

# Protection against Thermal Stress in Humans: Application of „Cooling Wear“ under Heated Conditions in Burn Centres

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## Background

Many professional groups have to work in places with high temperatures; this includes, for example, doctors and nursing staff working at burn centres. Increased ambient temperature during the care of severely burned patients in the operating theatre and intensive care unit is used to mitigate the loss of thermoregulation, prevent hypothermia, and minimize the impact of hypermetabolism. However, experimental evidence indicates, that even relatively mild thermal stress may affect human performance. Novel cooling strategies have been invented for reducing thermal stress in people, who are occupationally exposed to high temperatures, and have already been tested in several areas such as the military field. Especially burn medicine and their patients could as well profit from simple prevention strategies against thermal stress. Therefore the present study investigated the effects of cooling wear on the surgeons' performance under high ambient temperatures.

## Material and Methods

Effects of cooling wear on concentration and performance of surgeons were investigated in 6 subjects during a simulated burn surgery. Subjects were divided into two groups, one group wearing scrubs and cooling wear and one control group with scrubs exclusively. Directly before the exposure to high ambient temperatures, subjects of both groups underwent standardized tests for concentration, well-being and measurements of physiological parameters. By the portable thermography camera FLIR ONE Pro, surface temperature was measured at several timepoints to detect cooling effects and overheating. After a simulated burn surgery of 1 hour, subjects underwent the same analysing procedure again before switching groups.

## Results

Results proved that even relatively mild thermal stress affects performance whereby complex actions, that require high concentration, are primarily affected. Initial values of both groups showed approximately homogenous values. After heat exposure, however, subjects who received cooling wear showed higher results in tests for concentration. Furthermore, the comparison of physical parameters such as heart rate indicates the ability of cooling wear to reduce thermal stress and its' negative effects on the human organism.

## Disclosure

No author states a conflict of interest.  
This study was approved by the Ethics  
Committee at Medical university of Graz,  
Austria (EK:31-486 ex 18/19)

## Conclusion

Decrements in vigilance, performance and endurance are well documented effects of thermal stress. As an opportunity to withstand thermal stress and therefore improve medical care, cooling wear showed good results in many aspects. Based on these promising results cooling strategies may be used as an important tool in medical sectors in the future. Burn medicine may particularly profit from further development and rigorous investigation of cooling strategies.

