

Introduction

Hair loss is a common side-effect of chemotherapy (1). Scalp cooling is used to prevent chemotherapy-induced alopecia. Studies show that the scalp skin is preferably cooled to 19°C, but this temperature is not achieved in every patient, which probably contributes to suboptimal hair preservation (2). Today, there is no reliable method to measure scalp skin temperature during scalp cooling, which calls for personalized settings to improve cooling efficacy.

Methodology

Temperature sensors were developed with a 3D printed cover. Using EEG electrode paste, 4 sensors were adhered to the scalp skin of 8 healthy subjects (figure 1). Each subject underwent 3 30-minute measuring sessions, during which the cooling liquid was set at -4°C. The final scalp skin temperature (at t=30 minutes) was compared for each individual across the 3 measurement sessions. Based on these data and a previously developed heat transfer model, an algorithm was created to predict at t=10 minutes the final scalp skin temperature at t=30 minutes. The predicted temperature was compared to the actual measured temperature after t=30 minutes. In a 4th session cooling liquid temperatures were decreased from 2, 0, -2, -4 to -6°C.

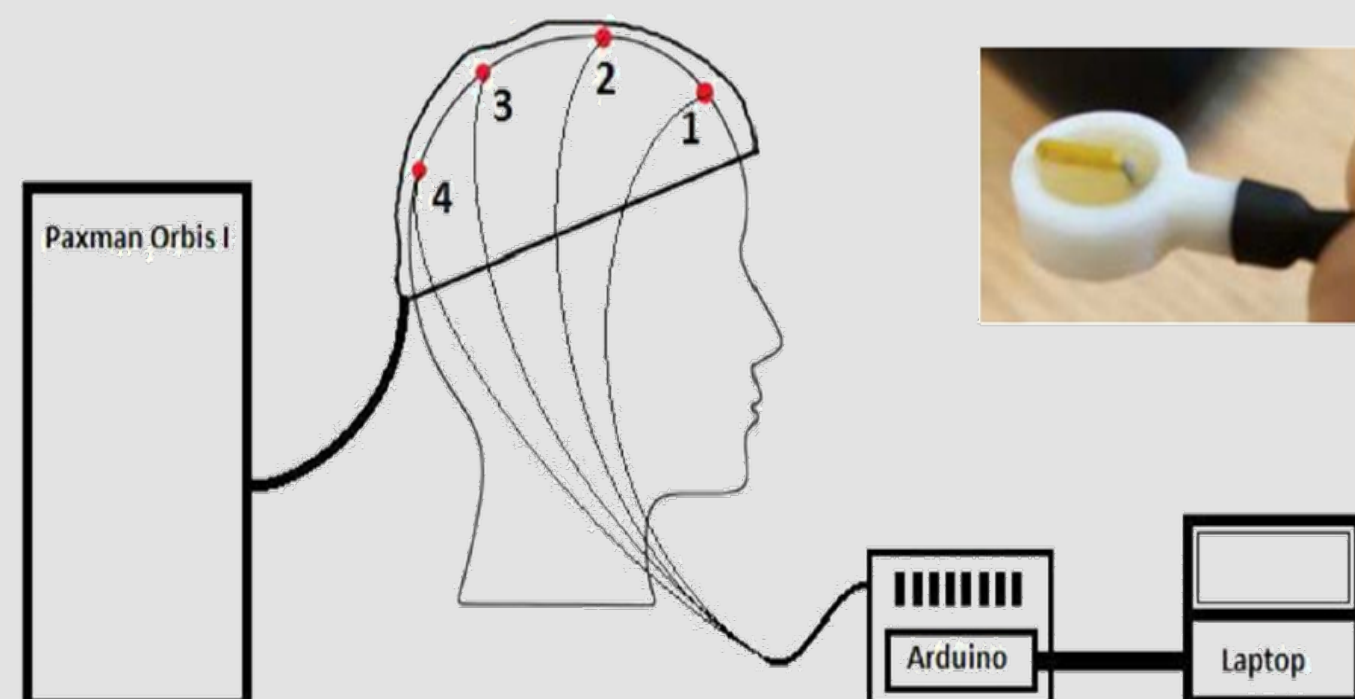


Figure 1: Schematic display of measurement set-up and photo of the epoxy resin encased NTC sensor.

Results

A 8° deviation in scalp skin temperature was observed when standard temperature settings were used. Lowering the cooling liquid in 2°C increments resulted in a decrease in scalp skin temperature by about 1°C. A typical course of the scalp skin temperature in one subject at different cooling liquid temperatures is shown in figure 3. The four sensors display a moderate deviation. When the mean temperature of the four sensors is used in the algorithm, at t=10 minutes the mean final temperature after t=30 minutes of cooling can be predicted with an accuracy of 1°C (+/- 0.7°C).

