were underrepresented compared to European hair types (91%). 87% had a high hair mass. The most reported cancer type was breast cancer (86%). Most patients were treated in adjuvant stage (73%). The median chemotherapy infusion time was 60 minutes (ranging from 15 to 390 minutes) and patients had a median of 5 scalp cooling sessions (ranging from 1 to 29 sessions).

Table 1: patient- and clinical population characteristics

	Total	**Wet hair**	**Dry hair**	**p-value**[a]
Patients included, n (%)	1825 (100)	1000 (55)	825 (45)	
Age, n (%)	1822 (100)			**0.010***
≤44		217 (62)	131 (38)	
45-54		341 (54)	289 (46)	
55-64		276 (51)	265 (49)	
≥65		165 (55)	138 (45)	
Missing	3 (0)			
Gender, n (%)	1821 (100)			0.234
Male		32 (48)	35 (52)	
Female		967 (55)	787 (45)	
Missing	4 (0)			
Ethnic hair type, n (%)	1748 (96)			0.842
European		921 (55)	745 (45)	
Asian		32 (58)	23 (42)	
African		16 (59)	11 (41)	
Missing	77 (4)			
Hair mass, n (%)	1703 (93)			0.916

High		876 (56)	702 (44)	
Low		70 (56)	55 (44)	
Missing	122 (7)			
Cancer type, n (%)	1807 (99)			0.408
Breast		864 (55)	701 (45)	
Ovarian		64 (50)	64 (50)	
Prostate		17 (50)	17 (50)	
Other		42 (53)	38 (47)	
Stage of treatment, n (%)	1807 (99)			**0.037***
Adjuvant		741 (56)	586 (44)	
Palliative		254 (53)	226 (47)	
Chemotherapy regimen[c], n (%)	1825 (100)			0.490
D		98 (54)	85 (46)	
FEC		252 (57)	194 (43)	
FECD		348 (52)	317 (48)	
P		218 (58)	161 (42)	
PC		84 (55)	68 (45)	

[a] Determined using Chi square test.

[b] Abbreviations: D = Docetaxel 100 mg/m^2, FEC = 5-fluorouracil 500 mg/m^2 + epirubicin 100 mg/m^2 + cyclophosphamide 500 mg/m^2, FECD = 5-fluorouracil 500 mg/m^2 + epirubicin 100 mg/m^2 + cyclophosphamide 500 mg/m^2 + docetaxel 100 mg/m^2, P = paclitaxel 80 mg/m^2, PC = paclitaxel 175 mg/m^2 + carboplatin area under the curve 6.

* Statistically significant difference.

An overview of hair preservation rates and univariate and multivariable associations between wetting hair and hair preservation per type of chemotherapy is presented in table 2. All multivariable associations were adjusted for confounding. None of the studied factors were effect modifiers.

Docetaxel (D)

Out of all patients receiving D (median number of scalp cooling sessions n=5, ranging from 1 to 14 sessions), 75% had successful hair preservation. When stratified, 77% of the patients in the group with wet hair and 74% of the patients in the group with dry hair had successful hair preservation. The crude univariate logistic regression analysis for D showed insignificant results between wetting hair and hair preservation (p=0.705; OR=1.1; CI=0.6-

2.2). After adjusting for gender, the number of sessions and age, the multivariable logistic regression analysis for D also showed insignificant results (p=0.808; OR=1.1; CI=0.5-2.4).

5-Fluorouracil-epirubicin-cyclophosphamide (FEC)

Out of all patients receiving FEC (median number of scalp cooling sessions n=2, ranging from 1 to 14 sessions), 35% had successful hair preservation. When stratified, 37% of the patients in the group with wet hair and 33% of the patients in the group with dry hair had successful hair preservation. The crude univariate logistic regression analysis for FEC showed insignificant results between wetting hair and hair preservation (p=0.391; OR=1.2; CI=0.8-1.8). After adjusting for the number of sessions, the multivariable logistic regression analysis for FEC also showed insignificant results (p=0.077; OR=1.6; CI=1.0-2.5).

5-Fluorouracil-epirubicin-cyclophosphamide-docetaxel (FECD)

Out of all patients receiving FECD (median number of scalp cooling sessions n=4, ranging from 1 to 15 sessions), 45% had successful hair preservation. When stratified, 50% of the patients in the group with wet hair and 39% of the patients in the group with dry hair had successful hair preservation. In the crude univariate logistic regression analysis for FECD, patients with wet hair were 1.6 times more likely to have successful hair preservation, than those with dry hair (OR=1.6; CI=1.1-2.1). The crude association was significant (p=0.005). After adjusting for the number of sessions, the multivariable logistic regression analysis for FECD showed that patients with wet hair were 1.8 times more likely to have successful hair preservation, than those with dry hair (OR=1.8; CI=1.2-2.6). The adjusted association was also significant (p=0.007).