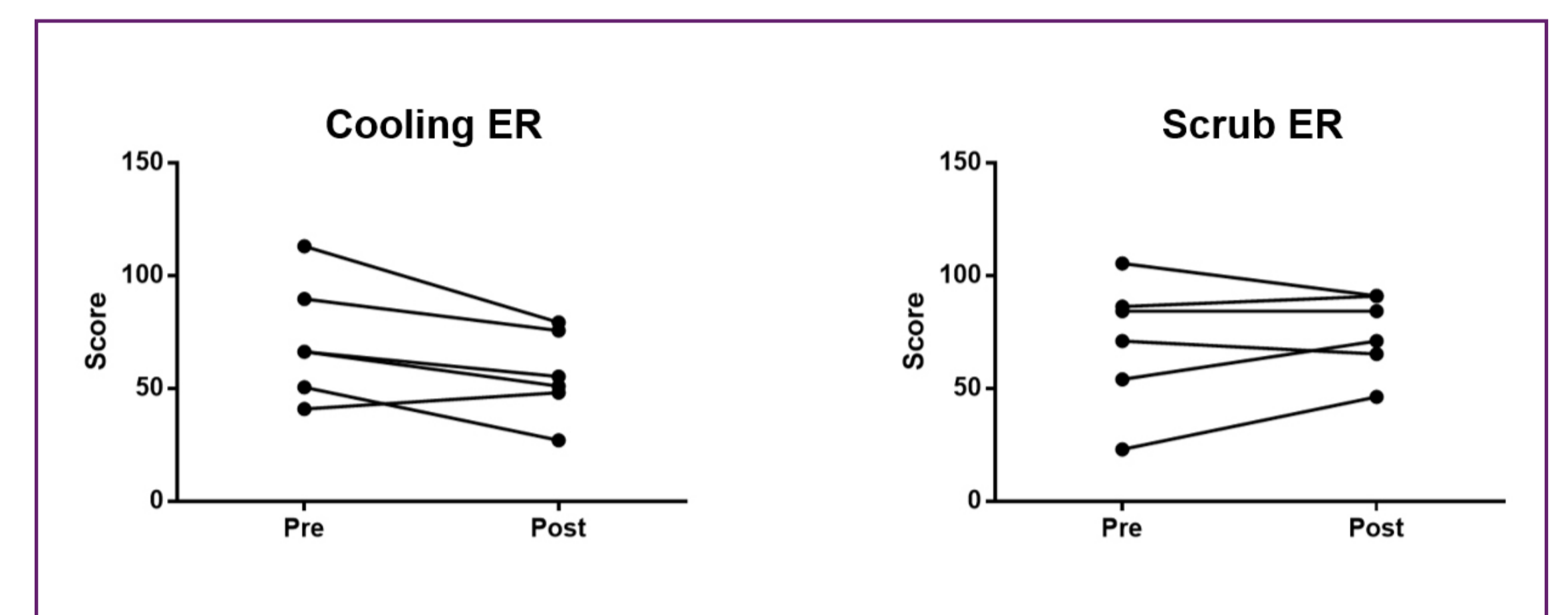


Figure 2: Error Rate (ER) pre and post thermal stress. After heat exposure, subjects with cooling wear made significantly less mistakes in concentration tests than the other group and performed even better than before. ( $p=0,0433$ )

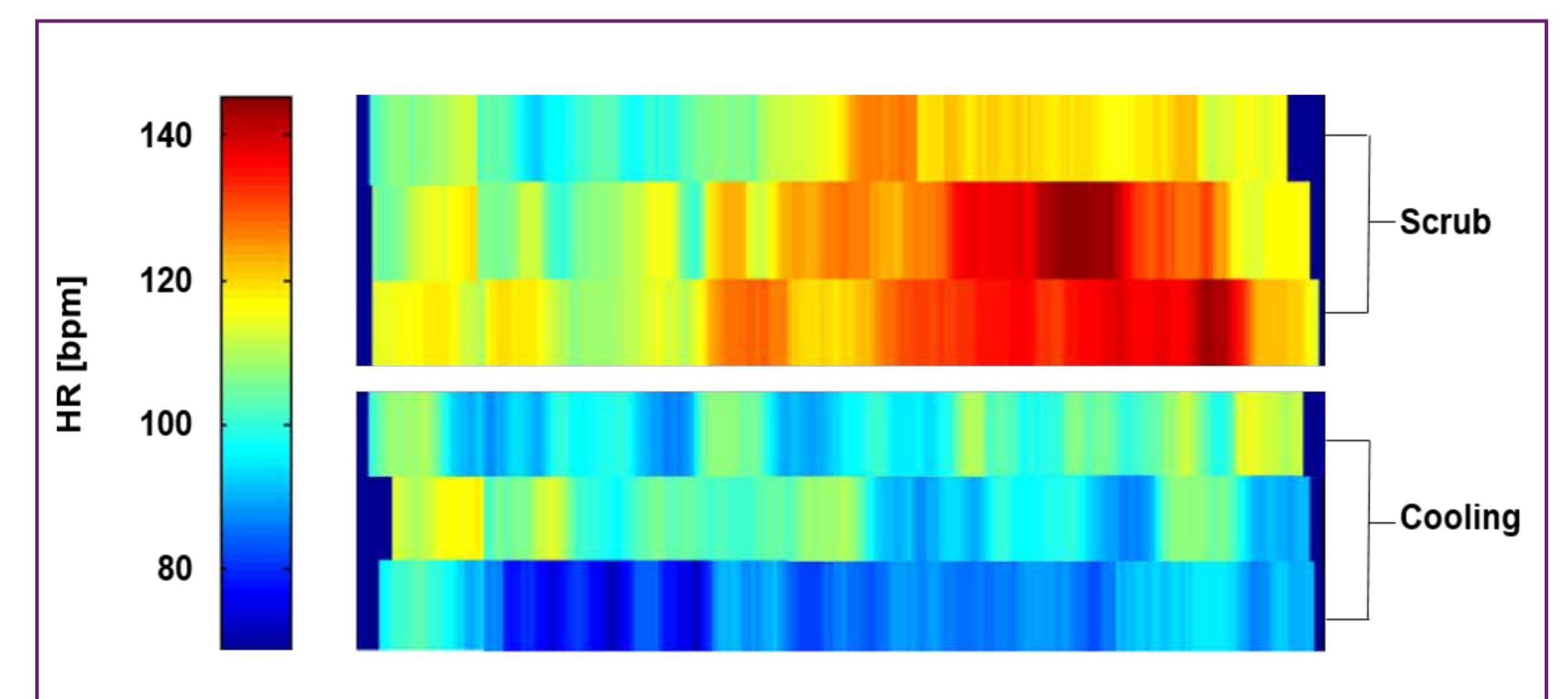


Figure 3: Heart rate [bpm] during 1 hour of heat exposure. Subjects with cooling wear showed lower and more steady heart rates than the control group. Without cooling wear, periods of very high heart rates as a sign of physical stress due to high temperatures could be observed.