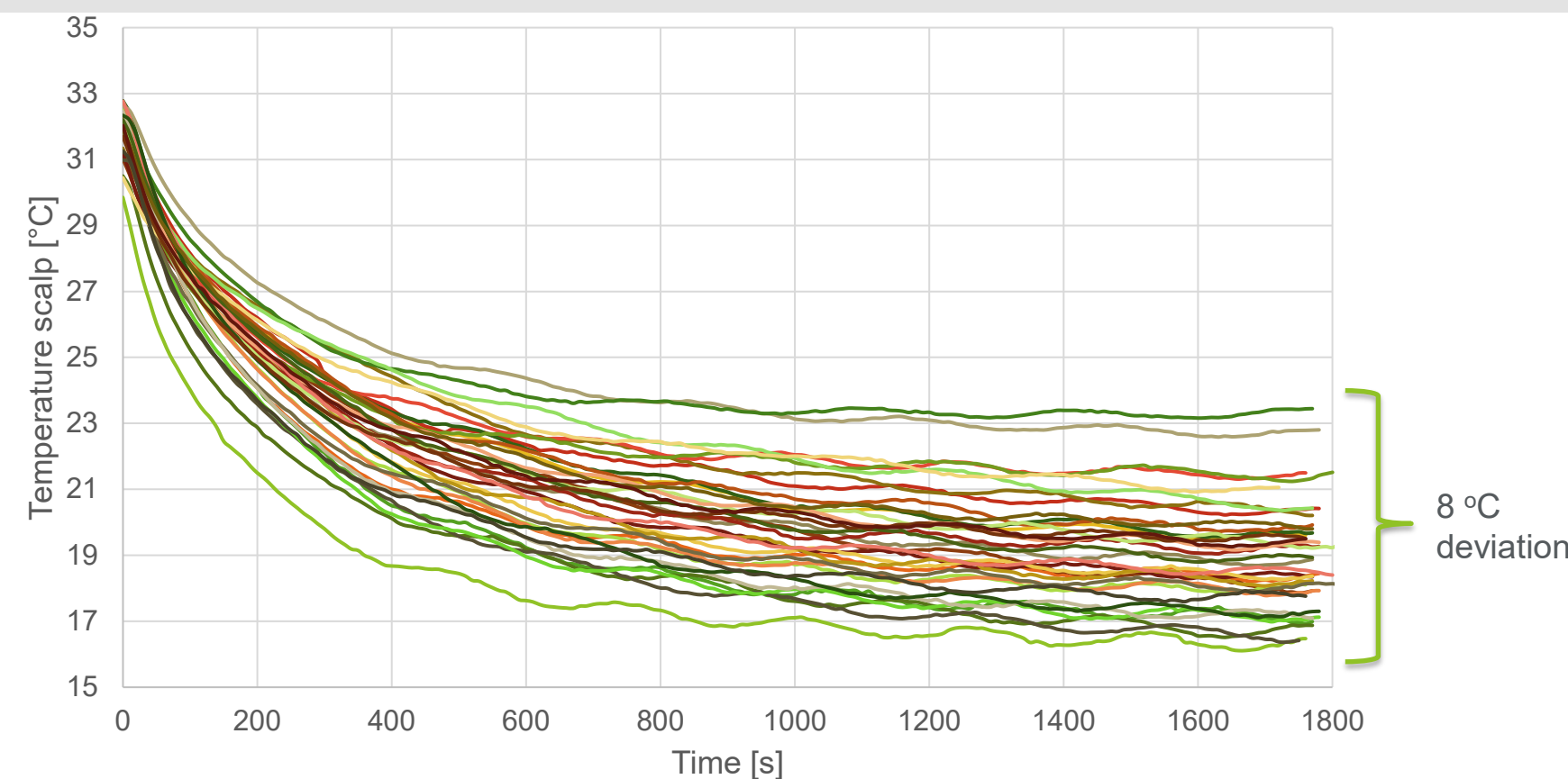


Figure 2: Scalp skin temperatures over time in healthy volunteers with standard temperature settings

“Can we prevent the deviation in scalp skin temperature by personalising scalp cooling?”