Paclitaxel (P)

Out of all patients receiving P (median number of scalp cooling sessions n=10, ranging from 1 to 29 sessions), 86% had successful hair preservation. When stratified, 88% of the patients in the group with wet hair and 83% of the patients in the group with dry hair had successful hair preservation. The crude univariate logistic regression analysis for P showed insignificant results between wetting hair and hair preservation (p=0.229; OR=1.4; CI=0.8-2.5). After adjusting for the number of sessions, the multivariable logistic regression analysis for P also showed insignificant results (p=0.183; OR=1.5; CI=0.8-2.7).

Paclitaxel-carboplatin (PC)

Out of all patients receiving PC (median number of scalp cooling sessions n=3, ranging from 1 to 18 sessions), 41% had successful hair preservation. When stratified, 42% of the patients in the group with wet hair and 41% of the patients in the group with dry hair had successful hair preservation. The crude univariate logistic regression analysis for PC showed insignificant results between wetting hair and hair preservation (p=0.951; OR=1.0; CI=0.5-2.0). After adjusting for the number of sessions, the multivariable logistic regression analysis for PC also showed insignificant results (p=0.137; OR=2.0; CI=0.8-4.8).

Table 2: Hair preservation rates and associations between wetting hair and hair preservation.

Chemotherapy[a]	**N**	**Hair preservation (no head cover) (%)**		**Univariate**		**Multivariable**[b]	
		Wet hair	Dry hair	OR (95%CI)	p-value	OR (95%CI)	p-value
D	183	77	74	1.1 (0.6-2.2)	0.705	1.1 (0.5-2.4)[c]	0.808
FEC	446	37	33	1.2 (0.8-1.8)	0.391	1.6 (1.0-2.5)[d]	0.077
FECD	665	50	39	1.6 (1.1-2.1)	0.005*	1.8 (1.2-2.6)[d]	0.007*
P	379	88	83	1.4 (0.8-2.5)	0.229	1.5 (0.8-2.7)[d]	0.183
PC	152	42	41	1.0 (0.5-2.0)	0.951	2.0 (0.8-4.8)[d]	0.137

[a] Abbreviations: D = Docetaxel 100 mg/m^2, FEC = 5-fluorouracil 500 mg/m^2 + epirubicin 100 mg/m^2 + cyclophosphamide 500 mg/m^2, FECD = 5-fluorouracil 500 mg/m^2 + epirubicin 100 mg/m^2 + cyclophosphamide 500 mg/m^2 + docetaxel 100 mg/m^2, P = paclitaxel 80 mg/m^2, PC = paclitaxel 175 mg/m^2 + carboplatin area under the curve 6.

[b] Potential confounders studied: age, gender, ethnic hair type, hair mass, infusion times and number of scalp cooling sessions.

[c] Adjusted for confounding by gender, number of sessions and age.

[d] Adjusted for confounding by number of sessions.

* Statistically significant.

Scalp cooling tolerance

Reasons to discontinue scalp cooling are presented in figure 1. Overall, scalp cooling discontinuation due to intolerance was rare (2%). Rates, however, differed significantly (p=0.034) between groups: in the group with wet hair, 27 patients (3%) discontinued scalp cooling because of intolerance, compared to 11 patients (1%) in the group with dry hair.