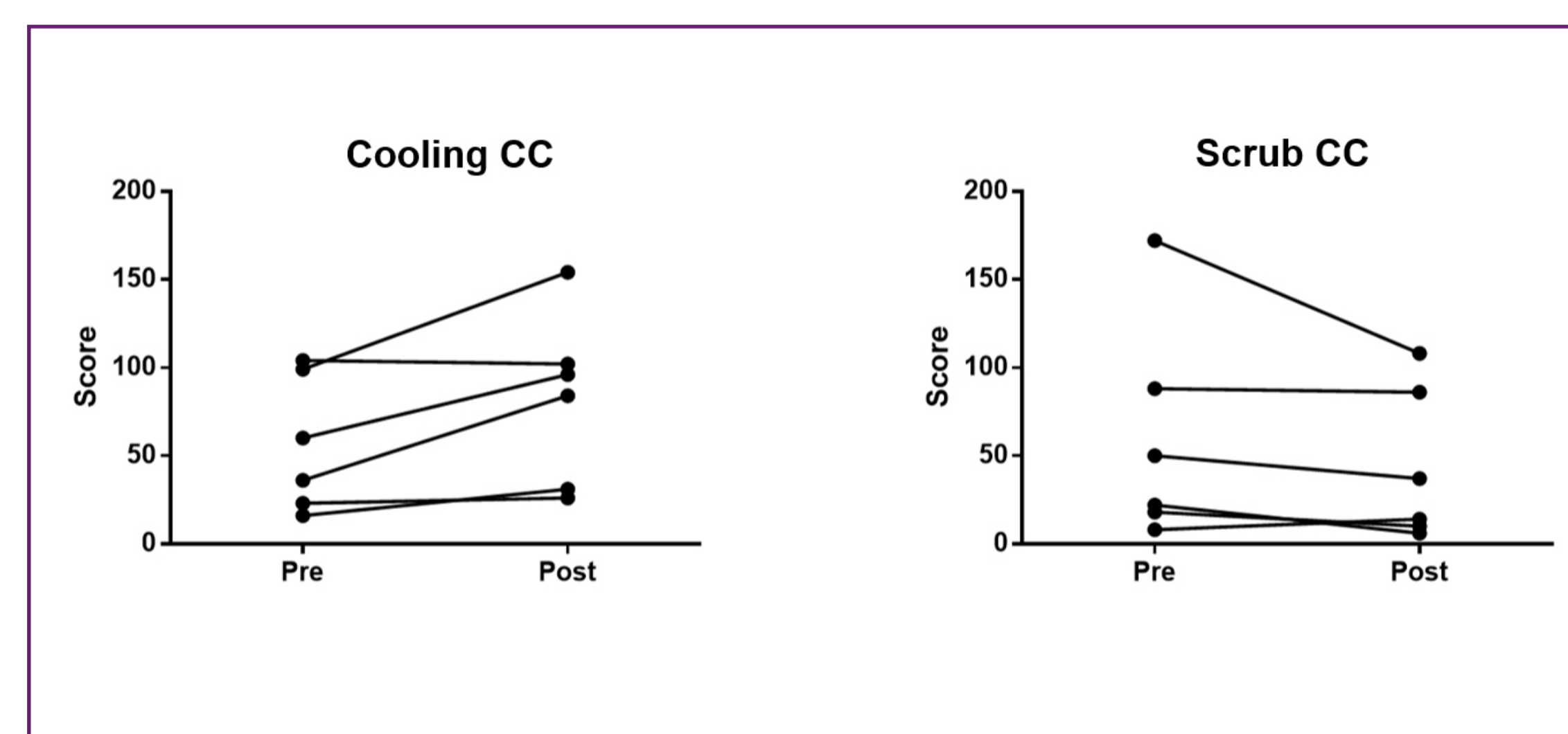


Figure 1: Concentration Capacity (CC) pre and post thermal stress. A visible difference and even increase of the concentration capacity is shown within the cooling group ( $p=0,0456$ ). In contrast, subjects without cooling wear showed a decrease in concentration capacity due to heat exposure.