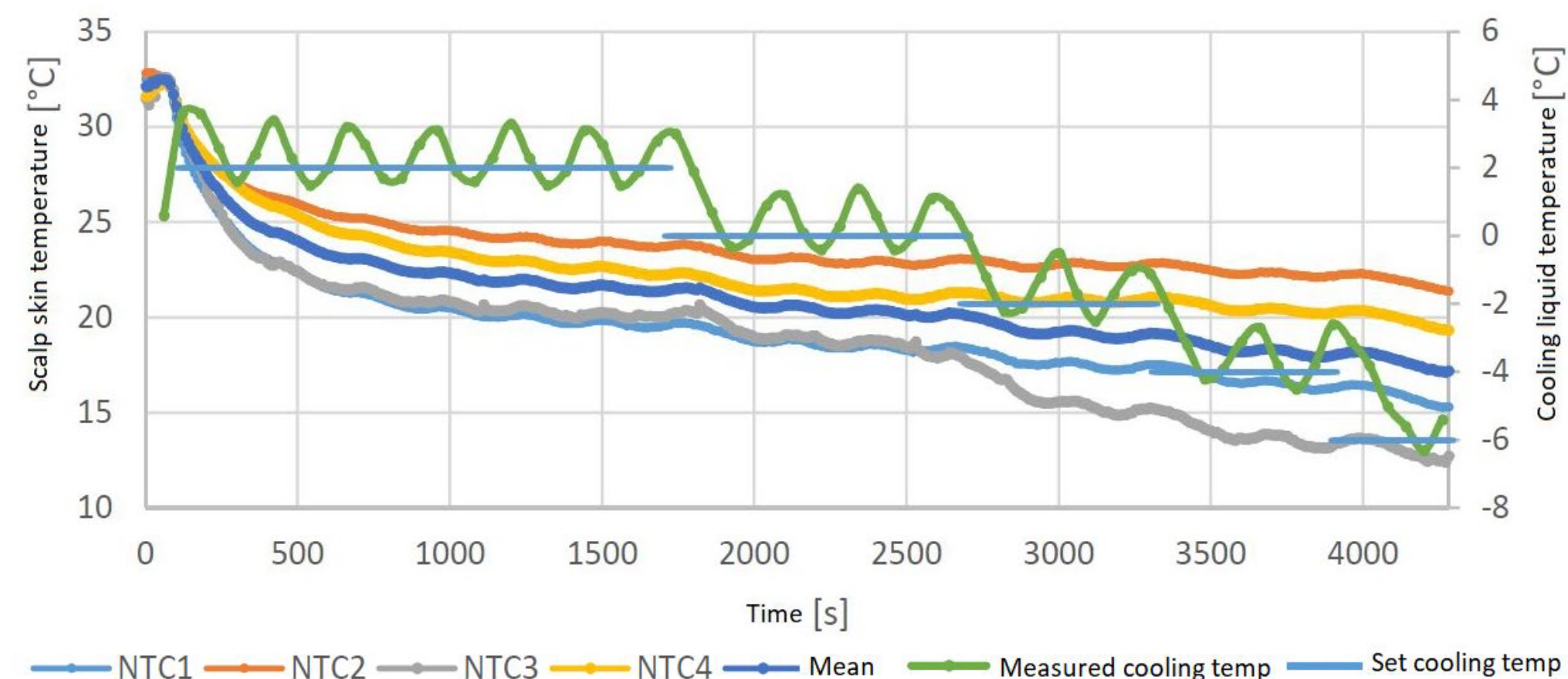


Figure 3: Scalp skin temperature in one subject (NTC 1-4) and the temperature of the cooling liquid plotted in time.

Conclusion

Based on multiple measurements in 8 subjects, the final scalp skin temperature after t=30 minutes can be predicted very accurately after t=10 minutes of scalp cooling. Scalp skin temperature reduction is possible by reducing the cooling liquid temperature. This enables personalized temperature setting with the expectation of further improving scalp cooling results.

Implications

This research takes a step towards further improving the results of scalp cooling results by using temperature sensors that are in direct contact with the scalp skin. The procedure is slightly more labour-intensive than regular scalp cooling care. Clinical relevance will need to be demonstrated before it will be applied in daily clinical practice. This pilot in which a prediction model was developed can be used to further investigate this procedure in a clinical setting.

Health care professionals play an important role in providing supportive care for oncology patients. This this consecutive series of studies will provide them insights into new scalp cooling techniques.

Contact: c.vandenhurk@iknl.nl

References

1. Lacouture ME, Sibaud V, Gerber PA, van den Hurk C, Fernández-Peñas P, Santini D, et al. Prevention and management of dermatological toxicities related to anticancer agents: ESMO Clinical Practice Guidelines☆. *Annals of Oncology*. 2021;32(2):157-70.
2. Komen MMC, Smorenburg CH, Nortier JWR, van der Ploeg T, van den Hurk CJG, van der Hoeven JJM. Results of scalp cooling during anthracycline containing chemotherapy depend on scalp skin temperature. *The Breast*. 2016;30:105-10.