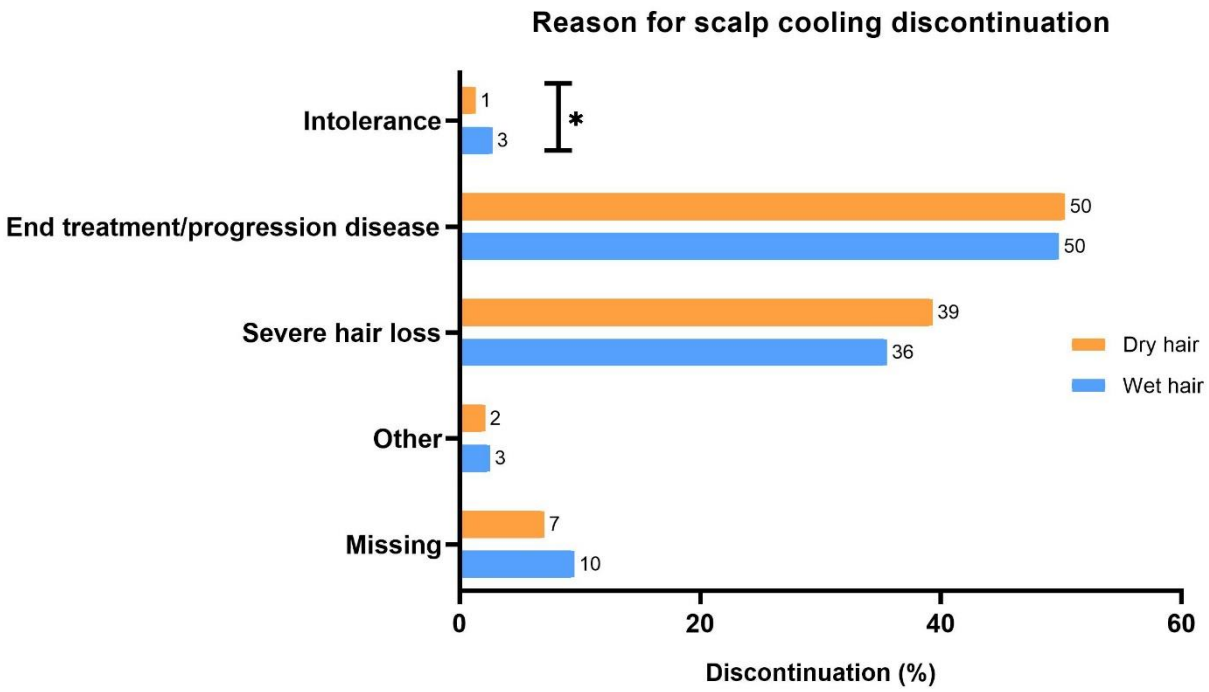

Figure 1: Reason for scalp cooling discontinuation.

* = Statistically significant difference.

Discussion

This study investigated the effects of wetting hair before scalp cooling on the prevention of CIA. Contrary to the hypothesis, wetting hair was not clearly associated with better hair preservation in most chemotherapy types. This result confirms the need for analyzing chemotherapy types separately. Patients on D, FEC, P and PC did not seem to benefit from the colder scalp skin temperatures achieved by wetting the hair. It appears as if patients i) already have scalp skin temperatures low enough during regular (dry) scalp cooling, ii) experience high scalp skin temperatures but wetting hair did not reduce them enough, or iii) other unknown factors are responsible for the absence of statistically significant differences between wet and dry hair in patients on D, FEC, P and PC. Other studies have already indicated temperature plateaus below which further cooling did not result in a higher reduction of scalp skin perfusion (17) or in vitro cytotoxicity (21). These findings suggest the existence of a critical scalp cooling temperature for optimal prevention of CIA, and cooling below that temperature will not prevent CIA more effectively. This means that temperature measurements are needed to obtain the optimal scalp skin temperature for each patient during the scalp cooling procedure.

It is important to note that, although we had a large patient sample size, the power of this study might have been insufficient to detect significant differences between groups, potentially because of dilution of the effect due to the choice of 3:1 ratio for wetting hair.

Currently, there is no explanation why patients on FECD regimens benefit from wetting hair, while results for FEC and D separately were insignificant. As an attempt to explain this finding, we compared hair preservation rates after three cycles of FEC in either a FECD regimen (so prior to the start of the D cycles) and in a FEC regimen (so prior to the start of the remaining FEC cycles). This was enabled because hair preservation was evaluated following each scalp cooling session. As in anthracycline combination therapies most hair loss occurs up to the fourth cycle (31), hair preservation rates were expected to be comparable following three FEC cycles in both groups (i.e. FECD and FEC). However, the additional analyses showed that the differences in hair preservation were already present after the third FEC cycle. Yet, up until that point, both groups had received the same chemotherapy type and dose. We observed already a slightly better overall result in the FECD group after three cycles of FEC (48% vs. 45% in the FEC group). At that point in time, the difference between wet hair and dry hair was prevalent for FECD (52% wet and 43% dry) but not for FEC (47% wet and 44% dry). For FECD, the results thereafter hardly decreased until the last cycle (50% wet and 39% dry), but did for FEC (37% wet and 33% dry). This proves higher toxicity for

hair root cells by additional FEC cycles than for sequential D. This result cannot be explained by the number of patients in both groups and thereby the power of the analyses, as the standard errors were comparable. In addition, for both groups, overall results as well as results compared between wet or dry hair fluctuated per hospital. We therefore conclude that this observation is caused by chance.