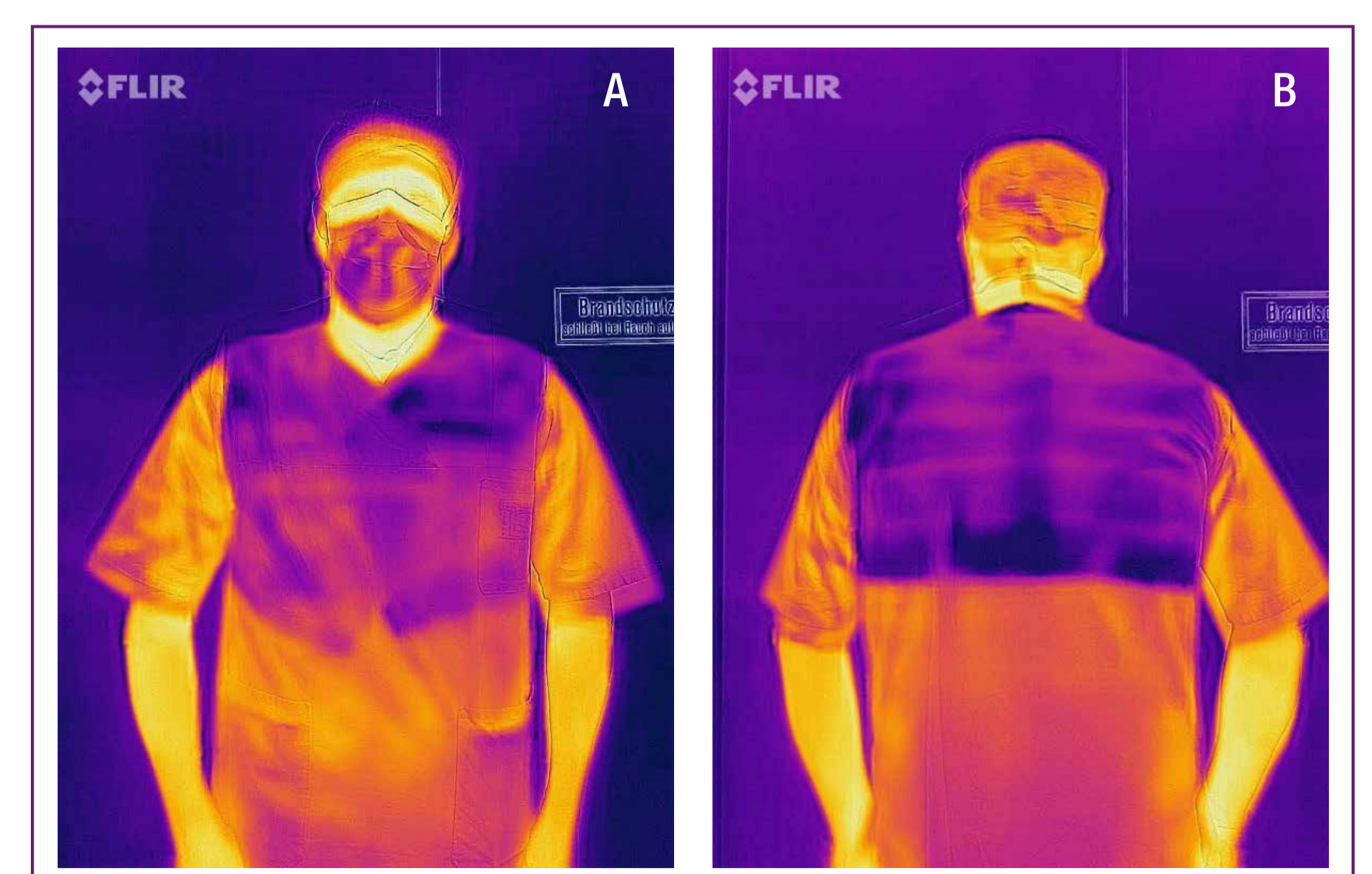


Figure 4: Thermal imaging via FLIR ONE Pro. A visible cooling effect is still detectable after 1 hour of heat exposure. By application of cooling wear, a reduction of the maximum surface temperature and therefore more endurable conditions can be achieved. A: Thermal imaging front. B: Thermal imaging back