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HEAT LOSS FROM THE HEAD IN THE COLD: NEW DATA CONFIRM MODEL

Erik J.G. van de Linde

Institute for Perception TNO, The Netherlands

Address for reprints:
P.O. Box *23*
3769 ZG SOESTERBERG, The Netherlands

At the 2nd International Conference on Environmental Ergonomics a simple model was presented to calculate heat loss from the head in the cold:

$$\dot{Q}_{head} = \frac{T_{core} - T_{ambient}}{\frac{1}{h_c + h_r} + 0.045} \quad (W/m^2)$$

with: $\dot{Q}_{head}$ = heat loss from the head (W/m^2)
T_{core} = head core temperature (°C)
$T_{ambient}$ = air temperature of the ambient (°C)
$h_c + h_r$ = sum of convective and radiative heat transfer coefficients $(W/m^2 °C)$
0.045 = mean skin insulation value $(m^2 °C/W)$

Since the variations in T_{core} are small compared to the difference between T_{core} and $T_{ambient}$, the equation can be simplified to Contain only physical parameters. The underlying assumption is that skin insulation, or more specific skin perfusion, is constant.
An experiment was conducted to validate this assumption and thereby the model. Six male subjects dressed in arctic gear exercised on a bicycle ergometer at four different workloads (0, 50, 100 and 150 Watt), two ambient temperatures (-15 and 0°C) and two wind speeds (1.4 and **4** m/s), while the head was either unprotected or fully covered with a balaclava. $\dot{Q}_{head}$ was measured with heat flux discs at seven locations. Thermograms of the face were made at stabilized, thermoneutral conditions.
Wind, temperature and protection had significant influences on $\dot{Q}_{head}$, the magnitude of which was in conformity with the model. Mean skin insulation did not change with the experimental conditions. There was no significant influence of workload. Differences between subjects were large and reflected the differences thermographically measured at thermoneutral conditions. For the face, all subjects showed the largest heat flux at the forehead and the smallest at the cheek. It is concluded that the model is valid for large groups, but that individual variation is too large to justify application to single persons. For this, additional input is required. Thermograms could serve for this purpose.