Tolerance differed significantly between groups. Evidently, wetting hair was more discomforting. Overall intolerance rates, however, were rather low and comparable to those found in other studies (20, 32-37). The use of (preventive) analgesics may affect how burdensome scalp cooling is to patients as it attenuates side-effects, especially severe headaches. In the Netherlands, use of analgesics during scalp cooling is relatively uncommon. In another Dutch study, only 14% of the patients used paracetamol at some time during their scalp cooling sessions (20). The influence of premedication to prevent side-effects may therefore be negligible in this study, but should be considered in future research. In order to prevent discontinuation due to intolerance, especially in patients that wet their hair, scalp cooling should be made as comfortable as possible e.g. by providing blankets or towels in the patients' neck, applying water or conditioner strictly to the hair roots instead of the lengths and by offering analgesics for side effects.

Regarding SOPs, the current recommended pre-infusion cooling time is 30 minutes. We at least know that not wetting the hair is as effective to reach the plateau phase of the scalp skin temperature. This is demonstrated in volunteers with dry hair (23) and patients with dry hair (20).

We were able to perform this study due to the availability of longitudinal data and uniquely large patient numbers from the DSCR. Findings from this study contribute to the limited existing evidence on the effects of wetting hair prior to scalp cooling. However, limitations of this study should be considered. Our main limitations are related to the is the study design. The first of which, is the observational study design. Data analyzed in this study was from the DSCR which collected observational data. Bias could have been introduced from variables that have not been collected, e.g. comorbidities or co-medication potentially influencing hair loss. One of the sources of bias could have been the use of head cover use as an outcome measure. Although head cover use has been used as an outcome in scalp cooling research before (20, 27, 38, 39), it is subject to bias. Especially males are less likely to wear head covers despite unsuccessful results from scalp cooling (27), considering baldness in males is generally more accepted by society than in women. The number of men participating in this study, however, was relatively low

and associations were corrected for gender if necessary. A more objective way to measure hair preservation is by the use of the cross-section trichometer (31, 40). Since this is more time-consuming and does not reflect the patients' satisfaction with the amount of hair retained, it is mainly used for research purposes and rarely used in daily practice (31). Therefore, the patients' opinion should still be considered the most important outcome measure in clinical practice (27). In a related limitation, our results may be less generalizable to men given the overrepresentation of women participating. This is primarily because the main malignancy in the DSCR population was breast cancer; something seen in the large majority of international studies as well (13). Besides, this study population consisted of mainly European patients with a high hair mass. Thus, results may be less representative for other populations.

This study did not consider the use of conditioner to wet the hair. In the Netherlands, using conditioner is an uncommon method to wet hair as it is more expensive, discomforting to patients given the greasy residue and difficult for the healthcare professionals to keep track of inventory. Nevertheless, using conditioner rather than water may have some beneficial effects on scalp cooling. According to clinical observations, conditioner may keep up thermal conduction throughout the entire scalp cooling session as it, unlike to water, does not solidify during the procedure. Conditioner might therefore achieve a more constant temperature reduction than water. Besides, patients with afro-structured hair types reported that water expanded their hair thus affecting proper connection to the scalp cooling cap (41). For this patient group, conditioner may be a more suitable option, especially because it is advised to use fatty products like hair grease (42). More research is required to determine the effect of conditioner in scalp cooling.

Conclusion

In an observational cohort of patient groups with mainly a European hair type and a high hair mass, no convincing evidence was found whether wetting hair before scalp cooling contributes to better prevention of CIA. It was however clear that tolerance was significantly worse when hair was wetted. Efforts should be made to make scalp cooling as comfortable as possible. As tolerance might affect compliance to the scalp cooling procedure, we believe that this is an important aspect for healthcare professionals to take into account in their delivery of care. While we cannot make conclusive statements based on our results, we would like to encourage healthcare professionals to make decisions on wetting hair based on their professional perspective and in consultation with the patient. Given the findings from this study, the type of chemotherapy should also be a factor in this decision.

However, additional evidence, preferably from a randomized controlled trial, is required to determine in which specific conditions wetting hair should be considered and to further unravel the mechanisms behind scalp cooling. These findings provide an opportunity to optimize scalp cooling SOPs towards a more patient-tailored approach.

Declarations

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No funding, grants or other support was received to conduct this study.

Conflicts of interest

The authors declare no conflicts of interest relevant to the content of this manuscript.

Availability of data and material

Not applicable.

Code availability (software application or custom code)

Not applicable.

Authors' contributions

All authors contributed to the study design and execution. Van den Hurk, C. collected the data in the DSCR. Heibloem, R. analyzed data and wrote the manuscript. Komen, M., Ilozumba, O., and van den Hurk, C. critically revised the manuscript. All authors read and approved the final version of the manuscript.

Additional declarations

Not applicable.

Consent to participate

Depending on the year of inclusion, all patients gave either verbal or digital consent to participate in this study.

Consent for publication

All patients gave verbal or digital consent to have their data used for publication purposes.

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